COMPLETE
MULTIPLE CHOICE

NEETS ASSIGNMENTS

Prepared by:

CyberReview – Intelligence Group

Answered by:

M.I.T. (Mapua) – Group

Executive editor:

Harlem A. Agnote
(BSECE, FEU-EAC)

ASSIGNMENT 1

Textbook assignment: Chapter 1, .Turning to Electricity,. pages 1-1 through 1-65.

1-1. Matter can be found in which of the following forms?

1. Solid
2. Liquid
3. Gaseous
4. **Each of the above**

1-2. A substance that CANNOT be reduced to a simpler substance by chemical means is called a/an

1. **element**
2. mixture
3. compound
4. solution

1-3. A molecule is the smallest possible particle that retains the characteristic of which of the following substances?

1. An element
2. A mixture
3. **A compound**
4. A solution

1-4. An atom is the smallest possible particle that retains the characteristic of which of the following substances?

1. **An element**
2. A mixture
3. A compound
4. A solution

1-5. What subatomic particle has a negative charge and a small mass?

1. Proton
2. **Electron**
3. Positron
4. Neutron

1-6. What subatomic particle has a positive charge and a large mass?

1. **Proton**
2. Electron
3. Positron
4. Neutron

1-7. What subatomic particle has no charge?

1. Proton
2. Electron
3. Positron
4. **Neutron**

1-8. When light is represented as a tiny packet of energy, what are these packets of energy called?

1. Angstroms
2. **Photons**
3. Wavelengths
4. Frequencies

1-9. If light energy collides with an orbiting electron, what happens to the electron?

1. The electron will move around the same orbit faster
2. **The electron will jump to an orbit further from the nucleus**
3. The electron will jump to an orbit closer to the nucleus
4. The electron will merge with the nucleus

1-10. After the action described in question 1-9 occurs, the electron will return to the condition it had before being acted upon by the light. When the electron returns to this condition, which of the following actions

Prepared by: Harlem A. Agnote

occurs?

1. The nucleus becomes lighter
2. The atom becomes an ion
3. **Light energy is emitted**
4. The valence of the atom changes

1-11. The number of electrons in the outermost shell of an atom determines which of the following characteristics of the atom?

1. **Valence**
2. Atomic weight
3. Atomic number
4. Number of shells

1-12. When an atom gains or loses an electron, which of the following terms applies?

1. Unbalanced
2. Lightened
3. Neutral
4. **Ionized**

1-13. What is the main difference between conductors, semiconductors, and insulators?

1. The temperature differences
2. The physical state of their mass
3. **The number of free electrons**
4. The designations of the outer shells

1-14. A substance with an excess of electrons is considered to be in what electrical state?

1. Neutral
2. Positive
3. **Negative**
4. Discharged

1-15. Which of following actions describes the easiest way to accumulate a static electric charge?

1. Friction between two conductors
2. **Friction between two insulators**
3. Pressure between two conductors
4. Pressure between two insulators

1-16. An atom that contains 6 protons and 5 electrons has what electrical charge?

1. **Positive**
2. Negative
3. Neutral
4. Intermediate

1-17. How do "like" and "unlike" charges react to
one another?

1. Unlike charges repel each other, like charges repel each other
2. Unlike charges attract each other, like charges attract each other
3. Unlike charges repel each other, like charges attract each other
4. **Unlike charges attract each other, like charges repel each other**

1-18. What is/are the term(s) applied to the space
between and around charged bodies in which their influence is felt?

1. **Electric field of force**
2. Electrostatic field
3. Dielectric field
4. Each of the above

1-19. Electrostatic lines of force are drawn in which of the following manners?

1. Entering negative charge, entering positive charge
2. **Entering negative charge, leaving positive charge**
3. Leaving negative charge, leaving positive charge
4. Leaving negative charge, entering positive charge

1-20. Which of the following devices use magnetism?

Prepared by: Harlem A. Agnote

1. Batteries
2. Light bulbs
3. **High-fidelity speakers**
4. Each of the above

1-21. Magnetic materials have which of the following qualities?

1. They are attracted by magnets
2. They can be magnetized
3. **Both 1 and 2 above**
4. They are electrical insulators

1-22. Ferromagnetic materials have which of the
following qualities?

1. They are all alloys
2. They all contain nickel
3. They make very weak magnets
4. **They are relatively easy to magnetize**

1-23. A material with low reluctance and high permeability such as iron or soft steel is used to make what type of magnet?

1. **Temporary**
2. Permanent
3. Residual
4. Natural

1-24. The ability of a material to retain magnetism is called

1. permeability
2. **retentivity**
3. reluctance
4. ionization

1-25. The law of magnetic poles states which of the following relationships?

1. Like poles attract, unlike poles attract
2. Like poles attract, unlike poles repel
3. Like poles repel, unlike poles repel
4. **Like poles repel, unlike poles attract**

1-26. The north indicating pole of a compass needle is attracted to which of the following poles of the earth?

1. **The geographic north pole**
2. The magnetic north pole
3. The geographic south pole
4. The magnetic south pole

1-27. Weber's theory of magnetism assumes that
magnetic material is composed of

1. **tiny molecular magnets**
2. domains of magnetic influence
3. large blocks of material acting as magnets
4. atoms with electrons spinning different directions

1-28. According to the domain theory, if an atom
with 26 electrons has 20 electrons spinning counterclock-wise, the atom is considered to be

1. charged
2. insulated
3. neutralized
4. **magnetized**

1-29. If a glass plate is placed over a magnet and
iron filings are sprinkled over the glass, a pattern will be visible. What does this pattern indicate?

1. **The magnetic field**
2. The electrostatic field
3. The piezoelectric effect
4. The chemical reaction of the magnet and the filings

1-30. An imaginary line used to illustrate a magnetic effect is known as a/an

1. magnetic pole
2. force field pole
3. **magnetic line of force**

4. electrostatic line of force

1-31. Which of the following is NOT a property of magnetic lines of force?

1. They form closed loops around the magnet
2. They leave the magnetic material at right angles to the surface
3. They cross each other at right angles
4. They leave the north pole and enter the south pole of the magnet

1-32. A magnetic shield or screen used to protect a delicate instrument should be made of which of the following materials?

1. Plastic
2. Copper
3. Soft iron
4. Aluminum

1-33. Bar magnets should be stored in which of the following manners?

1. Separately
2. In pairs at 90 degree angles
3. In pairs with north poles together
4. In pairs with a north pole and a south pole together

1-34. What is the term applied to the ability to do work?

1. Power
2. Energy
3. Voltage
4. Current

1-35. An object that is in motion has what type of energy?

1. Kinetic
2. Magnetic
3. Newtonian
4. Potential

1-36. A book sitting on a shelf has what kind of energy?

1. Kinetic
2. Potential
3. Newtonian
4. Magnetic

1-37. Which of the following term(s) apply(ies) to the difference of potential between two bodies?

1. Voltage
2. Electromotive force
3. Both 1 and 2 above
4. Current

1-38. Which of the following terms is equal to "2.1 kV?"

1. 210 V
2. 2100 V
3. 21,000 V
4. $2.1 \times 10_6$ V

1-39. 250µV is equal to which of the following terms?

1. .25 mV
2. .00025 V
3. $250 \times 10_{-6}$ V
4. All of the above

1-40. What is the general term that describes a device which supplies a voltage?

1. A voltage source
2. A voltage supply
3. A voltage generator
4. A voltage producer

1-41. In addition to friction, magnetism, and chemical action, which of the following methods can be used to produce a voltage?

1. Pressure
2. Heat
3. Light
4. Each of the above

IN ANSWERING QUESTIONS 1-42 THROUGH 1-46, MATCH THE VOLTAGE PRODUCING METHOD LISTED IN COLUMN B TO THE DEVICE LISTED IN COLUMN A.

COLUMN A

COLUMN B

1-42. Radio receiver's oscillator

1. Heat

1-43. Thermocouple 2. Pressure

1-44. Automobile battery 3. Magnetism

1-45. Automobile generator 4. Chemical action

1-46. Flashlight cell

1-47. Current in an electric circuit is caused by which of the following actions?

1. Electrons moving from negative to positive

2. Electrons moving from positive to negative
3. Protons moving from negative to positive
4. Protons moving from positive to negative

1-48. When directed drift takes place, at what speed does the effect take place?

1. 100,000 miles per hour
2. 186,000 miles per second
3. 300,000 meters per hour
4. 500,000 meters per second

1-49. If the voltage in a circuit increases, what happens to the current?

1. Current increases
2. Current decreases
3. Current remains the same
4. Current fluctuates rapidly

1-50. Which of the following values is equal to 100mA?

1. 1.0 ampere
2. 10.0 amperes
3. 0.10 ampere
4. 0.01 ampere

1-51. What symbol is used to represent the ohm?

1. A
2. O
3. µ
4. !

1-52. If low weight is the major factor, which of the following materials should be used as a conductor?

1. Aluminum
2. Copper
3. Silver
4. Gold

1-53. What material is MOST widely used as a conductor in electrical equipment?

1. Aluminum
2. Copper
3. Silver
4. Gold

1-54. Resistance of a conductor will increase with which of the following changes to the cross-sectional area and length of the conductor?

1. Cross-sectional area is increased, length is increased
2. Cross-sectional area is increased, length is decreased
3. Cross-sectional area is decreased, length is increased
4. Cross-sectional area is decreased, length is decreased

Prepared by: Harlem A. Agnote

1-55. A material whose resistance decreases as the temperature increases has what temperature coefficient?

1. Positive
2. **Negative**
3. Zero
4. Neutral

1-56. A material whose resistance remains constant as the temperature increases has what temperature coefficient?

1. Positive
2. Negative
3. **Zero**
4. Neutral

1-57. Which of the following units is NOT a unit of conductance?

1. Siemens
2. S
3. G
4. **Ohm**

1-58. Resistance bears which, if any, of the following relationships to conductance?

1. A direct relationship
2. **A reciprocal relationship**
3. An inverse square relationship
4. None

THIS SPACE LEFT BLANK INTENTIONALLY.

1-59. Which of the following schematic symbols is used to represent a resistor?

1-60. How is the ability of a resistor to dissipate heat indicated?

1. **By the wattage rating**
2. By the voltage rating
3. By the resistance rating
4. By the tolerance

1-61. Carbon resistors have which of the following disadvantages?

1. A high cost factor
2. An extremely large physical size
3. **The resistance value changes with age**
4. A limited range of resistance values

1-62. Which of the following types of resistors will overcome the disadvantages of a carbon resistor?

1. Rheostat
2. Potentiometer
3. Molded composition
4. **Wirewound resistor**

1-63. What is the total number of connections on
(a) a rheostat and (b) a potentiometer?

1. (a) Two (b) two
2. **(a) Two (b) three**
3. (a) Three (b) two
4. (a) Three (b) three

1-64. Which, if any, of the following types of variable resistors is used to control a large amount of current?

1. **Rheostat**
2. Potentiometer
3. Wirewound potentiometer
4. None of the above

1-65. A carbon resistor is color-coded orange, orange, orange. What is the resistance value of this resistor?

1. 2.2 k!
2. 3.3 k!
3. **33.0 k!**

Prepared by: Harlem A. Agnote

4. 440.0 k!

1-66. What are the allowable limits of ohmic value in a resistor color coded blue, green, yellow, gold?

1. 682.5 k! to 617.5 k!
2. 715.0 k! to 585.0 k!
3. 7.98 M! to 7.22 M!
4. 8.36 M! to 6.84 M!

1-67. Of the following, which color of the fifth band on a resistor indicates the LEAST chance of failure?

1. Red
2. Brown
3. Yellow
4. Orange

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 1A.—Resistor with color coding.

IN ANSWERING QUESTIONS 1-68 THROUGH 1-70, REFER TO FIGURE 1A.

1-68. What is the ohmic value of the resistor?

1. 8!
2. 79!
3. 790!
4. 800!

1-69. What is the specified tolerance of the resistor?

1. 1%
2. 5%
3. 10%
4. 20%

1-70. What is the specified reliability of the resistor?

1. 1.0%
2. 0.1%
3. 0.01%
4. 0.001%

Prepared by: Harlem A. Agnote

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Batteries," pages 2-1 through 2-29.

2-1. Which of the following is the purpose of an electrical cell?
1. To change mechanical energy to electrical energy
2. To change chemical energy to electrical energy
3. To change electrical energy to mechanical energy
4. To change electrical energy to chemical energy

2-2. What are the three basic parts of a cell?
1. Electrodes, electrolyte, container
2. Electrodes, acid, water
3. Anode, cathode, ions
4. Anode, load, depolarizer

IN ANSWERING QUESTIONS 2-3 THROUGH 2-6, SELECT THE PHRASE FROM THE FOLLOWING LIST THAT DESCRIBES THE PART OF A CELL IN THE QUESTION.
A. PARTS OF A CELL
B. DESCRIPTIVE PHRASE

2-3. Electrolyte 1. negative electrode
2-4. Container 2. positive electrode
2-5. Anode 3. solution acting upon the electrode
2-6. Cathode 4. mounting for the electrode

2-7. What term is given to the process that takes place inside a cell?
1. Electromagnetic action
2. Piezoelectric action
3. Electromechanical action
4. Electrochemical action

2-8. With respect to recharging a primary or secondary cell, of the following statements, which one is correct?
1. The secondary cell can be recharged by passing current through it in the proper direction
2. The primary cell can be recharged by passing current through it in the proper direction
3. The secondary cell can only be recharged by changing the electrodes
4. The primary cell can only be recharged by changing the electrolyte

2-9. What determines the amount of current that a cell can deliver to the external circuit?
1. The internal resistance of the cell only
2. The resistance of the external load only
3. The circuit resistance and the internal resistance of the cell
4. The circuit capacitance and number of free electrons in the load

2-10. Which of the following actions will lower the internal resistance of a cell?
1. Decreasing the size of the electrodes
2. Increasing the size of the electrodes
3. Increasing the spacing between the electrodes
4. Increasing the resistance of the Electrolyte

2-11. What causes negative ions to be attracted to the cathode of a primary cell while the cell is discharging?
1. A negative charge caused by a loss of electrons
2. A negative charge caused by an excess of electrons
3. A positive charge caused by a loss of electrons
4. A positive charge caused by an excess of electrons

2-12. What causes hydrogen to be attracted to

the anode of a primary cell when the cell is discharging?
1. A negative charge caused by a loss of electrons
2. A negative charge caused by an excess of electrons
3. A positive charge caused by a loss of electrons
4. A positive charge caused by an excess of electrons

2-13. What causes the cathode to be "eaten away" in the primary cell while the cell is discharging?
1. The material of the cathode combines with the negative ions to form a new substance.
2. The material of the cathode dissolves in the electrolyte.
3. The material of the cathode leaves the negative terminal of the cell and goes through the load to the anode.
4. Bacteria in the electrolyte erodes the material in the cathode.

2-14. The primary cell is completely discharged when which of the following conditions exists?
1. The cathode is completely eaten away
2. The active ingredient in the electrolyte is used up
3. The voltage of the cell is reduced to zero
4. Each of the above

2-15. In a zinc-carbon primary cell, what is the function of the carbon electrode?
1. To generate electrons
2. To supply a return path for current
3. To speed electrolysis
4. To collect hydrogen

2-16. The lead-acid cell is an example of which of the following types of cells?
1. The dry cell
2. The voltaic cell
3. The primary cell
4. The secondary cell

2-17. In a fully charged lead-acid cell, what is the composition of the anode, cathode, and electrolyte respectively?
1. Zinc, carbon, and water
2. Carbon, lead, sulfuric acid and water
3. Lead peroxide, sponge lead, sulfuric acid, and water
4. Nickel, cadmium, potassium hydroxide, and water

2-18. Which of the following actions will recharge a secondary cell?
1. Adding more water to the electrolyte
2. Adding more active ingredient to the electrolyte
3. Connecting the negative terminal of a voltage source to the cathode of the cell and the positive terminal of the voltage source to the anode of the cell
4. Connecting the negative terminal of a voltage source to the anode of the cell and the positive terminal of the voltage source to the cathode of the cell

A. Sulfuric acid decreasing
B. Sulfuric acid increasing
C. Sponge lead decreasing
D. Sponge lead increasing
E. Lead peroxide decreasing
F. Lead peroxide increasing
G. Lead sulfate decreasing
H. Lead sulfate increasing
Figure 2A.—Lead acid chemical actions.

IN ANSWERING QUESTIONS 2-19 AND 2-20, REFER TO FIGURE 2A. SELECT THE CORRECT CHEMICAL ACTIONS WITHIN A LEAD-ACID CELL FOR THE CONDITION STATED IN EACH QUESTION.

2-19. The cell is discharging.
1. A, C, E, H
2. A, D, E, G
3. B, C, F, G
4. B, D, F, H

Prepared by: Harlem A. Agnote

2-20. The cell is charging.
1. A, C, F, H
2. B, C, F, H
3. A, D, F, G
4. B, D, F, G

2-21. When all the lead sulfate in a lead-acid cell is converted to sulfuric acid, lead peroxide, and sponge lead, what is the condition of the cell?
1. Fully charged
2. Discharged
3. Sulfated
4. Unusable

2-22. Polarization has what effects on an electrical cell?
1. Decreases internal resistance, thereby increasing the output voltage
2. Decreases internal resistance, thereby decreasing the output voltage
3. Increases internal resistance, thereby increasing the output voltage
4. Increases internal resistance, thereby decreasing the output voltage

2-23. Which of the following methods is used to control polarization in a cell?
1. Venting the cell
2. Heating the electrolyte
3. Adding mercury to the electrode material
4. Using an electrolyte that absorbs Oxygen

2-24. Which of the following is caused by local action in a cell?
1. Shelf life is reduced
2. Hydrogen is generated in large quantities
3. Impurities rise to the surface of the electrolyte
4. Mercury coating of the zinc electrode is worn away

2-25. In a dry cell, what is the consistency of the electrolyte?
1. Solid
2. Liquid
3. Paste
4. Powder

2-26. What serves as the cathode in a common type of dry cell?
1. Carbon electrode
2. Zinc container
3. Steel cover
4. Nickel terminal

2-27. How should the dry cell be stored to obtain maximum shelf life?
1. In a dark container
2. In a heated cabinet
3. In a ventilated area
4. In a refrigerated space

2-28. The blotting paper in a dry cell serves which of the following purposes?
1. Separates the paste from the zinc
2. Permits the electrolyte from the paste to filter through to the zinc slowly
3. Both 1 and 2 above
4. Keeps the electrolyte dry

2-29. Of the following characteristics, which one describes the mercury cell?
1. It is physically one of the largest cells
2. It has a very stable output voltage
3. It is designed to be rechargeable
4. It produces a large amount of current but has a short shelf life

2-30. Which of the following describes the shorting of a cell?
1. Decreasing the length of a cell
2. Connecting the anode and cathode together without a load
3. Using the cell below its full potential
4. Providing a recharge voltage that is not sufficient to recharge the cell

2-31. What is/are the advantages(s) of using a manganese-dioxide-alkaline- zinc cell over the zinc-carbon cell?

1. Better voltage stability
2. Longer storage life
3. Operates over a wide temperature range
4. All the above

2-32. What is the common name for manganesedioxide-alkaline-zinc cell?
1. Alkaline cell
2. Long-life cell
3. Moz cell
4. Manganese-dioxide cell

2-33. Which of the following factors should be considered when selecting a primary cell as a power source?
1. Power requirement
2. Type of electrolyte used
3. Container material
4. All of the above

2-34. Of the following types of cells, which one is a primary cell?
1. Nickel cadmium
2. Silver zinc
3. Lithium organic
4. Silver cadmium

2-35. Which of the following is/are the difference(s) in the construction of a NICAD cell as compared to a lead-acid cell?
1. The electrolyte used
2. The material of the anode
3. The material of the cathode
4. All of the above

2-36. What is the most common use of a silverzinc cell?
1. Flashlight batteries
2. Automobile batteries
3. Aircraft storage batteries
4. Emergency equipment batteries

2-37. In addition to the nickel-cadmium and silver-zinc cells, which of the following cells uses potassium hydroxide as the active ingredient in the electrolyte?
1. Lead-acid cell
2. Silver-cadmium
3. Lithium-inorganic cell
4. Magnesium-manganese dioxide cell

2-38. What is the minimum number of cells necessary to form a battery?
1. One
2. Two
3. Three
4. Four

Figure 2B.—Battery consisting of five cells.

IN ANSWERING QUESTIONS 2-39 AND 2-40, REFER TO FIGURE 2B. EACH CELL IS 1.5 VOLTS AND HAS A CAPACITY OF 1/8 AMPERE.

2-39. What type of connection is used to combine the cells?
1. Series
2. Parallel
3. Series-parallel

2-40. What is the (a) voltage output and (b) current capacity of the circuit?
1. (a) 1.5 volts (b) 1/8 ampere
2. (a) 1.5 volts (b) 5/8 ampere
3. (a) 7.5 volts (b) 1/8 ampere
4. (a) 7.5 volts (b) 5/8 ampere

IN ANSWERING QUESTIONS 2-41 AND 2-42, REFER TO FIGURE 2C. EACH CELL IS 1.5 VOLTS AND HAS A CAPACITY OF 1/8 AMPERE.

2-41. What type of connection is used to combine the cells?
1. Series
2. Parallel
3. Series-parallel

2-42. What is the (a) voltage output and (b) current capacity of the circuit?
1. (a) 1.5 volts (b) 1/8 ampere
2. (a) 1.5 volts (b) 5/8 ampere

3. (a) 7.5 volts (b) 1/8 ampere
4. (a) 7.5 volts (b) 5/8 ampere

2-43. Which of the following diagrams shows the proper connections for obtaining 6 volts at 1/4 ampere? (Each cell is 1.5 volts and has a capacity of 1/8 amp.)

Figure 2D.—Battery consisting of 12 cells.

IN ANSWERING QUESTIONS 2-44 AND 2-45, REFER TO FIGURE 2D. EACH CELL EQUALS 1.5 VOLTS AND HAS A CAPACITY OF 1/8 AMPERE.

2-44. What type of connection is used to combine the cells?
1. Series
2. Parallel
3. Series-parallel

2-45. What is the (a) voltage output and (b) current capacity of the circuit?
1. (a) 1.5 volts (b) 1.5 amperes
2. (a) 4.5 volts (b) 1/2 ampere
3. (a) 9 volts (b) 1/4 ampere
4. (a) 18 volts (b) 1/8 ampere

2-46. What is the first step in performing maintenance on a secondary-cell battery?
1. Check the level of the electrolyte
2. Check the technical manual for information on the specific type of battery
3. Check the terminals for cleanliness and good electrical connection
4. Check the battery case for cleanliness and evidence of damage

2-47. When a hydrometer is used to check the specific gravity of the electrolyte in a battery, to what level should the electrolyte be drawn?
1. Enough to just wet the float
2. Enough so the float will rise without entering the suction bulb
3. Enough so the top one-third of the float will rise into the suction bulb
4. Enough so the float is completely covered by the electrolyte

2-48. To flush a hydrometer, which of the following liquids should be used?
1. Sulfuric acid
2. Salt water
3. Fresh water
4. A solution of baking soda and water

2-49. If the electrolyte level in a battery is low, what should be added to the electrolyte to bring it to the proper level?
1. Tap water
2. Sulfuric acid
3. Potassium hydroxide
4. Distilled water

2-50. Which one of the following safety precautions for batteries is NOT correct?
1. Terminals should be electrically connected together before transporting a battery
2. Care should be taken to prevent the spilling of electrolyte
3. Smoking, open flames, and electrical sparks are prohibited around charging batteries
4. Protective clothing, such as rubber apron, rubber gloves, and face shield, should be worn when working on batteries

2-51. If electrolyte comes in contact with the skin, what first aid treatment should be given immediately to the affected area?
1. Cover with petroleum jelly
2. Wrap with a sterile bandage
3. Apply an antiseptic lotion
4. Flush with fresh water

2-52. A battery with a capacity of 600 ampere-hours should provide 3 amperes for a maximum of how many hours?
1. 100 hr
2. 200 hr
3. 300 hr
4. 600 hr

2-53. A battery is rated according to a 20-hour rate of discharge at 300 ampere-hours. Which of the following currents is the maximum current that will allow the battery to deliver its rated capacity?
1. 15 amperes
2. 20 amperes
3. 25 amperes
4. 30 amperes

2-54. Which of the following types of routine charges follows the nameplate data in restoring a battery to its charged condition during the ordinary cycle of operation?
1. Initial
2. Floating
3. Normal
4. Fast

THIS SPACE LEFT BLANK INTENTIONALLY.

IN ANSWERING QUESTIONS 2-55 THROUGH 2-58, MATCH THE DESCRIPTION GIVEN IN THE FOLLOWING LIST WITH THE TYPE OF BATTERY CHARGE IN THE QUESTION.
A. TYPE OF CHARGE
B. DESCRIPTION

2-55. Initial charge 1. Used in emergency Only

2-56. Equalizing Charge

2. Used periodically as part of a maintenance routine
2-57. Floating Charge

3. Used to keep a battery at full charge while the battery is idle

2-58. Fast charge

4. Used after electrolyte is added to adry-shipped battery

2-59. If violent gassing occurs during the charging of a battery, which of the following actions should be taken?
1. Increase the room ventilation
2. Decrease the room temperature
3. Increase the charging rate
4. Decrease the charging rate

2-60. If a battery is being charged at the proper rate, which, if any of the following types of gassing should occur?
1. Steady gassing
2. Intermittent gassing
3. Violent gassing
4. None

ASSIGNMENT 3

Textbook assignment: Chapter 3, .Direct Current,. pages 3-1 through 3-126.

Figure 3A.—Basic circuit.

IN ANSWERING QUESTIONS 3-1 THROUGH 3-3, REFER TO FIGURE 3A.

3-1. What parts of the circuit represent the (a) source and (b) load?

1. (a) E_S (b) S_1
2. (a) E_S (b) R_1
3. (a) S_1 (b) R_1
4. (a) S_1 (b) E_S

3-2. Which of the following terms describes the circuit condition?

1. Partially shorted
2. Partially open
3. Shorted
4. Open

3-3. Which of the following terms describes the figure 3A?

1. Parts layout
2. Exploded view
3. Wiring diagram
4. Schematic diagram

3-4. If circuit voltage is held constant, circuit current will react in what manner as the resistance (a) increases, and (b) decreases?

1. (a) Increase (b) decrease
2. (a) Increase (b) increase
3. (a) Decrease (b) decrease
4. **(a) Decrease (b) increase**

3-5. If circuit resistance is held constant, circuit current will react in what manner as the voltage (a) increases, and (b) decreases?

1. (a) Increase (b) decrease
2. (a) Increase (b) increase
3. (a) Decrease (b) decrease
4. (a) Decrease (b) increase

3-6. According to Ohm's law, what formula should be used to calculate circuit voltage if resistance and current value are known?

1. $E = \frac{R}{I}$
2. $E = \frac{I}{R}$
3. $E = IR$
4. $E = \frac{I}{IR}$

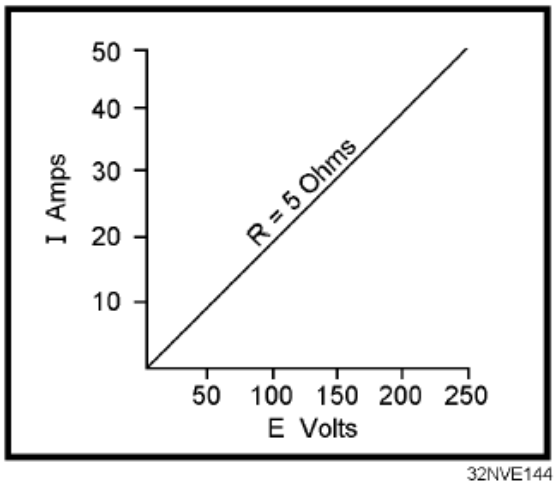


Figure 3B.—Graph of current and voltage.

IN ANSWERING QUESTIONS 3-7 AND 3-8, REFER TO FIGURE 3B.

Prepared by: Harlem A. Agnote

3-7. If the current is 15 amperes, what is the value of the voltage?

1. 50 V
2. 75 V
3. 100 V
4. 150 V

3-8. If the voltage is 200 volts, what is the value of the current?

1. 10 A
2. 20 A
3. 30 A
4. 40 A

3-9. Which of the following terms applies to the rate at which an electrical force causes motion?

1. Power
2. Energy
3. Inertia
4. Each of the above

3-10. Which of the following circuit quantities can be varied ONLY by varying one of the other circuit quantities?

1. Voltage
2. Current
3. Resistance
4. Each of the above

3-11. Which of the following is a correct formula for determining power in an electrical circuit?

1. $P = EI$
2. $P = I^2R$
3. $P = \frac{E^2}{R}$
4. Each of the above

3-12. What is the current in a circuit with 15 ohms of resistance that uses 135 watts of power?

1. 10 A
2. 15 A
3. 3 A
4. 9 A

3-13. What is the total power used by a 15-ohm resistor with 4 amps of current?

1. 60 W
2. 240 W
3. 360 W
4. 900 W

3-14. What type of resistor should be used in question 3-13?

1. Carbon
2. Wirewound
3. Precision
4. Composition

3-15. How much total energy is converted by a l-horsepower motor in 10 hours?

1. 7.46 kWh
2. 8.32 kWh
3. 8.59 kWh
4. 9.32 kWh

3-16. If the energy used by the motor in question 3-15 is 9.5 kWh, what is the efficiency of the motor?

1. .981
2. .904
3. .876
4. .785

Prepared by: Harlem A. Agnote

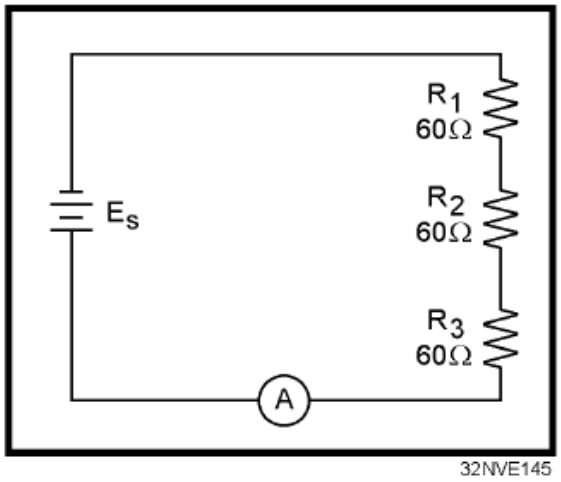


Figure 3C.—Series circuit.

IN ANSWERING QUESTIONS 3-17 THROUGH 3-23, REFER TO FIGURE 3C.

3-17. What is the total circuit resistance (R)?

1. 20
2. 60
3. 180
4. 240

3-18. If the circuit current is 3 amps, what is the source voltage (E_s)?

1. 60 V
2. 180 V
3. 540 V
4. 720 V

3-19. What is the total voltage dropped by each resistor in question 3-18?

1. 20 V
2. 60 V
3. 180 V
4. 540 V

3-20. If the current decreases to 2 amps, what is the total voltage drop across each resistor?

1. 120 V
2. 230 V
3. 310 V
4. 400 V

3-21. What would have to be done to the circuit to cause the current to decrease to 2 amps?

1. The source voltage would have to be increased
2. The source voltage would have to be decreased
3. The resistance of R_1 would have to be decreased
4. One of the resistors would have to be removed from the circuit

3-22. If the circuit current is 2 amps, what is the total power used by each resistor?

1. 240 W
2. 460 W
3. 620 W
4. 800 W

3-23. What is the total power used in the circuit if E_s = 360 V?

1. 720 W
2. 1380 W
3. 1860 W
4. 2400 W

3-24. When Kirchoff's voltage law is used to assign polarities to the voltage drop across a resistor, which of the following references is used to indicate the end of the resistor that the current enters?

1. Ground
2. Neutral
3. **Negative**
4. Positive

Prepared by: Harlem A. Agnote

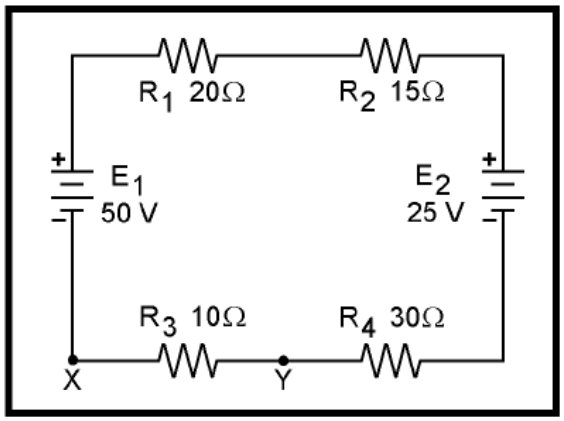


Figure 3D.—Multiple source circuit.

IN ANSWERING QUESTIONS 3-25 AND 3-26, REFER TO FIGURE 3D.

3-25. What is the effective source voltage?

1. 15 V
2. 25 V
3. 50 V
4. 75 V

3-26. What is the total amount and direction of current through R_3?

1. 1.0 A from Y to X
2. 1.0 A from X to Y
3. .33 A from Y to X
4. .33 A from X to Y

3-27. Which of the following terms applies to a circuit in which there is NO complete path for current?

1. Open
2. Short
3. Closed
4. Grounded

3-28. A circuit in which the resistance is almost zero ohms is referred to by which of the following terms?

1. Open
2. Short
3. Closed
4. Broken

THIS SPACE LEFT BLANK INTENTIONALLY.

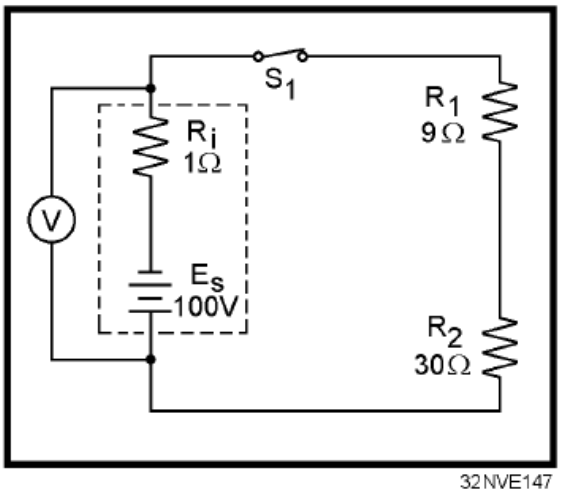


Figure 3E.—Series circuit and source resistance.

IN ANSWERING QUESTIONS 3-29 THROUGH 3-32, REFER TO FIGURE 3E.

3-29. If R_2 has a short circuit, what will most likely happen to the circuit?

1. R_1 will be destroyed
2. E_s will increase
3. V will indicate O volts
4. S_1 will automatically open

3-30. What is the total voltage drop across R_i when the switch is closed?

1. 2.5 V
2. 6.5 V
3. 97.5 V
4. 100.0 V

3-31. What will the meter indicate with (a) S_1 open, and (b) S_1 closed?

1. (a) 100 V (b) 100 V
2. (a) 97.5 V (b) 100 V
3. (a) 100 V (b) 97.5 V
4. (a) 97.5 V (b) 97.5 V

3-32. To achieve maximum power transfer in the circuit, which of the following conditions must be met?

1. $R_i = R_L$
2. $I_s = I_L$
3. $E_s = E_L$
4. $K_s = K_L$

3-33. Maximum power is transferred from a source to a load when the value of the load resistance is of what value when compared to the source resistance?

1. Equal
2. Twice
3. One-half
4. Several times

3-34. When maximum power is transferred from
a source to a load, what is the efficiency of power transfer?

1. 5%
2. 25%
3. 50%
4. 95%

3-35. A circuit consists of three resistors connected in parallel. R_1 = 30 ohms, R_2 = 15 ohms, and R_3 = 10 ohms. If the current through R_2 = 4 amperes, what is the total source voltage?

1. 20 V
2. 60 V
3. 120 V
4. 220 V

3-36. What is the relationship of total current to the current through a component in (a) a series circuit, and (b) a parallel circuit?

1. (a) Divides (b) divides
2. (a) Divides (b) equals
3. (a) Equals (b) equals
4. (a) Equals (b) divides

3-37. If a current has a negative polarity when Kirchoff's current law is applied, which of the following, statements is true of the current?

1. It is from a battery
2. It is from a generator
3. It is entering a junction
4. It is leaving a junction

3-38. Three equal resistors are connected in parallel and each resistor has an ohmic value of 300 ohms. What is the equivalent resistance of the circuit?

1. 100!
2. 150!
3. 600!
4. 900!

3-39. Three resistors with ohmic values of 120 ohms, 60 ohms, and 40 ohms are connected in parallel. What is the equivalent resistance of the circuit?

1. 10!
2. 20!
3. 30!
4. 40!

3-40. Two resistors with ohmic values of 90 ohms and 45 ohms are connected in parallel. What is the equivalent resistance of the circuit?

1. 10!
2. 20!
3. 30!
4. 40!

3-41. Which of the following terms describes a single resistor that represents a complex

circuit?

1. Equal resistor
2. Phantom resistor
3. Schematic resistor
4. **Equivalent resistor**

THIS SPACE LEFT BLANK INTENTIONALLY.

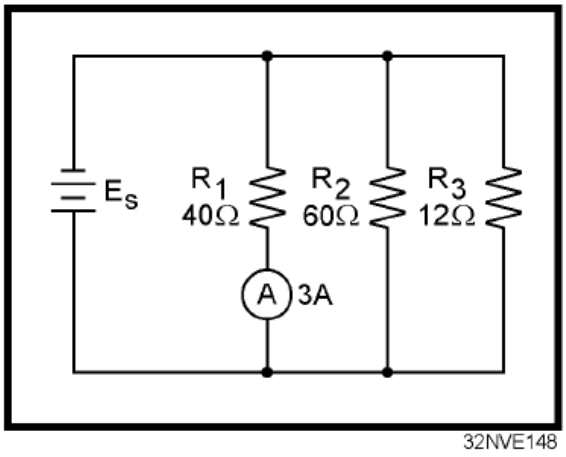


Figure 3F.—Parallel circuit.

IN ANSWERING QUESTIONS 3-42 THROUGH 3-46, REFER TO FIGURE 3F.

3-42. What is the value of E_S?

1. 336 V
2. 300 V
3. 240 V
4. 120 V

3-43. What is the value of current through R_2?

1. 1 A
2. 2 A
3. 3 A
4. 4 A

3-44. What is the approximate value of total resistance?

1. 8!
2. 37!
3. 112!
4. 257!

3-45. What is the value of total power?

1. 1.2 kW
2. 1.5 kW
3. 1.8 kW
4. 2.0 kW

3-46. What is the total power consumed by R_3?

1. 108 W
2. 240 W
3. 360 W
4. 1200 W

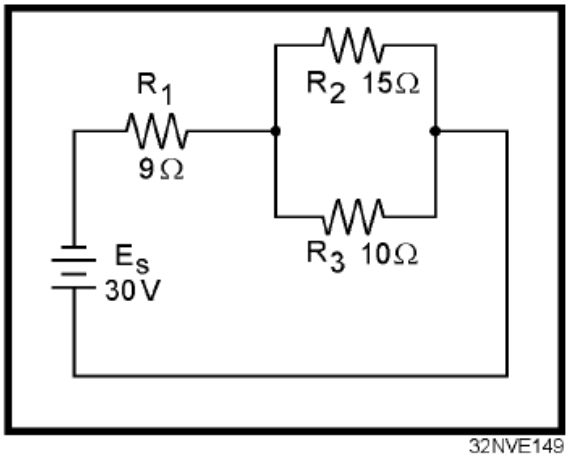


Figure 3G.—Series-parallel circuit.

IN ANSWERING QUESTIONS 3-47 THROUGH 3-49, REFER TO FIGURE 3G.

3-47. What is the value of the total resistance?

1. 3.6!
2. 15!
3. 34!
4. 40!

3-48. What is the total power used in the circuit?

1. 22.5 W
2. 26.5 W

3. 60.0 W
4. 250.0 W

3-49. What is the total voltage drop across R_3?

1. 8 V
2. 12 V
3. 18 V
4. 30 V

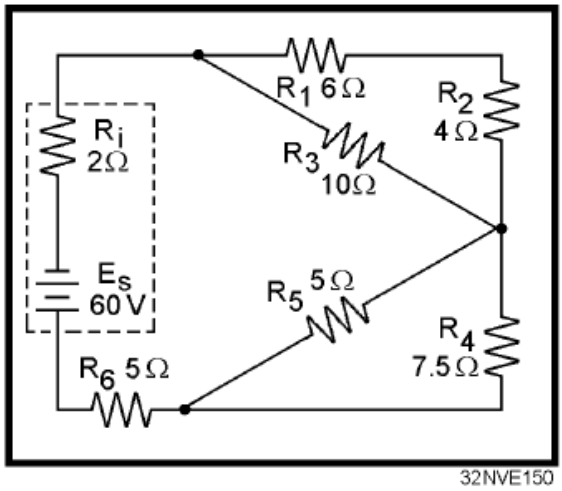


Figure 3H.—Complex circuit.

IN ANSWERING QUESTIONS 3-50 AND 3-51, REFER TO FIGURE 3H.

3-50. What is the value of total resistance?

1. 5!
2. 8!
3. 13!
4. 15!

3-51. If an equivalent resistor is used to represent the network of R_1, R_2, R_3, R_4, R_5, and R_6, what is the total voltage drop across this resistor?

1. 8V
2. 26V
3. 52V
4. 60V

3-52. If an open occurs in a series portion of a circuit, what is the effect on (a) total resistance, and (b) total current?

1. (a) Decreases to zero
   (b) Becomes infinite
2. (a) Decreases to zero
   (b) Decreases to zero
3. (a) Becomes infinite
   (b) Becomes infinite
4. **(a) Becomes infinite**
   (b) Decreases to zero

3-53. If an open occurs in a parallel branch of a circuit, what is the effect on (a) total resistance, and (b) total current?

1. **(a) Increases (b) decreases**
2. (a) Increases (b) increases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

3-54. If a short circuit occurs in a series portion of a circuit, what is the effect on (a) total resistance, and (b) total current?

1. (a) Increases (b) decreases
2. (a) Increases (b) increases
3. (a) Decreases (b) decreases
4. **(a) Decreases (b) increases**

3-55. If a short circuit occurs in a parallel branch of a circuit, what is the effect in (a) total resistance, and (b) total current?

1. (a) Increases (b) decreases
2. (a) Increases (b) increases
3. (a) Decreases (b) decreases
4. **(a) Decreases (b) increases**

3-56. If one branch of a parallel network shorts, what portion of the circuit current, if any, will flow through the remaining branches?

1. An amount determined by the combined resistance of the remaining branches
2. All
3. One-half

4. None

3-57. Which of the following circuit quantities need NOT be known before designing a voltage divider?

1. The current of the source
2. The voltage of the source
3. The current requirement of the load
4. The voltage requirement of the load

THE FOLLOWING INFORMATION IS TO BE USED IN ANSWERING QUESTIONS 3-58 THROUGH 3-60: A VOLTAGE DIVIDER IS REQUIRED TO SUPPLY A SINGLE LOAD WITH +150 VOLTS AND 300 MILLIAMPS OF CURRENT. THE SOURCE VOLTAGE IS 250 VOLTS. (HINT: DRAW THE CIRCUIT.)

3-58. What should be the value of the bleeder current?

1. 3 A
2. 300 mA
3. 30 mA
4. 3 mA

3-59. What should be the ohmic value of the bleeder resistor?

1. 50
2. 500
3. 5 k
4. 50 k

3-60. What is the value of total current?

1. 303 mA
2. 330 mA
3. 600 mA
4. 3300 mA

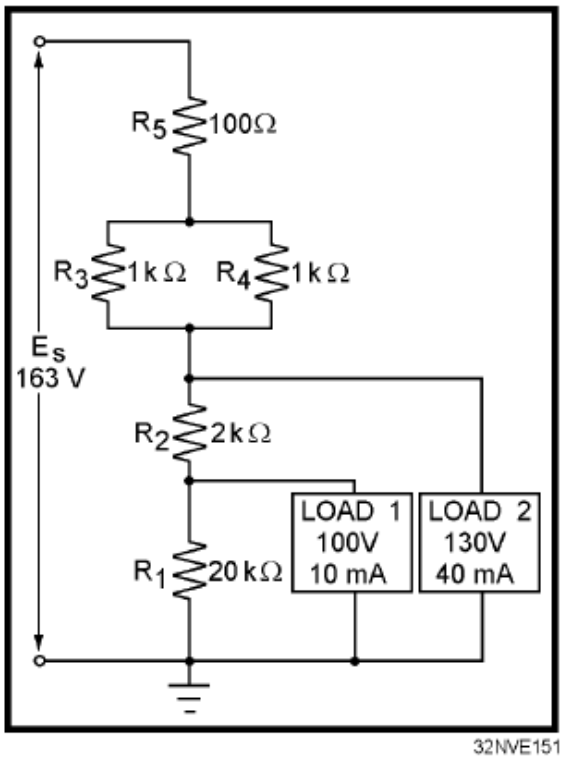


Figure 3I.—Voltage divider.

IN ANSWERING QUESTIONS 3-61 THROUGH 3-66, REFER TO FIGURE 3I.

3-61. Why must the value of R_1 be calculated first?

1. For convenience
2. The current through R_2 depends on the value of R_1
3. The voltage drop across R_1depends on the value of load 1
4. In any circuit, values for resistors labeled R_1 are calculated first

3-62. How is the current through R_2 calculated?

1. By adding I_{R1} and the current requirement of load 1
2. By adding the current requirements of load 1 and load 2
3. By subtracting the current requirement of load 1 from the current requirement of load 2

Prepared by: Harlem A. Agnote

4. By subtracting the current requirement of load 2 from the current requirement of load 1

3-63. How is the voltage drop across R_2 calculated?

1. By adding the voltage requirements of load 1 and load 2
2. By subtracting the voltage drops across R_5 and R_3 from the source voltage
3. By subtracting the voltage requirement of load 1 from the voltage requirement of load 2
4. By subtracting the voltage requirements of load 1 and load 2 from the source voltage

3-64. What is the minimum wattage rating required for R_5?

1. 1 W
2. 2 W
3. 1/2 W
4. 1/4 W

3-65. What is the total power supplied by the source?

1. 3.765 W
2. 7.965 W
3. 8.209 W
4. 8.965 W

3-66. What is the purpose of using the series-parallel network consisting of R_3, R_4, and R_5 in place of a single resistor?

1. It provides the desired resistance with resistor values that are easily obtainable
2. It provides the close tolerance required for the circuit
3. It is more reliable than the use of a single resistor
4. It costs less by using three resistors of lower wattage rating than a single, large power resistor

3-67. A single voltage divider provides both negative and positive voltages from a single source voltage through the use of a

1. ground between two of the dividing resistors
2. ground to the positive terminal of the source
3. ground to the negative terminal of the source
4. ground to the input of all loads requiring a negative voltage

3-68. Which of the following voltages are considered dangerous?

1. Voltages above 115 volts only
2. Voltages above 230 volts only
3. Voltages above 450 volts only
4. All voltages

3-69. If you discover a possible malfunction in an electric circuit, which of the following actions should be taken?

1. Attempt repairs yourself
2. Report the malfunction to a qualified technician
3. Ignore the malfunction unless you were assigned to repair it
4. Secure the circuit immediately by removing power at the nearest switch

3-70. If a person has stopped breathing and there is NO detectable heartbeat, who should perform CPR?

1. Medical personnel only
2. The first person on the scene
3. Emergency Medical Technicians only
4. Trained, qualified personnel only

MODULE 2

INTRODUCTION TO ALTERNATING CURRENT AND TRANSFORMERS

PREPARED BY:

Vonell Quioge

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Concepts of Alternating Current," pages 1-1 through 1-33.

1-1. Alternating current can be defined as current that varies in
1. amplitude and direction
2. magnitude and phase
3. amplitude and time
4. time and phase

1-2. Before a 120-volt dc source can be used to power a 12-volt load, the voltage must be reduced. Which of the following methods can be used?
1. A resistor placed in parallel with the load
2. A resistor placed in series with the load
3. A step-down transformer placed in series with load
4. A step-down transformer placed in parallel-with the load

1-3. Alternating current has replaced direct current in modern transmission systems because it has which of the following advantages?
1. Ac can be transmitted with no line loss
2. Ac can be transmitted at higher current levels
3. Ac can be transmitted at lower voltage levels
4. Ac can be readily stepped up or Down

1-4. A waveform is a graphic plot of what quantities?
1. Current versus time
2. Amplitude versus time
3. Voltage versus amplitude
4. Magnitude versus amplitude

1-5. Which of the following properties surrounds a current-carrying conductor?
1. A magnetic field
2. A repulsive force
3. An attractive force
4. An electrostatic field

Figure 1A.—Conductors, cross-sectional view.

IN ANSWERING QUESTIONS 1-6 AND 1-7, REFER TO FIGURE 1A.

1-6. The direction of the magnetic field is correctly depicted by which of the followings
1. A and B
2. B and D
3. A and C
4. B and C

IN ANSWERING QUESTION 1-7, REFER TO FIGURE 1A AND IGNORE THE MAGNETIC FIELD ARROWS SHOWN IN THE FIGURE.

1-7. In which conductors will the magnetic fields (a) aid, and (b) oppose each other?
1. (a) A and C, (b) C and D
2. (a) A and D, (b) B and C
3. (a) A and C, (b) B and D
4. (a) A and B, (b) A and D

Figure 1B.—A magnetic field surrounding a currentcarrying conductor.

IN ANSWERING QUESTIONS 1-8, REFER TO FIGURE 1B.

1-8. In figure 1B, the direction of the magnetic field surrounding the conductor is correctly indicated by what arrow?
1. A
2. B
3. C
4. D

1-9. Which of the following statements accurately describes the magnetic field surrounding a current-carrying

Prepared by: Harlem A. Agnote

conductor?
1. It is parallel to and equal along all parts of the conductor
2. It is parallel to and maximum at the most negative part of the conductor
3. It is perpendicular to and equal along all parts of the conductor
4. It is perpendicular to the conductor and maximum at the most negative point of the conductor

1-10. Which of the following factors determine(s) the intensity of a magnetic field surrounding a coil?
1. The amount of current flow through the coil
2. The type of core material
3. The number of turns in the conductor
4. All of the above

1-11. When you grasp a coil in your left hand with your thumb pointing in the direction of the north pole, your fingers will be wrapped around the coil in the direction of the
1. voltage potential
2. magnetic field
3. current flow
4. south pole

1-12. The power consumed in a conductor in realigning the atoms which set up the magnetic field is known as what type of loss?
1. Hysteresis loss
2. Magnetic loss
3. Field loss
4. Heat loss

1-13. The magnetic field surrounding a straight conductor is (a) what shape, and (b) is in what position relative to the conductor?
1. (a) Linked oblong
(b) Parallel
2. (a) Concentric circles
(b) Parallel
3. (a) Linked oblong
(b) Perpendicular
4. (a) Concentric circles
(b) Perpendicular

1-14. Why is a two-pole magnetic field set up around a coil?
1. Because separate lines of magnetic force link and combine their effects
2. Because concentric lines of force cross at right angles and combine.
3. Because lines of force are separated and bent at the coil ends
4. Because separate lines of force are attracted to the two poles of the coil

1-15. When a conductor is moving parallel to magnetic lines of force, (a) what relative number of magnetic lines are cut, and (b) what relative value of emf is induced?
1. (a) Minimum, (b) maximum
2. (a) Minimum, (b) minimum
3. (a) Maximum, (b) maximum
4. (a) Maximum, (b) minimum

1-16. When the induced voltage in a conductor rotating in a magnetic field is plotted against the degrees of rotation, the plot will take what shape?
1. A circle
2. A sine curve
3. A square wave
4. A straight line

1-17. When a loop of wire is rotated through 360º in a magnetic field, the induced voltage will be zero at which of the following points?
1. 45º
2. 90º
3. 180º
4. 270º

1-18. When a loop of wire is rotated 360º in a magnetic field, at what points will the induced voltage reach its maximum (a) positive, and (b) negative values?

1. (a) 0º , (b) 180º
2. (a) 0º , (b) 270º
3. (a) 90º , (b) 180º
4. (a) 90º , (b) 270º

1-19. When a coil of wire makes eight complete revolutions through a single magnetic field, (a) what total number of alternations of voltage will be generated and, (b) what total number of cycles of ac will be generated?
1. (a) 32, (b) 16
2. (a) 16, (b) 8
3. (a) 8, (b) 4
4. (a) 4, (b) 2

1-20. According to the left-hand rule for generators, when your thumb points in the direction of rotation, your (a) forefinger and (b) your middle finger will indicate the relative directions of what quantities?
1. (a) Current,
(b) Magnetic flux, south to north
2. (a) Current,
(b) Magnetic flux, north to south
3. (a) Magnetic flux, south to north,
(b) Current
4. (a) Magnetic flux, north to south,
(b) Current

1-21. Continuous rotation of a conductor through magnetic lines of force will produce what type of (a) voltage and (b) waveform?
1. (a) Ac, (b) sine wave
2. (a) Dc, (b) continuous level
3. (a) Ac, (b) sawtooth
4. (a) Dc, (b) pulsating wave

1-22. What is the term for the number of complete cycles of ac produced in one second?
1. Period
2. Waveform
3. Frequency
4. Wavelength

1-23. What is the unit of measurement for frequency?
1. Cycle
2. Hertz
3. Period
4. Maxwell

1-24. A loop of wire rotating at 60 rpm in a magnetic field will produce an ac voltage of what frequency?
1. 1 Hz
2. 60 Hz
3. 120 Hz
4. 360 Hz

1-25. An ac voltage of 250 hertz has a period of
1. 0.004 second
2. 0.025 second
3. 0.4 second
4. 2.5 seconds

1-26. What is the approximate frequency of an ac voltage that has a period of .0006 second?
1. 6 Hz
2. 16.67 Hz
3. 600 Hz
4. 1667 Hz

Figure 1C.—Components of a sinewave.

IN ANSWERING QUESTIONS 1-27 THROUGH 1-36, REFER TO FIGURE 1C.
IN ANSWERING QUESTIONS 1-27 THROUGH 1-31, SELECT FROM COLUMN B THE COMPONENT THAT IS DESCRIBED BY THE TERM IN COLUMN A.

A. TERM
B. COMPONENT

1-27. Period 1. a
1-28. Negative alternation
2.
3.
b
c

1-29. Wavelength 4. D

1-30. One-half cycle

1-31 Postive alternation

1-32. Component a is a measure of what quantity?
1. Frequency
2. Polarity
3. Amplitude
4. Time

1-33. Component a differs from component b in which of the following characteristics
1. Frequency
2. Polarity
3. Amplitude
4. Period

1-34. Component c would represent what quantities if it were expressed as (a) physical distance, and (b) time?
1. (a) Frequency (b) period
2. (a) Period (b) wavelength
3. (a) Frequency (b) wavelength
4 (a) Wavelength (b) period

1-35. The combined values of components a and b represent what ac value?
1. Peak-to-peak value
2. Average value
3. Effective value
4. Instantaneous value

1-36. A peak voltage is represented by which of the following components?
1. a
2. c
3. d
4. e

1-37. An ac voltage has a frequency of 350 Hz. In two seconds, what total number of times will the peak value of voltage be generated?
1. 350 times
2. 700 times
3. 1400 times
4. 2800 times

1-38. The value of current of an ac waveform taken at any particular moment of time is what type of value?
1. Average value
2. Effective value
3. Instantaneous value
4. Peak-to-peak value

1-39. While the value of an ac voltage may be expressed as one of several values, the accepted practice is to express it as what type value?
1. Average value
2. Instantaneous value
3. Peak-to-peak value
4. Effective value

1-40. The total of ten instantaneous values of an alternation divided by ten is equal to what value?
1. The peak value
2. The average value
3. The instantaneous value
4. The effective value

1-41. Which of the following mathematical formulas is used to find the average value of voltage for an ac voltage?
1. $E_{avg} = 0.707 \times E_{max}$
2. $E_{avg} = 1.414 \times E_{eff}$
3. $E_{avg} = 0.636 \times E_{max}$
4. $E_{avg} = 0.226 \times E_{eff}$

1-42. What is the average value of all of the instantaneous voltages occurring during one cycle of an ac waveform with a peak value of 60 volts?
1. 0 volts
2. 38 volts
3. 76 volts
4. 128 volts

1-43. If an ac voltage has an E_{max} of 220 volts, what is E_{avg}?
1. 50 volts

Prepared by: Harlem A. Agnote

2. 140 volts
3. 156 volts
4. 311 volts

1-44. If an ac waveform has a peak-to-peak value of 28 volts, what is E_{avg}?
1. 40 volts
2. 20 volts
3. 18 volts
4. 9 volts

1-45. If an ac waveform has a peak value of 4.5 amperes, what is its average value?
1. 2.9 amperes
2. 3.2 amperes
3. 5.7 amperes
4. 6.4 amperes

1-46. If the average value of current of an ac waveform is 1.2 amperes, what is its maximum value of current?
1. 0.8 amperes
2. 0.9 amperes
3. 1.7 amperes
4. 1.9 amperes

1-47. The value of alternating current that will heat a resistor to the same temperature as an equal value of direct current is known as
1. I_{avg}
2. I_{eff}
3. I_{in}
4. I_{max}

1-48. The rms value for an ac voltage is equal to what other ac value?
1. E_{avg}
2. E_{max}
3. E_{eff}
4. E_{in}

1-49. What value will result by squaring all values for E_{inst}, averaging these values, and then taking the square root of that average?
1. E_{avg}
2. E_{max}
3. E_{eff}
4. E_{in}

1-50. The accepted, nominal value for household power in the United States is 120-volts, 60 Hz. What is the value of maximum voltage?
1. 170 volts
2. 120 volts
3. 85 volts
4. 76 volts

1-51. An ac voltmeter is usually calibrated to read which of the following ac values?
1. Average
2. Effective
3. Peak
4. Peak-to-peak

1-52. If the maximum value for an ac voltage is known, the E_{eff} can be found by using which of the following formulas?
1. $E_{eff} = E_{max}/.636$
2. $E_{eff} = E_{max}/.707$
3. $E_{eff} = E_{max}$ □ .707
4. $E_{eff} = E_{max}$ □ 1.414

1-53. If the I_{eff} of an ac waveform is 3.25 amperes, what is I_{max}?
1. 4.6 amperes
2. 2.3 amperes
3. 2.1 amperes
4. 1.6 amperes

1-54. If the rms value of the voltage of an ac waveform is 12.4 volt what is its average value? (Hint: compute E_{max} first.)
1. 8 volts
2. 11 volts
3. 15 volts
4. 18 volts

Figure 1D.—Phase relationship of sinewaves.
IN ANSWERING QUESTIONS 1-55 THROUGH 1-60, REFER TO FIGURE 1D.
1-55. What two waveforms are in phase?
1. A and B
2. A and C

3. C and D
4. B and C

1-56. What is the phase difference, if any, between waveform B and C?
1. B is 225º out of phase with C
2. B is 180º out of phase with C
3. B is 90º out of phase with C
4. None; they are in phase

1-57. What is the phase difference, if any, between waveform A and D?
1. A is 270º out of phase with D
2. A is 180º out of phase with D
3. A is 90º out of phase with D
4. None; they are in phase

1-58. If the voltage represented by waveform A is summed to the voltage represented by waveform D, what is the resultant voltage?
1. 20 volts
2. 15 volts
3. 10 volts
4. 0 volts

1-59. What is E_{in} at 90º that results from adding waveform B to waveform D?
1. +7.5 volts
2. +2.5 volts
3. -7.5 volts
4. -10 volts

1-60. What is the phase difference between waveform A and waveform C?
1. A lags C by 90º
2. A leads C by 90º
3. A leads C by 180º
4. A lags C by 180º

1-61. Which of the following is an important rule to remember when using Ohm's Law to solve ac circuit problems?
1. Always solve for resistance first
2. Give the answer as effective value
3. Never mix values
4. Convert all given values to effective before attempting to solve

1-62. An ac circuit is composed of three 20-ohm resistors connected in parallel. The average voltage supplied to this circuit is 62-volts ac. What is the maximum current?
1. 9.3 amperes
2. 14.6 amperes
3. 17.5 amperes
4. 22.5 amperes

1-63. If the ac source in question 1-62 is raised to an average value of 120 volts, what is the I_{eff}?
1. 11.48 amperes
2. 12.70 amperes
3. 20.01 amperes
4. 25.52 amperes

1-64. If E_{eff} is 150 volts and I_{max} is 4.5 amperes, what is the total resistance (R_T) of a circuit?
1. 21.2Ω
2. 23.6Ω
3. 33.3Ω
4. 47.1Ω

Prepared by: Harlem A. Agnote

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Inductance," pages 2-1 through 2-27.

2-1. The property of inductance offers opposition to which of the following quantities?
1. Constant current
2. Constant voltage
3. Changes in current
4. Changes in voltage

2-2. What is the symbol for inductance?
1. L
2. H
3. X_L
4. IND

2-3. What is the unit of measurement for inductance?
1. Ohm
2. Rel
3. Farad
4. Henry

2-4. If 9 volts are induced in a conductor when the current changes by 4.5 amperes in one second, what is the total inductance of the circuit?
1. 1.5 henries
2. 2.0 henries
3. 13.5 henries
4. 40.0 henries

2-5. What physical property is similar to inductance?
1. Mass
2. Motion
3. Velocity
4. Inertia

2-6. The difference in potential across a resistor, created by current through the resistor is an example of which of the following forces?
1. Resistive
2. Inertia
3. Inductive
4. Electromotive

2-7. When a magnetic field moves through a stationary conductor, the electrons in orbit are affected in what manner?
1. They are dislodged from orbit
2. They move closer to their nucleus
3. They move closer to other orbiting electrons
4. They bunch up on one side of the Nucleus

2-8. When electrons are moved in a conductor by a magnetic field, a force known by which of the following terms is created?
1. Voltage
2. Electromotive
3. Potential difference
4. All of the above

2-9. Self-induced emf is also known as what force?
1. magnetic force
2. Inertial force
3. Electromotive force
4. Counter electromotive force

2-10. According to Lenz's Law, the induced emf produced by a change in current in an inductive circuit tends to have what effect on the current?
1. It aids a rise in current and opposes fall in current
2. It aids a fall in current and opposes a rise in current
3. It opposes either a rise or a fall in current
4. It aids either a rise or fall in current

2-11. The direction of the induced voltage in an inductor may be found by application of which of the following rules?
1. The left-hand rule for inductors
2. The left-hand rule for generators

Prepared by: Harlem A. Agnote

3. The right-hand rule for conductors
4. The right-hand rule for motors

2-12. The left-hand rule for generators states that the thumb of the left hand points in the direction of motion of the
1. conductor
2. magnetic field
3. generator poles
4. induced current

2-13. When source voltage is removed from a current-carrying conductor, a voltage will be induced in the conductor by which of the following actions?
1. The decreasing voltage
2. The collapsing magnetic field
3. The reversal of current
4. The reversing electrical field

2-14. The property of inductance is present in which of the following electrical circuits?
1. An ac circuit
2. A dc circuit
3. A resistive circuit
4. Each of the above

2-15. How are inductors classified?
1. By core type
2. By conductor type
3. By the number of turns
4. By the direction of the windings on the core

2-16. Normally, most coils have cores composed of either air or
1. copper
2. carbon
3. soft iron
4. carbon steel

2-17. The hollow form of nonmagnetic material found in the center of an aircore coil has what purpose?
1. To focus the magnetic flux
2. To support the windings
3. To act as a low resistance path for flux
4. To serve as a container for the core

2-18. Which of the following factors will NOT affect the value of inductance of a coil?
1. Number of coil turns
2. Diameter of the coil
3. Conductor tensility
4. Core materials used

2-19. When the number of turns is increased in a coil from 2 to 4, the total inductance will increase by a factor of
1. eight
2. two
3. six
4. four

2-20. Why do large diameter coils have greater inductance than smaller diameter coils, all other factors being the same?
1. Large diameter coils have more wire and thus more flux
2. Large diameter coils have less resistance
3. Small diameter coils have less resistance
4. Small diameter coils have large cemfs which oppose current flow

2-21. If the radius of a coil is doubled, its inductance is increased by what factor?
1. One
2. Two
3. Eight
4. Four

2-22. If the length of a coil is doubled while the number of turns is kept the same, this will have (a) what effect on inductance and (b) by what factor?
1. (a) Decrease, (b) by 1/4
2. (a) Decrease, (b) by 1/2
3. (a) Increase, (b) by 2 times
4. (a) Increase, (b) by 4 times

2-23. A soft iron core will increase inductance

because it has which of the following characteristics?
1. Low permeability and low reluctance
2. Low permeability and high reluctance
3. High permeability and high reluctance
4. High permeability and low Reluctance

2-24. An increase in the permeability of the core of a coil will increase which of the following coil characteristics?
1. Magnetic flux
2. Reluctance
3. Resistance
4. Conductance

2-25. If a coil is wound in layers, its inductance will be greater than that of a similar single-layer coil because of a higher
1. permeability
2. flux linkage
3. reluctance
4. conductance

2-26. Regardless of the method used, inductance of a coil can ONLY be increased by increasing what coil characteristic?
1. Transconductance
2. Reluctance
3. Flux linkage
4. Conductance

2-27. What is the symbol used to denote the basic unit of measurement for inductance?
1. L
2. H
3. I
4. F

2-28. What does the Greek letter Delta signify as in "□I" or "□t"?
1. The values are constant
2. The values are average
3. The values are changing
4. The values are effective

2-29. An electrical circuit contains a coil. When the current varies 2.5 amperes in one second, 7.5 volts are induced in the coil. What is the value of inductance of the coil?
1. 1 henry
2. 2.2 henries
3. 3.3 henries
4. 4 henries

2-30. An ac electrical current varies 1.5 amperes in one second and is applied to a 10-henry coil. What is the value of the emf induced across the coil?
1. 1.0 volt
2. 1.5 volts
3. 11.5 volts
4. 15.0 volts

2-31. If a coil is rated at 10 henries, what is its value in (a) millihenries and (b) microhenries?
1. (a) 10,000 mH, (b) 10,000,000 µH
2. (a) 10,000 mH, (b) 1,000,000 µH
3. (a) 1,000 mH, (b) 1,000,000 µH
4. (a) 1,000 mH, (b) 100,000 µH

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 2A.—LR circuit characteristics.

IN ANSWERING QUESTIONS 2-32 THROUGH 2-40, REFER TO FIGURE 2A.

2-32. What waveform is an illustration of the voltage (E_S) present across the voltage divider when switch S1 is closed?
1. B
2. C
3. E
4. G

2-33. The voltage dropped across R when switch S1 is closed is depicted in which of the following waveforms?

1. G
2. H
3. F
4. C

2-34. The voltage developed across L when switch S1 is closed is depicted in what waveform?
1. A
2. B
3. E
4. H

2-35. Which of the following waveforms depicts growth current (I_g) through the coil (L)?
1. A
2. D
3. E
4. H

2-36. What waveform depicts the voltage developed across R when switch S2 is closed?
1. E
2. F
3. H
4. D

2-37. During the first instant when switch S1 is closed, maximum voltage is dropped across
1. the battery
2. the resistor
3. the coil
4. both the coil and resistor

2-38. During the first instant when switch S1 is closed, current is maximum in which, if any, of the following parts of the h circuit?
1. The battery
2. The coil
3. The resistor
4. None of the above

2-39. In the first instant when switch S1 is closed, the entire battery-voltage is used to overcome the
1. resistance of R
2. resistance of L
3. emf developed in R
4. emf developed in L

2-40. When switch S2 is closed, energy is supplied to the circuit by the
1. battery through S_2
2. battery through S_1
3. collapsing magnetic field of L_1
4. expanding magnetic field of L_1

2-41. One L/R time constant is equal to the time required for the current in an inductor to reach what portion of its maximum value?
1. 63.2%
2. 37.8%
3. 25.2%
4. 12.8%

2-42. Maximum current will flow in an LR circuit after a minimum of how many time constants have elapsed?
1. One
2. Five
3. Three
4. Four

2-43. The maximum current in an LR circuit is 20 amperes. What total current will be flowing in the circuit at the end of the second time constant of the charge cycle?
1. 20.0 amperes
2. 17.3 amperes
3. 12.6 amperes
4. amperes

2-44. Refer to the circuit described in question 2-43. Circuit current will increase by what amount during the second time constant?
1. 17.3 amperes
2. 12.6 amperes
3. 7.6 amperes
4. 4.7 amperes

2-45. An LR circuit has a maximum current of 30 mA. At the end of the first time constant of the discharge cycle, what total current will be flowing in the circuit?
1. 11 mA
2. 19 mA
3. 26 mA
4. 28 mA

2-46. An LR circuit contains a 150-ohm resistor and a 2-henry coil. What is the time value of one L/R time constant?
1. 7.5 seconds
2. .75 seconds
3. 1.33 seconds
4. .0133 seconds

2-47. An LR circuit has a time constant of .05 second and an inductor with a value of .60 henry. What value of resistor is required?
1. 5 ohms
2. 12 ohms
3. 24 ohms
4. 64 ohms

2-48. An LR circuit is composed of a coil of .5 henry and a 10-ohm resistor. The maximum current in the circuit is 5 amperes. After the circuit is energized, how long will it take for the current to reach maximum value?
1. 1.0 second
2. 0.05 second
3. 0.25 second
4. 5.0 seconds

2-49. Inductors experience copper loss for what reason?
1. Because of flux leakage in the copper core
2. Because the reactance of an inductor is greater than the resistance of an inductor
3. Because all inductors have resistance which dissipates power
4. Because the inertia of the magnetic field must be overcome every time the direction of current changes

2-50. Copper loss of an inductor can be calculated by the use of which of the following formulas?
1. 3.
2. 4.

2-51. What term applies to the power loss in an iron core inductor due to the current induced in the core?
1. Iron loss
2. Heat loss
3. Hysteresis loss
4. Eddy-current loss

2-52. Power consumed by an iron core inductor in reversing the magnetic field of the core is termed as what type of loss?
1. Iron loss
2. Heat loss
3. Hysteresis loss
4. Eddy-current loss

2-53. When does mutual inductance occur between inductors?
1. Whenever eddy-currents do not exist
2. Whenever the flux of one inductor causes an emf to be induced in another inductor
3. Whenever the effect of one inductor is aided by another inductor
4. Whenever the effect of one inductor is opposed by another inductor

2-54. Mutual inductance between two coils is affected by which of the following factors?
1. Material of the windings
2. Physical dimensions of the coils
3. Direction of the coil windings
4. Hysteresis characteristics of the Coils

Prepared by: Harlem A. Agnote

2-55. The coefficient of coupling between two coils is a measure of what factor?
1. The turns ratio of the coils
2. The distance between the coils
3. The relative positive of the coils
4. The magnetic flux ratio linking the Coils

2-56. Two coils have a coefficient of coupling of .7 and are rated at 12 µH and 3 µH respectively. What is their total mutual inductance?
1. 4.2 µH
2. 5.2 µH
3. 7.0 µH
4. 10.5 µH

2-57. An electrical circuit contains four noncoupled inductors in a series configuration. The inductors have the following values: 2 µH, 3.5 µH, 6 µH, and 1 µH. What is the total inductance (L_T) of the circuit?
1. 45.0 µH
2. 42.5 µH
3. 12.5 µH
4. 11.5 µH

2-58. Two inductors of 3.6 µH and 7.3 µH are wired together in series and they aid each other. The mutual inductance for the circuit is 3.6µH. What is the total inductance (L_T) Of the circuit?
1. 17.5 µH
2. 18.1 µH
3. 24.8 µH
4. 34.4 µH

2-59. An electrical circuit contains three noncoupled
inductors of 3.3 µH, 4.5 µH,
and 2.0 µH wired in parallel. What is the total inductance of the circuit?
1. 9.8 µH
2. 3.6 µH
3. 0.98 µH
4. 0.28 µH

Prepared by: Harlem A. Agnote

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Capacitance," pages 3-1 through 3-41.

3-1. Capacitance and inductance in a circuit are similar in which of the following ways?
1. Both oppose current
2. Both aid voltage
3. Both cause the storage of energy
4. Both prevent the storage of energy

3-2. Capacitance is defined as the property of a circuit that
1. opposes a change in voltage
2. aids a change in voltage
3. opposes a change in current
4. aids a change in current

3-3. A capacitor is a device that stores energy in a/an
1. electrostatic field
2. electromagnetic field
3. induced field
4. molecular field

3-4. Electrostatic fields have what effect on (a) free electrons, and (b) bound electrons?
1. (a) Attracts them to the negative charges
(b) Frees them from their orbits
2. (a) Attracts them to the positive charges
(b) Frees them from their orbits
3. (a) Attracts them to the negative charges
(b) Distorts their orbits
4. (a) Attracts them to the positive Charges
(b) Distorts their orbits

3-5. The influence of a charge on an electron orbit is correctly depicted by which of the following illustrations?

3-6. Electrostatic lines of force radiate from a charged particle along what type of lines?
1. Straight lines
2. Curved lines
3. Elliptical lines
4. Orbital lines

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 3A.—Electron and proton entering an electrostatic field.

IN ANSWERING QUESTION 3-7, REFER TO FIGURE 3A.

3-7. When the illustrated electron and proton enter the electrostatic field, toward what plate(s), will the (a) electron and, (b) proton be deflected?
1. (a) A (b) B
2. (a) B (b) A
3. (a) A (b) A
4. (a) B (b) B

Figure 3B.—Effect of electrostatic lines of force.

IN ANSWERING QUESTION 3-8, REFER TO FIGURE 3B.

3-8. If the charges on the two plates are reversed, what will happen to the electrons?
1. They will dislodge from the atom
2. They will stay where they are
3. They will go back to circular orbits
4. They will distort in the opposite Direction

3-9. Which of the following combinations describe(s) a simple capacitor?
1. Two copper plates separated by an iron plate
2. Two copper plates separated by a sheet of mica
3. Two iron plates separated by an air gap
4. Both 2 and 3 above

Prepared by: Harlem A. Agnote

3-10. A capacitor that stores 6 coulombs of electrons when a potential of 2 volts is applied across its terminals has what total value of capacitance?
1. 12 farads
2. 8 farads
3. 3 farads
4. 6 farads

IN ANSWERING QUESTIONS 3-11 THROUGH 3-14, MATCH THE TERMS IN COLUMN B WITH THEIR MATHEMATICAL VALUES IN COLUMN A.
A. VALUES
B. TERMS

3-11. .000001 F 1. Farad
3-12. 1 x 10^{-12} F 2. Microfarad
3-13. 1 x 10^{-6} F 3. Picofarad
3-14. 1 x 10^{0} F

3-15. A capacitor of .0069 microfarad has which of the following capacitance values when measured in picofarads?
1. .000069 pF
2. 6900 pF
3. 6.9 □ □10^{-9} pF
4. Both 2 and 3 above, individually, are correct

3-16. Which of the following characteristics of a capacitor can be varied WITHOUT altering its capacitance?
1. Area of the plates
2. Thickness of the dielectric
3. Material of the dielectric
4. Thickness of the plates

3-17. Which of the following actions will increase the capacitance of a capacitor?
1. The plates are moved closer together
2. The plates are moved farther apart
3. The dielectric constant is decreased
4. Both 2 and 3 above

3-18. Two capacitors are identical with the exception of the material used for the dielectric. Which of the following combinations of dielectric material will cause capacitor (b) to have a larger capacitance than capacitor (a)?
1. (a) Glass (b) Paraffin paper
2. (a) Glycerine (b) Pure water
3. (a) Petroleum (b) Air
4. (a) Paraffin paper (b) Petroleum

3-19. Two capacitors are identical with the exception of the material used for the dielectric. Which of the following combinations of dielectric materials will cause the capacitors to have almost the same capacitance?
1. Glass, paraffin paper
2. Mica, petroleum
3. Vacuum, air
4. Petroleum, rubber

3-20. A capacitor is composed of two plates. Each plate has an area of 7 square inches. The plates are separated by a 2-inch thick paraffin paper dielectric. What is its capacitance?
1. 2.76 µF
2. 2.76 pF
3. 5.51 µF
4. 5.51 pF

3-21. The maximum voltage that can be applied to a capacitor without causing current flow through the dielectric is called
1. breaking voltage
2. limiting voltage
3. conduction voltage
4. working voltage

3-22. A capacitor with a working voltage of 300 volts would normally have what maximum effective voltage applied to it?
1. 200 volts
2. 250 volts
3. 300 volts
4. 350 volts

3-23. An ac voltage of 350 volts effective can be safely applied to a capacitor with which of the following working voltages?
1. 550 volts
2. 400 volts
3. 350 volts
4. 250 volts

3-24. Which, if any, of the following conditions may cause a capacitor to suffer power losses?
1. Dielectric hysteresis
2. Plate loading
3. Plate heating
4. None of the above

3-25. Rapid reversals in the polarity of the line voltage applied to a capacitor will cause what type of capacitor power loss?
1. Dielectric-leakage
2. Dielectric-hysteresis
3. Plate-loading
4. Plate-leakage

3-26. What type of dielectric is LEAST sensitive to power dielectric-hysteresis losses?
1. Pure water
2. Air
3. Vacuum
4. Mica

3-27. As the current through a capacitor increases, which of the following types of capacitor losses will increase?
1. Dielectric-hysteresis
2. Dielectric-leakage
3. Plate-leakage
4. Plate-breakdown

Figure 3C.—Simple capacitor circuit.

IN ANSWERING QUESTIONS 3-28 THROUGH 3-33, REFER TO FIGURE 3C.

3-28. Assume that the switch has been moved from position 4 to the position shown. Which of the following conditions now exists?
1. An electrostatic field exists between the capacitor's plates
2. No potential difference exists across the capacitor
3. Current flow is at its maximum
4. Energy is being stored in the capacitor's electrostatic field

3-29. To charge the capacitor, the switch must be in what position?
1. 1
2. 2
3. 3
4. 4

3-30. Which of the following are paths for current flow when the capacitor is charging?
1. Plate A, Plate B, Batt (+) and -Batt (−), Plate A
2. Batt (+) and -Batt (−), Plate A
Batt (−) and Batt (+), Plate B
3. Batt (−), Plate A and Plate B, Batt (+), Batt (−)
4. Batt (+), Plate B and Plate A, Batt (−), Batt (+)

3-31. When the switch is placed in position 4, after being in position 2, which of the following conditions exits within the circuit?
1. E_C is increasing
2. L_C is increasing
3. Electrical energy is stored in the capacitor
4. Stored energy is returned to the circuit

3-32. With S1 in position 4, which of the following is the path for current flow?
1. Plate B, Plate A, S1, Plate B
2. Plate A, Plate B, S1, Plate A
3. Plate A, S1, Plate B
4. Plate B, S1, Plate A

3-33. If the illustrated capacitor has a value of 50 pF and a potential difference of 300 volts exists across its plates, what is the

total number of coulombs it contains?
1. 0.015
2. 0.15
3. 1.50
4. 15.0

Figure 3D.—RC charge and discharge circuits.

IN ANSWERING QUESTIONS 3-34 THROUGH 3-41, REFER TO FIGURE 3D.

3-34. The greatest rate of change in current occurs between what two times?
1. T_1 –T_2
2. T_2 –T_3
3. T_4 –T_5
4. T_0 –T_1

3-35. At what instant does the maximum voltage appear across the resistor?
1. T_1
2. T_2
3. T_5
4. T_0

3-36. When the charge on the capacitor is equal to 100 volts, what is the voltage drop across the resistor?
1. 100 volts
2. 63 volts
3. 27 volts
4. 0 volts

3-37. After the capacitor has reached full charge, S1 is placed in position 2. The greatest rate of change in current is between what two times?
1. T_1 –T_2
2. T_2 –T_3
3. T_4 –T_5
4. T_0 –T_1

3-38. The capacitor will be completely discharged at what minimum time interval?
1. T_1
2. T_5
3. T_3
4. T_4

3-39. What is the RC time constant for the circuit?
1. 300 sec
2. 35 sec
3. 300 µsec
4. 35 µsec

3-40. What total time will it take the capacitor to charge to 98 volts? (You may use figure 3-11 of your text, or figure 3 located on this page.)
1. 140 µsec
2. 1200 µsec
3. 140 sec
4. 1200 sec

3-41. After the capacitor has reached full charge, S1 is moved to position 2. What total number of RC time constants will it take for the capacitor to discharge to 5 volts?
1. One
2. Two
3. Three
4. Four

Figure 3E.—Universal time constant chart for RC and RL circuit.

IN ANSWERING QUESTION 3-42, REFER TO FIGURE 3E ABOVE.

3-42. An RC circuit is designed in which a capacitor must charge to 55 percent (.55) of the maximum charging voltage in 200 microseconds. The resistor has a value of 30,000 ohms. What value of capacitance is needed?
1. 0.0089 pF
2. 89.0 pF
3. 0.0089 µF
4. 89.0 µF

MATCH THE CAPACITOR CONFIGURATION IN COLUMN B WITH THE CHARACTERISTICS IN COLUMN A.

A. CHARACTERISTICS
B. CONFIGURATION

3-43. Increases total capacitance
1. Capacitors in parallel
3-44. Effectively moves plates further apart
2. Capacitors in series
3-45. Increases plate area
3-46. Total capacitance is found by adding all capacitances
3-47. Decreases total capacitance
3-48. Similar to resistors in parallel

3-49. A circuit contains four parallelconnected capacitors of 33 µF each. What is the total capacitance of the circuit?
1. 8.3 µF
2. 33.0 µF
3. 183.0 µF
4. 132.0 µF

3-50. A circuit contains two series-connected capacitors of 15 µF, and 1500 pF. What is the total capacitance of the circuit?
1. 0.0015 pF
2. 150.0 pF
3. 0.0015 µF
4. 0.1500 µF

3-51. A circuit contains two 10 µF capacitors wired together in a parallel configuration. The two parallel-wired capacitors are wired in series with a 20 µF capacitor and a 20 K ohm resistor. Which of the following expresses the RC time constant for this circuit?
1. .2 sec
2. 2 sec
3. 20,000 sec
4. Both 2 and 3 above

3-52. How are fixed capacitors classified?
1. By their plate size
2. By their dielectric materials
3. By the thickness of their dielectric materials
4. By the thickness of their conductors

3-53. Which of the following types of capacitors are referred to as selfhealing?
1. Ceramic
2. Paper
3. Oil
4. Mica

MATCH THE CAPACITOR TYPE IN COLUMN B WITH THE CHARACTERISTIC IN COLUMN A.

A. CHARACTERISTIC
B. TYPE

3-54. Has an oxide film dielectric
1. Electrolytic
3-55. Can be adjusted by a screw setting
2. Trimmer
3-56. A polarized capacitor 3. Mica
3-57. Has a waxed paper dielectric
4. Paper
3-58. An adjustable capacitor with a mica dielectric

Figure 3F.—Types of capacitors.

IN ANSWERING QUESTIONS 3-59 THROUGH 3-63, REFER TO FIGURE 3F AND TO THE ASSOCIATED PAGES IN YOUR TEXTBOOK.

3-59. Capacitor A is what type of capacitor?
1. Electrolytic
2. Ceramic
3. Paper
4. Mica

3-60. Capacitor B is what type of capacitor?
1. Mica
2. Paper
3. Ceramic
4. Electrolytic

3-61. What is the capacitance of capacitor B?
1. 2,200,000 pF
2. 2,200,000 µF
3. 72,000 pF
4. 72,000 µF

3-62. What is the (a) temperature coefficient and (b) multiplier of capacitor C?
1. (a) -30 (b) 100
2. (a) -30 (b) 1000
3. (a) -330 (b) 100
4. (a) -330 (b) 1000

3-63. What is the (a) capacitance, and (b) voltage rating of capacitor D?
1. (a) 4800 µF (b) 200 volts
2. (a) 4800 pF (b) 200 volts
3. (a) 98,000 µF (b) 800 volts
4. (a) 980,000 pF (b) 800 volts

ASSIGNMENT 4

Textbook assignment: Chapter 4, "Inductive and Capacitive Reactance," pages 4-1 through 4-40. Chapter 5, "Transformers," pages 5-1 through 5-31.

4-1. Inductance has what effect, if any, on a change in (a) current, and (b) voltage?
1. (a) No effect (b) aids it
2. (a) Aids it (b) no effect
3. (a) Opposes it (b) no effect
4. (a) No effect (b) opposes it

4-2. Voltage leads current in which of the following types of circuits?
1. Resistive
2. Capacitive
3. Both 1 and 2 above
4. Inductive

4-3. Opposition to the flow of current by a coil in an ac circuit is represented by what symbol?
1. R
2. XL
3. L
4. H

4-4. What is the opposition offered by a coil to (a) the flow of alternating current and (b) a change in current?
1. (a) Resistance (b) Inductance
2. (a) Reactance (b) Counterreactance
3. (a) Reactance (b) Inductance
4. (a) Resistance (b) Reactance

4-5. The formula 2□fL is used to determine what electrical quantity?
1. Resistance
2. Inductance
3. Counterreaction
4. Inductive reactance

4-6. An inductive circuit contains a 200-µH coil and the ac voltage applied is at a frequency of 120 Hz. What is the value of reactance for the circuit?
1. 0.15 Ω
2. 1.50 □
3. 7.50 □
4. 75.0 □

4-7. If the frequency applied to a circuit with a 200-µH coil is increased from 120 Hz to 50 kHz, what will be the value of reactance for the circuit?
1. 1.0.75 □
2. 2.7.5 □
3. 3.62.8 Ω
4. 628.0 □

4-8. A capacitor will (a) conduct what type of current, and (b) block what type of current?
1. (a) Dc (b) All ac
2. (a) All ac (b) Dc
3. (a) Dc (b) Ac above 60 Hz
4. (a) Ac above 60 Hz (b) Dc

THIS SPACE LEFT BLANK INTENTIONALLY.

IN ANSWERING QUESTIONS 4-9 THROUGH 4-13, SELECT FROM COLUMN B THE PROPERTY THAT CAUSES THE ELECTRICAL EFFECT IN COLUMN A.

4-14. An electrical circuit contains a 25-µF capacitor and operates from a 60-Hz ac source. What is the value of capacitive reactance of the circuit?
1. 0.00106 □
2. 0.0106 □
3. 10.6 □
4. 106.2 Ω

THIS SPACE LEFT BLANK INTENTIONALLY.

IN ANSWERING QUESTIONS 4-15 AND 4-16 USE THE FOLLOWING INFORMATION: A SERIES CIRCUIT HAS AN INDUCTIVE REACTANCE OF 56□, A

CAPACITIVE REACTANCE OF 25Ω, AND OPERATES AT A FREQUENCY OF 400 HZ.

4-15.What formula should you use to determine the total reactance for the circuit?

1. $X = 2\pi fL$
2. $X = \frac{1}{2\pi fC}$
3. $X = X_L - X_C$
4. $X = X_C - X_L$

4-16. What is the total value of reactance for the circuit?
1. 31Ω
2. 81Ω
3. 1,400Ω
4. 14,067Ω

4-17. What term is used to express the total opposition to ac in an electrical circuit?
1. Reactance
2. Impedance
3. Resistance
4. Conductance

4-18. A series ac circuit has the following values: XL = 5Ω, XC = 6Ω, and R = 7Ω. What is the value of Z?
1. 1.00Ω
2. 3.03Ω
3. 7.07 Ω
4. 14.14Ω

4-19. A series circuit contains an inductor having 12 ohms of resistance and 30 ohms of inductive reactance in series with a capacitor having 21 ohms of capacitive reactance. The applied voltage is 100 volts. What is the value of current for the circuit?
1. 6.6 amps
2. 8.4 amps
3. 15.0 amps
4. 25.6 amps

4-20. A series circuit contains an inductor having 12 ohms of resistance and 64 ohms of inductive reactance in series with a capacitor having 69 ohms of capacitive reactance. If the current through the circuit is 6.5 amperes, what is the value of the voltage applied to the circuit?
1. 26.5 volts
2. 55.5 volts
3. 75.5 volts
4. 84.5 volts

4-21. True power in a circuit is dissipated in what circuit element?
1. Resistance
2. Reactance
3. Capacitance
4. Inductance

4-22. In a purely reactive circuit, what happens to power?
1. It is dissipated across the reactive returned to the source
loads
2. It is cancelled by the reactive elements
3. It is stored in the reactive elements
4. It is returned to the source

4-23. True power is measured in what unit?
1. Watt
2. Volt-ampere
3. Var
4. Pt-watt

4-24. An ac series circuit has the following characteristics: R = 8 ohms, XC = 100 ohms, XL = 70 ohms, and E = 220 V. What is the value of true power for the circuit?
1. 46 W
2. 57 W
3. 268 W
4. 402 W

4-25. What is the unit of measurement for

reactive power?
1. Watt
2. Var
3. Volt-ampere
4. Volt-ohm

4-26. An ac series circuit has the following values: I = 7.5 amps, X L = 80Ω, and XC = 35Ω. What is the value of reactive power for the circuit?
1. 2531 var
2. 1567 var
3. 1283 var
4. 861 var

4-27. Apparent power in an ac circuit is a combination of which of the following factors?
1. Applied power and true power
2. Reactive power and true power
3. Applied power and the power returned to the source
4. Reactive power and the power

4-28. What is the unit of measurement for apparent power?
1. Watt
2. Var
3. Volt-ampere
4. Volt-ohm

4-29. An ac circuit dissipates 800 watts across its resistance and returns 600 var to the source. What is the value of the apparent power of the circuit?

4-30. The portion of apparent power dissipated in an ac circuit can be calculated by which of the following formulas?

1. $PF = (I_R)^2 R$
2. $PF = (I_Z)^2$
3. $PF = \frac{(I_Z)^2 Z}{(I_Z)^2 R}$
4. $PF = \frac{(I_R)^2 R}{(I_Z)^2 Z}$

4-31. A series ac circuit has a XC of 110 ohms, an X L of 30 ohms, and a circuit resistance of 22 ohms. What is the power factor of this circuit?
1. .91
2. .27
3. .20
4. .13

IN ANSWERING QUESTIONS 4-32 THROUGH 4-36, REFER TO FIGURE 4A.

4-32. What is the value of X?
1. 19.7 Ω
2. 27.8 Ω
3. 31.6 Ω
4. 42.3 Ω

4-33. What is the value of Z?
1. 23 Ω
2. 28 Ω
3. 33 Ω
4. 38 Ω

4-34. What is the value of IT for the circuit?
1. 1.8 A
2. 2.8 A
3. 3.4 A
4. 4.4 A

4-35. What is the value of true power?
1. 67 W
2. 83 W
3. 94 W
4. 125 W

4-36. What is the power factor?
1. .46
2. .52
3. .73
4. .88

4-37. When impedance is calculated for a parallel ac circuit, an intermediate value must first be calculated. The intermediate value must then be divided into the source voltage to derive

impedance. What is this intermediate value?
1. Reactance
2. Resistance
3. Power factor
4. Total current

4-38. Which of the following defines transformer action?
1. The transfer of energy from one circuit to another through electromagnetic action
2. The transfer of energy from one circuit to another through electrostatic action
3. The development of counter electromotive force where a magnetic field cuts a coil
4. The development of a voltage across a coil as it cuts through a magnetic field

Figure 4A.—Circuit characteristics.

271. 200 VA

2. 500 VA

3. 1000 VA

4. 1400 VA

4-39. Which of the following is NOT a necessary element in a basic transformer?
1. A core
2. A primary winding
3. A secondary winding
4. A magnetic shield

4-40. What three materials are most commonly used for transformer cores?
1. Copper, soft iron, and air
2. Copper, soft iron, and steel
3. Air, copper, and steel
4. Air, soft iron, and steel

4-41. The two types of transformer cores most commonly used are the shell-core and the
1. I-core
2. E-core
3. hollow-core
4. laminated-core

4-42. What is the major difference between the primary and secondary windings of a transformer?
1. The primary has more turns than the secondary
2. The secondary has more insulation than the primary
3. The primary is connected to the source; the secondary is connected to the load
4. The primary is connected to the load; the secondary is connected to the source

4-43. What is the principal difference between a high-voltage transformer and a lowvoltage transformer?
1. A high-voltage transformer has more turns of wire than a lowvoltage transformer
2. A high-voltage transformer uses a hollow-core, while a low-voltage transformer uses a shell-type core
3. A high-voltage transformer uses a shell-type core, while a low-voltage transformer uses a hollow-core
4. A high-voltage transformer has more insulation between the layers of windings than does a low-voltage transformer

THIS SPACE LEFT BLANK INTENTIONALLY.

4-47. When the secondary of a transformer is NOT connected to a circuit, the transformer is said to be operating under which of the following conditions?

1. Uncoupled

2. No-load
3. Loaded
4. Open

4-48. What term applies to the current in the primary of a transformer that creates the magnetic field?
1. Exciting current
2. Primary current
3. Magnetizing current
4. Counter current

4-49. In the primary of a transformer, what opposes the current from the source?
1. The impedance
2. The forward emf
3. The self-induced emf
4. The exciting current

4-50. What is the source of the magnetic flux that develops secondary voltage in a transformer?
1. Primary emf
2. Secondary counter emf
3. Primary exciting current
4. Secondary exciting current

4-51. The illustrated transformer is (a) what type, and (b) in what direction is the current flowing in the secondary?
1. (a) Like-wound (b) ↑
2. (a) Unlike-wound (b) ↑
3. (a) Like-wound (b) ↓
4. (a) Unlike-wound (b) ↓

4-52. Which of the following terms applies to the flux from the primary that does NOT cut the secondary
1. Lost flux
2. Leakage flux
3. Uncoupled flux
4. Coefficient flux

4-53. What is the main cause for the coefficient of coupling of a transformer being less than unity?

1. Counter emf
2. Induced emf
3. Uncoupled flux
4. Leakage flux

4-54. A transformer has a source voltage of 50 volts ac, with a turns ratio of 1:6. The coefficient of coupling is 1.0. What is the voltage of the secondary winding?

1. 150
2. 300
3. 500
4. 600

4-55. A transformer has a unity coefficient of coupling with a 5:1 turns ratio; 20 volts are induced in the secondary. What is the primary voltage?

1. 100 volts
2. 50 volts
3. 10 volts
4. 4 volts

4-56. A transformer has a unity coefficient of coupling. Thirty-five volts applied to its primary induces 105 volts in its secondary. The secondary is composed of 99 turns. What is the number of turns in the primary?
1. 11 turns
2. 22 turns
3. 33 turns
4. 44 turns

4-57. A transformer secondary has 20 amperes of current flowing at 60 volts potential. The applied voltage is 10 volts. What is (a) the turns ratio of the transformer and (b) what total current is flowing in the primary?
1. (a) 6:1, (b) 3.3 amperes
2. (a) 1:6, (b) 120 amperes
3. (a) 1:2, (b) 10 amperes
4. (a) 2:1, (b) 120 amperes

4-58. A 2:1 transformer delivers 30 watts to

the load and 3 watts of power are lost to internal losses. What total power is drawn from the source?

1. 63 watts
2. 57 watts
3. 33 watts
4. 27 watts

4-59. What is the efficiency of the transformer described in question 4-58?

1. 33 %
2. 46 %
3. 53 %
4. 91 %

THIS SPACE LEFT BLANK INTENTIONALLY.

A. LOSS TYPE
4-60. Power lost in realigning domains
4-61. Power dissipated by the resistance of the windings
4-62. Power loss caused by random core currents

B. TERMS
1. Copper loss
2. Eddy-current loss
3. Hysteresis loss
4. Leakage Loss

4-63. A transformer designed for a low frequency will NOT be damaged when used at higher frequencies. What change within the transformer, limits transformer current to a safe value at higher frequencies?
1. Increased hysteresis loss
2. Increased inductive reactance
3. Increased leakage flux
4. Increased eddy-current loss

IN ANSWERING QUESTIONS 4-64 THROUGH 4-67, SELECT THE TRANSFORMER TYPE FROM COLUMN B THAT PERFORMS THE TASK OR HAS THE CHARACTERISTICS DESCRIBED IN COLUMN A.
A. TASK
4-64. Used above 20 kHz
4-65. The secondary is a tapped primary
4-66. Used to deliver voltage from a source to a load
4-67. Can be used to match impedance in a sound system

B. TRANSFORMER TYPE
1. Power
2. Autotransformer
3. Audio-Frequency
4. Radio-Frequency

4-68 What wire colors conventionally identify the secondary center tap of a power transformer?
1. Black and yellow
2. Red and white
3. Black and red
4. Red and yellow

4-69. Before starting to work on any electrical equipment, you should first determine that the equipment is in which of the following conditions?
1. Connected
2. Deenergized
3. Energized
4. Operational

4-70. A person is working on electrical equipment. The power is secured and tagged. The technician receives a shock on the hand. What safety precaution was overlooked?
1. The technician was not standing on

approved rubber matting
2. The technician had not discharged the equipment's capacitors
3. The technician was working on energized equipment
4. The technician had two hands in the Equipment

4-71. When working on electrical equipment, why should you use only one hand?
1. The free hand can be used to turn off the power in case of shock
2. The free hand can be used to pull the other hand free in case of muscle contraction from shock
3. The free hand will ensure that you are properly grounded
4. The free hand will minimize the possibility of creating a low resistance path to ground through your body

MODULE 3

INTRODUCTION TO CIRCUIT PROTECTION, CONTROL, AND MEASUREMENT

PREPARED BY:

Jenilyn Fabian

1-1. Circuit measurement is used for which of the following purposes?
1. To find the weight of a circuit
2. To increase the power used in a circuit
3. To discover the length and width of a circuit
4. To determine the reason a circuit is not functioning properly

1-2. An in-circuit meter is used for which of the following purposes?
1. To reduce circuit losses
2. To monitor circuit operation
3. To control power to a circuit
4. To prevent circuit overload conditions

1-3. Out-of-circuit meters have which of the following advantages over in circuit meters?
1. They can be used on more than one device
2. They are lighter weight
3. They are more rugged
4. All of the above

1-7. The d'Arsonval meter movement is based on which of the following principles?
1. Moving vane
2. Electrostatic
3. Electrodynamic
4. Permanent-magnet moving-coil

1-8. Current through a meter results in the pointer. In d'Arsonval meter movement, what force produces this deflection?
1. Thermocouple action
2. Electrostatic repulsion
3. Mechanical spring tension
4. The interaction of magnetic fields

1-9. The hairsprings in a d'Arsonval meter movement perform which of the following functions?
1. They keep the pointer in the position of the last indication when current is removed
2. They aid the movement of the pointer when there is current through the meter
3. They make electrical connections to the meter movement
4. All of the above

1-12. What device allows a d'Arsonval meter movement to measure ac by converting ac to pulsating dc?
1. A pulsator
2. A modulator
3. A rectifier
4. A converter

1-13. What is meant by the term "meter damping"?
1. Moistening the felt pads
2. Smoothing the oscillations of the pointer
3. Preventing excessive current through the coil
4. Compensating for electromagnetic induced interference

1-14. Which of the following methods is used to dampen a meter?
1. Mount the meter in a mu-metal case
2. Install a fuse in one of the input leads
3. Incorporate an airtight chamber containing a van
4. Provide a fluid reservoir and sponge arrangement next to the pads

1-15. A d'Arsonval meter movement reacts to which of the following values of voltage?
1. Peak
2. Average
3. Effective
4. Peak-to-peak

1-16. What value of ac is indicated by a meter scale?
1. Peak
2. Average
3. Effective
4. Peak-to-peak

1-17. Which of the following meter movements will measure either ac or dc without the use of a rectifier?
1. GMS
2. d'Arsonval
3. Electrostatic
4. Electrodynamic

Prepared by: Harlem A. Agnote

1-18. What electrical property is reacted to by the electrodynamic, d'Arsonval, movingvane, and thermocouple meter movements?
1. Power
2. Current
3. Voltage
4. Resistance

1-19. What electrical property is measured by an ammeter?
1. Power
2. Current
3. Voltage
4. Resistance

1-20. How are ammeters connected in an electrical circuit?
1. In series with the load
2. In parallel with the load
3. In accordance with Lenz's Law
4. In series-parallel with the load

1-21. How does an ammeter affect the circuit being measured?
1. It acts as a resistances in series and lowers the circuit current
2. It acts as a resistance in series and raises the circuit current
3. It acts as a resistance in parallel and lowers the circuit current
4. It acts as a resistance in parallel and raises the circuit current

1-22. How is the effect that an ammeter produces in a circuit kept to a minimum?
1. By using a large resistor in series with the ammeter
2. By using a large capacitor in parallel with the ammeter
3. By ensuring that the meter resistance is low compared to circuit resistance
4. By ensuring that the meter resistance is high compared to circuit resistance

1-23. The ammeter with the greatest sensitivity has which of the following characteristics?
1. The lowest amount of current for fullscale deflection indication
2. The highest amount of current for fullscale deflection indication
3. A low ratio of internal resistance to full-scale deflection indication
4. A high ratio of internal resistance to full-scale deflection indication

1-24. Ammeters measure various ranges through the addition of which of the following components?
1. Shunt resistors in series with the meter movement
2. Shunt resistors in parallel with the meter movement
3. Capacitors in series with the meter movement
4. Capacitors in parallel with the meter movement

1-25. What range of an ammeter should you use for an initial measurement?
1. The lowest range
2. The highest range
3. The mid-scale range

1-26. What portion of the ammeter scale should be used to take a final reading?
1. The upper half
2. The lower half
3. The mid-scale portion
4. Anywhere on the meter face

1-27. When, if ever, can you use a dc ammeter to measure ac values?
1. When the ac is high frequency
2. For low values
3. Always
4. Never

1-28. Which of the following safety precautions should be observed prior to connecting an ammeter into a circuit?
1. Switch to the highest range
2. Observe proper dc polarity
3. Deenergize the circuit
4. All of the above

Prepared by: Harlem A. Agnote

1-29. What electrical property is measured by a voltmeter?
1. Power
2. Current
3. Voltage
4. Resistance

1-30. A voltmeter should be connected in an electrical circuit in what manner?
1. In series with the load
2. In parallel with the load
3. In accordance with Lenz's Law
4. In series-parallel with the load

1-31. A voltmeter has an effect on the circuit being measured; what is this effect called?
1. Loading
2. Damping
3. Rectification
4. Eddy-current drag

1-32. To keep the effect of a voltmeter on a circuit to a minimum, the internal resistance of the voltmeter must have which of the following relationships to the circuit load?
1. Equal to
2. Lower than
3. Higher than
4. In proportion to

1-33. Which of the following types of meters can be made from a current sensitive meter movement?
1. Ammeter
2. Ohmmeter
3. Voltmeter
4. Each of the above

1-34. A voltmeter has a high sensitivity when it has which of the following characteristics?
1. Low deflection indication
2. High deflection indication
3. Low ratio of internal resistance to fullscale deflection indication
4. High ratio of internal resistance to full-scale deflection indication

1-35. Which of the following configurations extends the range of a voltmeter?
1. A resistor in series with the meter movement
2. A resistor in parallel with the meter movement
3. A capacitor in series with the meter movement
4. A capacitor in parallel with the meter movement

1-36. What voltmeter range should be used for initial measurements?
1. The lowest
2. The highest
3. The mid-scale

1-37. The electrostatic meter movement reacts to which of the following electrical properties?
1. Power
2. Current
3. Voltage
4. Resistance

1-38. Electrostatic meter movements are used to measure which of the following current/voltage values?
1. Low voltage
2. Low current
3. High voltage
4. High current

1-39. Which of the following safety precautions should be observed when a voltmeter is used?
1. Deenergize the circuit before connecting the meter
2. Start with the lowest range of the meter
3. Connect the meter in series with the circuit
4. All of the above

1-40. What electrical property is measured with an ohmmeter?
1. Power
2. Current
3. Voltage
4. Resistance

1-41. An ohmmeter is used to check for which of the following conditions?
1. Continuity
2. Overheating
3. Overcurrent
4. Undercurrent

1-42. How should an ohmmeter be connected in an electrical circuit?
1. In series with the load
2. In parallel with the load
3. In parallel with the source
4. In series-parallel with the load

1-43. An ohmmeter can measure different ranges because of the use of which of the following components?
1. Range coils
2. Range resistors
3. Range capacitors
4. Range potentiometers

1-44. What area of an ohmmeter scale should be used when a measurement is taken?
1. Upper half
2. Lower half
3. Mid-scale portion
4. Anywhere on the meter face

1-45. Ohmmeter are classified by type. What are the two types of ohmmeters?
1. Series and shunt
2. Normal and reverse
3. Full- and half-scale

1-46. What is the most obvious differences in the two types of ohmmeters?
1. The ranges of the meters
2. The scales of the meters
3. The power sources of the meters
4. The size of the test leads of the meters

1-47. Which of the following safety precautions should be observed when an ohmmeter is used?
1. Always start with the highest scale of the meter
2. Deenergize the circuit before connecting the meter
3. Observe proper polarity
4. All of the above

1-48. Meggers (megohmmeters) are used to measure which of the following quantities?
1. Low voltage
2. High voltage
3. Low resistance
4. High resistance

1-49. When a megger is used to check the insulation of a wire, which of the following indications should be considered normal?
1. ∞
2. 0
3. 500 V
4. 1000 V

1-50. Which of the following safety precautions should be observed when a megger is used?
1. Do not use a dc megger to measure circuits that are powered by ac
2. Always start with the highest scale selection of the meter
3. Do not touch the meter leads when a measurement is being taken
4. All of the above

1-51. A multimeter can be used to measure which of the following electrical properties?
1. Voltage
2. Current
3. Resistance
4. Each of the above

1-52. The function switch on a multimeter does NOT perform which of the following functions?
1. Selection of the meter range
2. Determination of the proper scale
3. Selection of ac or dc capability
4. Changing of the multimeter from an ammeter to a voltmeter

Prepared by: Harlem A. Agnote

1-53. One of the problems encountered in building a multimeter is that the meter movement gives different readings for the same values of ac and dc. Which of the following features of a multimeter will solve this problem?
1. A rectifier
2. An ac/dc switch
3. Separate scales for ac and dc
4. A mirror on the face of the meter

1-54. Why is there a mirror on the face of a multimeter?
1. To illuminate the meter face
2. To aid in reducing parallax error
3. To reduce the friction between the pointer and the meter face
4. To compensate for the difference in ac and dc measurements

1-55. If the mirror on the face of a multimeter is used properly, where will the image of the pointer appear?
1. Hidden behind the pointer
2. Barely visible on either side of the pointer
3. Clearly visible to the left of the pointer
4. Clearly visible to the right of the pointer

1-56. Which of the following safety precautions does NOT apply to a multimeter?
1. Observe proper dc polarity when measuring dc
2. Deenergize the circuit before connecting the meter
3. Be sure the meter is switched to ac for ac measurements
4. Never apply power to the circuit when measuring voltage with the meter

1-57. If a multimeter has no OFF position, and it is returned to storage, on which of the following positions should the meter be set?
1. +dc; highest voltage range
2. dc; higher resistance range
3. Ac; highest voltage range
4. Ac; highest current range

1-58. When the current in a conductor is measured without the conductor being disconnected, which of the following meters could be used?
1. Multimeter
2. Hook-on voltameter
3. Induction wattmeter
4. Transformer voltmeter

1-59. Which of the following electrical quantities is measured by a wattmeter?
1. Power
2. Energy
3. Voltage
4. Current

1-60. Which of the following electrical quantities is measured by a watt hour meter?
1. Power
2. Energy
3. Voltage
4. Current

Prepared by: Harlem A. Agnote

CHAPTER 2

2-1. Circuit protection devices are used for which of the following purposes?
1. To protect people
2. To protect circuits
3. To guard against hazardous conditions
4. All of the above

2-2. Which of the following conditions does NOT require the use of a circuit protection device?
1. Direct short
2. High resistance
3. Excessive current
4. Abnormal heating

2-3. When a point in a circuit, where full system voltage is present, comes in direct contact with the ground or return side of the circuit, which of the following terms applies?
1. Direct short
2. High resistance
3. Excessive current
4. Abnormal heating

2-4. When circuit current increases beyond the designed current carrying capability of the circuit, which of the following terms applies?
1. Direct short
2. High resistance
3. Excessive current
4. Abnormal heating

2-5. If the bearings of a generator were to fail, which of the following circuit conditions would probably occur?
1. Direct short
2. High resistance
3. Excessive current
4. Abnormal heating

2-6. How are circuit protection devices connected to the circuit they are protecting?
1. Alongside
2. In series
3. In parallel
4. In series-parallel

2-7. Which of the following two are circuit protection devices?
1. Electrical plugs and CO2 cartridges
2. CO2 cartridges and circuit breakers
3. Fuses and circuit breakers
4. Fuses and electrical plugs

2-14. Which of the following factors is NOT used to rate fuses?
1. Size
2. Current
3. Voltage
4. Time delay

2-15. A fuse current rating has which of the following definitions?
1. The maximum current that can flow through a circuit without causing the circuit to overheat
2. The maximum current that will flow through a circuit if there is a direct short
3. The maximum current that will flow through a fuse without opening the fuse
4. The maximum current that will not"jump" an open fuse

2-16. A fuse voltage rating has which of the following definitions?
1. The maximum voltage that can exist in a circuit without causing the circuit to overheat
2. The maximum voltage that can exist in a circuit if there is a direct short
3. The maximum voltage across a fuse that will not cause the fuse to open
4. The maximum voltage across a fuse that will not jump the open fuse

2-20. What is the voltage rating for a fuse with the designation F03D1R00B?
1. 32 V or less
2. 125 V or less
3. 250 V or less
4. 500 V or less

2-21. What is the current rating for a fuse with the designation F03B0R50B?
1. 1/2 amp

Prepared by: Harlem A. Agnote

2. 1.5 amp
3. 3 amp
4. 50 amp

2-22. What is the time-delay rating for a fuse with the designation F03A20R0C?
1. Fast
2. Delay
3. Standard
4. Intermediate

2-23. What is the voltage rating for a fuse with the designation F02B250V10AS?
1. 10 V or less
2. 32 V or less
3. 52 V or less
4. 250 V or less

2-24. What is the current rating for a fuse with the designation F03A125V5A?
1. 125 amp
2. 5 amp
3. 3 amp
4. 1/8 amp

2-25. What is the time-delay rating for a fuse with the designation F04C125V2AS?
1. Fast
2. Delay
3. Standard
4. Intermediate

2-26. What is the voltage rating for a fuse with the designation 3AG20125V?
1. 20 V or less
2. 90 V or less
3. 125 V or less
4. 250 V or less

2-27. What is the current rating for a fuse with the designation 3AG1032V?
1. 1 amp
2. 2 amp
3. 3 amp
4. 10 amp

2-28. What is the voltage rating for a fuse with the designation AGC5125V?
1. 12 V or less
2. 25 V or less
3. 51 V or less
4. 125 V or less

2-29. What is the current rating for a fuse with the designation AGC2125V?
1. 1 amp
2. 2 amp
3. 3 amp
4. 25 amp

2-30. What is the new military designation for a fuse with the old, military designation F03D1R50B?
1. F03A125V1.5A
2. F02B125V1.5A
3. F03A250V11/2A
4. F03B125V1.5A

2-35. Which of the following methods will provide an ABSOLUTE determination as to whether or not a fuse is open?
1. A visual inspection
2. A check of the fuse indicator
3. A voltmeter check of the fuse
4. A thermometer check of the temperature of the fuse

2-36. A fuse is removed from a circuit, checked with an ohmmeter, and found to be shorted. What action should be taken?
1. Discard the fuse
2. Check the fuse with a voltmeter
3. Put the fuse back in the circuit
4. Return the fuse to the supply department

2-37. Which of the following methods should be used to check a .002 ampere fuse?
1. Use a megger and place a capacitor in parallel with the fuse
2. Use a megger and place a capacitor in series with the fuse
3. Use an ohmmeter and place a resistor in parallel with the fuse

4. Use an ohmmeter and place a resistor in series with the fuse

2-38. What should you use to remove a fuse from a clip-type fuseholder?
1. A scribe
2. A fusepuller
3. A screwdriver
4. A pair of pliers

2-39. Which of the following is a safety precaution to be observed when a fuse is checked?
1. Turn the power off and discharge the circuit before the fuse is removed
2. When you check a fuse with an ohmmeter, be careful to avoid short circuits
3. When you use a voltmeter to check a low current fuse, be careful to avoid opening the fuse by excessive current from the voltmeter
4. All of the above

2-47. Before replacing a fuse, you should check for which of the following conditions?
1. Proper fit
2. Proper fuse
3. Both 1 and 2 above
4. Proper input voltage

2-48. Which of the following is NOT a safety precaution to be observed when a fuse is changed?
1. Be sure to "tag out" the fuseholder when you remove the fuse
2. Remove the power from a circuit before removing and replacing a fuse
3. Remove any corrosion from the fuseholder before replacing a fuse
4. Be sure the fuse fits properly in the fuseholder

2-49. When you perform preventive maintenance on fuses, which of the following is NOT a condition you should check?
1. Corrosion
2. Shorted fuse
3. Improper fit
4. Improper fuse

2-50. What is the total number of main components in a circuit breaker?
1. Five
2. Two
3. Three
4. Four

2-51. Which of the following is NOT a type of trip element for a circuit breaker?
1. Thermal
2. Magnetic
3. Mechanical
4. Thermal-magnetic

2-55. A circuit breaker that will trip even if the operating mechanism is held ON is known as what type of circuit breaker?
1. Standard
2. Emergency
3. Trip free
4. Nontrip free

2-56. What type of circuit breaker can be overridden if the operating mechanism is held ON?
1. Standard
2. Emergency
3. Trip free
4. Nontrip free

2-57. Which of the following is NOT a timedelay rating for a circuit breaker?
1. Long
2. Short
3. Standard
4. Instantaneous

2-58. Selective tripping is used to cause which of the following circuit breakers to trip when there is an overload?
1. The least expensive
2. The most accessible
3. The smallest current rating
4. The closest to the fault

2-59. Selective tripping is used to accomplish which of the following purposes?
1. To reduce wear and tear on circuit breakers

2. To isolate a faulty circuit without affecting othercircuits
3. To simplify the task of resetting the circuit breaker
4. To enable the application of power to emergency circuits during an overload

2-63. The following actions must be taken prior to working on a circuit breaker. Arrange these items in the proper sequence, then select the choice below that lists the events in the proper sequence.
A. Tag the power switch
B. Obtain the approval of the electrical officer
C. Remove power to the circuit breaker
D. Check the applicable technical manual
1. A, B, C, D
2. C, B, D, A
3. D, B, C, A
4. B, A, D, C

2-64. Which of the following items is NOT checked during maintenance on a circuit breaker?
1. Input power voltage
2. Operating mechanism smoothness
3. Terminal tightness and corrosion
4. Contact surfaces for pitting

CHAPTER 3

3-1. Circuit control devices should NOT be used for which of the following reasons?
1. To adjust the power level of a device
2. To remove power from a malfunctioning device
3. To apply power to a device when work is completed on it
4. To select the function or circuit desired within a device

3-2. Which of the following are types of circuit control devices?
1. Relays
2. Switches
3. Solenoids
4. All of the above

3-6. Which of the following is a manual switch?
1. A light switch
2. A limit switch
3. A thermostat
4. A distributor

3-7. Which of the following is an automatic switch?
1. An ignition switch on a motor vehicle
2. A switch that turns on a light in a refrigerator
3. A channel selector on a television
4. A dial or push button on a telephone

3-8. Control or selection of one or more circuits is a function of which of the following switches?
1. A manual switch
2. An automatic switch
3. A multicontact switch
4. A single contact switch

3-25. A switch actuator is described by which of the following terms?
1. Momentary
2. Two-position
3. Toggle
4. Four-position

3-26. What is the maximum number of different single-pole, single throw switch positions possible?
1. One
2. Two
3. Three
4. Four

3-27. What is the maximum number of different single-pole, double throw switch positions possible?
1. One
2. Two
3. Three
4. Four

3-28. Control of a circuit requiring a temporary actuation signal is provided by which of the following switches?
1. Momentary
2. Locked-in
3. Locked-out
4. Rotary

3-29. To guard against the accidental actuation of a circuit, which of the following types of switches are used?
1. Momentary
2. Locked-in
3. Locked-out
4. Rotary

3-30. To guard against the accidental turning off of a circuit, which of the following types of switches areused?
1. Momentary
2. Locked-in
3. Locked-out
4. Rotary

3-31. What is the common name for a accurate snap-acting switch?
1. Maxiswitch
2. Multiswitch
3. Miniswitch
4. Microswitch

3-32. Designation of switch current rating is based on which of the following current values?
1. Maximum
2. Minimum
3. Nominal
4. Average

3-33. Designation of switch voltage rating is based on which of the following voltage values?
1. Maximum
2. Minimum
3. Nominal
4. Average

3-34. Checking a switch with the circuit power NOT applied is accomplished by using which of the following meters?
1. Wattmeter
2. Frequency meter
3. Temperature meter
4. Ohmmeter

3-35. Checking a switch with the power applied is accomplished by using which of the following meters?
1. Megger
2. Ohmmeter
3. Wattmeter
4. Voltmeter

3-46. When you perform preventive maintenance on a switch, which of the following items should be checked?
1. The terminals for corrosion
2. The physical condition of the switch
3. The switch operation for smooth and correct operation
4. All of the above

3-47. A solenoid is based upon which of the following principles?
1. A bimetallic strip bends when it is heated
2. A thermocouple produces a current when heated
3. A coil attracts a soft iron core when current flows in the coil
4. A soft iron core moving in a magnetic field creates a current

3-48. A solenoid is commonly used in which of the following devices?
1. A fuel quantity indicating system
2. A shipboard lighting system
3. A sound-powered telephone system
4. A starter for a motor vehicle

3-49. If a solenoid is not operating properly,which of the following items need NOT be checked?
1. Coil
2. Armature
3. Plunger
4. Energizing voltage

3-55. If a relay is hermetically sealed with an opaque cover, which of the following methods should be used to determine whether the relay is operating?
1. Shake the relay and listen for loose parts
2. Place your finger on the cover and feel the relay contact movement
3. Remove the cover and visually observe the relay contacts when the relay is activated
4. Activate the relay and observe whether a metal object is attracted by the magnetic field

3-56. If a relay is NOT operating properly, which of the following items need NOT be checked?
1. The armature resistance
2. The terminal leads
3. The contact surfaces
4. The contact spacing

3-57. What should be used to clean the contacts of a relay?
1. Sandpaper
2. Emery cloth
3. A jeweler's file
4. A burnishing tool

Prepared by: Harlem A. Agnote

3-58. What should be used to adjust contact clearances on a relay?

1. A point bender

2. A burnishing tool
3. A pair of pliers
4. A pair of hemostats

MODULE 4

INTRODUCTION TO ELECTRICAL CONDUCTORS, WIRING TECHNIQUES, AND SCHEMATIC READING

PREPARED BY:

Harlem A. Agnote, BSECE

1-1. Why has a "unit size" for conductors been established?
1. To compare the size and resistance of one conductor with that of another
2. To establish a uniform style for conductors
3. To determine the requirements for conductors
4. To ensure all conductors are interchangeable

1-2. What is the decimal equivalent of one (1) mil?
1. 1.000 in.
2. 0.100 in.
3. 0.010 in.
4. 0.001 in.

1-3. If a conductor has a diameter of 1/4 inch, what is its diameter in mils?
1. 250.0 mil
2. 25.0 mil
3. 2.50 mil
4. 0.250 mil

1-4. What is the definition of a mil foot?
1. A conductor .001 foot in length with a diameter of .001 millimeter
2. A conductor 1 foot in length with a diameter of .001 foot
3. A conductor 1 foot in length with a diameter of 1 mil
4. A conductor .001 foot in length with a diameter of .001 inch

1-5. A square mil is defined as the area of a square, the sides of which are each equal in length to what dimension?
1. 1 mil-foot
2. 1 mil
3. 1.0 inch
4. .001 mil

1-7. A circular mil is defined as the area of a circle having what dimension?
1. A radius of 1 mil
2. A diameter of 1 mil
3. A circumference of 1 mil
4. A chord of 1 mil

1-8. If you have a 12-strand conductor and each strand has a radius (one half the diameter) of 2/10 inch, what is the circular mil area of the conductor?
1. 1,920,000 cir. mil
2. 57,680 cir. mil
3. 48,000 cir. mil
4. 2,400 cir. mil

1-9. What is the square mil area for the conductor explained in question 1-8?
1. 244,344,097 sq. mil
2. 1,507,965 sq. mil
3. 61,115 sq. mil
4. 45,239 sq. mil

1-10. What is the definition of specific resistance?
1. The resistance of a length of conductor, at a given temperature, to voltage
2. The resistance of a cross-sectional area of a conductor, at a given temperature, to the flow of current
3. The resistance of a unit volume of a substance to the flow of current expressed in ohms

1-11. What factor(s) must be known to compute the resistance of a conductor?
1. The length of the conductor
2. The cross-sectional area of the conductor
3. The specific resistance of the substance of the conductor
4. Each of the above

1-13. When a wire gauge is used to determine the size of a wire, the measurement should be made in what part of the gauge?
1. In the slot
2. In the semicircular opening
3. Either 1 or 2 above, depending on wire size

A. Conductor size
B. Material of conductor
C. Load requirement
D. Wire ductility

Prepared by: Harlem A. Agnote

E. Type of insulation
F. Location of wire in circuit
G. Source voltage

1-15. What types of insulation are best suited for use in a high-temperature environment?
1. Cotton, polytetrafluoroethylene, and oiled paper
2. FEP, silicone rubber, and extruded polytetrafluoroethylene
3. Oiled paper, FEP, and rubber
4. Rubber. polytetrafluoroethylene, and silk

1-16. What is the "ambient" temperature of a conductor?
1. It is the normal temperature of a conductor through which current is flowing
2. It is the heat generated by external sources and affecting a conductor's temperature
3. It is the maximum heat a conductor can withstand according to its current rating
4. It is the temperature at which the insulation of a conductor begins to break down

1-17. Which of the following metals is the best conductor of current?
1. Aluminum
2. Copper
3. Silver
4. Manganin

1-20. Because its resistance changes very little with temperature changes, what conductor is best suited for use in measuring instruments?
1. Copper
2. Aluminum
3. Manganin
4. Silver

1-21. If a 75-ohm sample of copper wire at 0ºC is heated to 30ºC, what is the approximate total resistance? (The temperature coefficient of resistance of copper at 0ºC is 0.00427).
1. 0.32 ohm
2. 9.61 ohms
3. 65.39 ohms
4. 84.61 ohms

1-22. What definition best describes an insulating material?
1. A material that has a very high resistance
2. A material that has a very low resistance
3. A material that has a very high conductivity
4. A material that has a very low dielectric strength

1-23. The dielectric strength of an insulating material is a measurement of the material's ability to resist electrostatic stress caused by what factor?
1. Resistance
2. Current
3. Voltage
4. Chafing or friction

1-24. Insulation resistance can best be defined as the ability of an insulating material to resist what action?
1. Current leakage
2. Electrostatic stress
3. Breakdown by voltage
4. External factors acting upon the conductor

1-25. For a material to be a good insulator, what two properties are most important?
1. High dielectric strength and low insulation resistance
2. High dielectric strength and high insulation resistance
3. Low dielectric strength and high insulation resistance
4. Low dielectric strength and low insulation resistance

1-26. When rubber is used as the insulating material over a copper conductor, why is a thin coating of tin used between the two materials?
1. To decrease the electrostatic stress
2. To increase the insulation resistance of the rubber
3. To prevent a chemical action from taking place between the copper and rubber
4. To reduce the amount of insulating

material required.

1-27. What is the NEC for a rubber heatresistance
compound?
1. RHH
2. RWH
3. RTW
4. RWT

1-28. Latex rubber is a high-grade compound consisting of what percentage of unmilled grainless rubber?
1. 70%
2. 80%
3. 90%
4. 95%

1-29. Plastic insulation is normally used for what levels of voltage?
1. Very high to high
2. High to medium
3. Medium to low
4. Low to very low

1-30. When dealing with NEC type designators for thermoplastics, the letter "W" stands for what type of insulation?
1. Oil-resistant
2. Moisture-resistant
3. Heat-resistant
4. Asbestos

1-31. When you work on synthetic insulated wiring, what safety precaution must be observed?
1. Wear protective goggles at all times
2. Avoid breathing the vapors when the insulation is **heated**
3. Wear a dust mask in confined spaces
4. Wear protective gloves if there are cuts or abrasions on your hands

1-32. What nonmetallic material is most commonly used to protect wires and cables?
1. Rubber
2. Jute and asphalt covering
3. Fibrous tape
4. Fibrous braid

1-33. What is the common name for woven covers?
1. Yarn
2. Loom
3. Fibrous tape
4. Unspun felted cotton

1-34. What percentage of tin is used in alloylead sheathing?
1. 6%
2. 2%
3. 8%
4. 4%

1-35. Why is the use of asbestos being discontinued as an insulating material in the Navy?
1. It breaks down rapidly with continued use
2. It is not as effective as other types of insulation
3. It has not proven suitable for a shipboard environment
4. It poses a health hazard to personnel

1-36. What happens to asbestos insulation when it gets wet?
1. Its insulation resistance becomes too high
2. It emits dangerous fumes
3. It acquires too great a dielectric strength
4. It becomes a conductor

1-37. What insulating materials are best suited for use with high voltage?
1. Thermoplastic and rubber
2. Varnished cambric and oil impregnated paper
3. Teflon and silk
4. Silk and cotton

1-38. What is the common name for enamel insulated
wire?

1. Winding wire
2. Motor wire
3. Magnet wire
4. Coil wire

1-39. What types of conductor protection are normally used for shipboard wiring?
1. Wire braid armor and nonmagnetic steel tape
2. Lead cable and Jute
3. Jute and nonmagnetic steel tape
4. Lead sheathing and rubberized tape

1-40. What are the basic requirements for a splice or terminal connection?
1. To be mechanically and electrically effective
2. To be preinsulated and nonconductive
3. To have minimum cost and maximum efficiency
4. To have circuit continuity and minimum cost

1-41. The preferred method for removing insulation from most types of insulated wire is by using what tool?
1. Razor blade
2. Electrician's pliers
3. Wire stripper
4. Knife

1-42. When a wire is insulated with glass braid or asbestos and requires stripping, which of the following tools should NOT be used?
1. Knife
2. Rotary wire stripper
3. Hand wire stripper
4. Hot-blade wire stripper

1-43. What is the preferred tool to use to strip aluminum wire?
1. Knife
2. Rotary wire stripper
3. Hand wire stripper
4. Hot-blade wire stripper

1-44. When a Western Union splice is used to connect two wires, why should the twisted ends of the wires be pressed down as close as possible to the straight portion of the wire?
1. To increase the strength of the splice
2. To prevent the wires from puncturing the tape covering
3. To minimize the resistance change in the circuit
4. To increase the dielectric strength of the insulation

1-45. When multiconductor cables are spliced, why are the splices staggered?
1. To prevent possible shorting between conductors
2. To increase the strength of the individual splices
3. To decrease insulated resistance
4. To reduce the overall size of the joint

1-46. When is a rattail joint normally used?
1. When a branch circuit is required and a junction box is used to join conduit
2. When a Western Union splice would be too bulky
3. When asbestos or glass braid is used as insulation
4. When the branch wire will be subjected to a heavy strain

1-47. If a fluorescent light is to be attached to a branch circuit, which of the following splices should normally be used?
1. Staggered splice
2. Knotted tap joint
3. Western Union splice
4. Fixture joint

1-48. When is a knotted tap joint normally used?
1. When a branch circuit is joined to a continuous wire (main wire)
2. When a Western Union splice would be too bulky
3. When a lighting fixture is joined to a branch circuit
4. When a wire nut is used to complete the joint

Prepared by: Harlem A. Agnote

1-49. Which of the following splices is NOT butted?
1. Fixture joint
2. Rattail joint
3. Knotted tap joint
4. Western Union splice

1-50. Why is friction tape used over a splice?
1. To provide a protective covering over the rubber tape
2. To provide maximum insulation to the splice
3. To prevent shock when latex rubber is used
4. To reduce the amount of rubber tape required

1-51. Why would you use a crimped terminal instead of a soldered terminal?
1. Connections can be made more rapidly
2. Less operator skill is required
3. Connections are more uniform in construction
4. Each of the above

1-52. When noninsulated splices and terminal lugs are insulated, what types of insulation are most commonly used?
1. Rubber tape and friction tape
2. Spaghetti and heat-shrinkable tubing
3. Spaghetti and friction tape
4. Rubber tape and heat shrinkable tubing

1-53. When heat-shrinkable tubing is used, what is the maximum temperature to which the wire should be subjected?
1. 180ºF
2. 220ºF
3. 300ºF
4. 340ºF

1-54. When a large aluminum terminal lug or splice is installed, why is it NOT necessary to clean the aluminum wire?
1. It is done automatically by the tubing
2. The wire is cleaned by the abrasive compound in the lug or splice
3. Oxide film does not form on aluminum
4. The insulation used provides the necessary cleaning agent

1-55. When aluminum terminals lugs or splices are installed, which of the following tools is generally recommended for use?
1. Pliers
2. Power crimping tool
3. Hand crimping tool
4. Vise grips

1-56. Why is a lockwasher NOT used with an aluminum terminal?
1. The washer will reduce conductivity at the terminal
2. The washer will gouge the lug and cause deterioration
3. The washer will set up a corrosive action between dissimilar metals
4. The washer will increase resistance and heat causing eventual failure

1-57. The most common method of terminating and splicing wires is by using preinsulated terminal lugs and splices.
1. True
2. False

1-58. Which of the following is an advantage of using preinsulated splices and terminal lugs?
1. Heat shrinkable tubing is not required
2. Spaghetti is not required
3. They offer extra supporting strength to the wire insulation
4. Each of the above

1-59. Color codes are used on preinsulated terminal lugs and splices to indicate what information?
1. The resistance, in ohms, of the lugs and splices
2. The style of crimping tool to be used
3. The type of circuit in which they are to be used
4. The wire sizes on which they are to be used

Prepared by: Harlem A. Agnote

CHAPTER 2

2-1. Why must materials to be soldered be cleaned just prior to the soldering process?
1. To ensure the solder will adhere to the surface
2. To prevent the solder from becoming brittle from impurities and eventually failing
3. To prevent an uneven flow of solder to the surface
4. Each of the above

2-2. What is meant by the term "tinning"?
1. Removing the oxide coating of the material to be soldered
2. Preheating the material to be soldered to remove any impurities left from the stripped insulation
3. Coating the material to be soldered with a light coat of solder
4. Applying pure tin to the material to be soldered to ensure adherence of the solder

2-3. When a wire is soldered to a connector, why should the wire be stripped approximately 1/32 inch longer than the depth of the solder barrel?
1. To prevent burning the wire insulation
2. To allow the wire to flex more easily at stress points
3. Both 1 and 2 above
4. To prevent the flux from touching the insulation

2-4. When a wire has been properly stripped and is to be soldered to a connector, what total length of the exposed wire should be tinned?
1. One-third
2. One-half
3. Two-thirds
4. The entire exposed length

2-5. What action generally causes a fractured solder joint?
1. Movement of the soldered parts during the cooling process
2. Application of too much heat to the parts
3. Introduction of impurities to the joint from dirty solder or flux
4. Application of too much solder to the joint

2-6. What term defines the capacity of a soldering iron to generate and maintain a satisfactory soldering temperature while giving up heat to the joint being soldered?
1. Iron current flow
2. Thermal inertia
3. Resistance soldering
4. Self-regulating heat

2-7. Why should a small wattage soldering iron NOT be used to solder large conductors?
1. The current flow is limited
2. The iron cannot reach a high enough temperature
3. The iron cannot maintain a satisfactory soldering temperature while giving up heat to the conductor
4. The tip of a small wattage iron is too small for large conductors

2-8. Which of the following features BEST describes a well designed soldering iron?
1. It may be used for both large and miniature soldering jobs
2. It is light weight with an all-purpose tip
3. It can be automatically switched from a low wattage to a high wattage output
4.It has a built-in self-regulating element

2-9. What should be done with the removable tip of a soldering gun after it becomes pitted?
1. Dip it in flux and continue to use it
2. Discard the tip and replace it
3. Grind the tip down to the next smaller size and reuse it
4. File the tip smooth and retin it

2-10. If, during the soldering process, the soldering gun switch is depressed for longer than 30 seconds, what danger exists?
1. The insulation of the wire may be burned

2. An oxide film will rapidly form on the conductor
3. The flux may ignite
4. The finger switch may be locked in the depressed position from the heat

2-11. What condition causes the nuts or screws which hold the tip of a soldering gun to loosen?
1. The trigger is depressed for too long a period
2. The gun is pulsed too often
3. The heating and cooling cycle loosens them
4. The gun is used for soldering items beyond its capacity

2-12. Which of the following electronic components should NOT be installed or removed by the use of a soldering gun?
1. Transistors
2. Resistors
3. Capacitors
4. Each of the above

2-13. Why are resistance soldering irons safer for electrical equipment components than other soldering irons or guns?
1. The current flow is very low
2. The tips are hot only during the brief period of actual soldering
3. The transformer provides a high voltage for a measured period of time
4. The tips are made from highly conductive ferrous iron which heat and cool very rapidly

2-14. For which of the following reasons is antisieze compound used with a pencil iron equipped with removable tips?
1. To allow the tip to be easily removed
2. To prevent the tip form loosening during repeated soldering operations
3. To minimize the number of times the tip must be retinned
4. Each of the above

2-15. If you do not have a suitable tip for desoldering, how can one be improvised?
1. File an available tip down to the desired size
2. Bend a piece of wire to the desired shape and insert the ends of the wire into the barrel
3. Bend a piece of copper wire to the desired shape after wrapping it around a regular tip
4. File a piece of round stock, preferably steel, to the desired shape and insert it in the barrel

2-16. What are the two metals most often used to form soft solder?
1. Lead and antimony
2. Tin and lead
3. Bismuth and tin
4. Tin and cadmium

2-17. What chemical or physical change causes a joint of soldered copper conductors to become one common metal?
1. A physical change takes place as the solder flows between the molecules of copper joining them together
when cooled
2. A physical change takes place as both metals displace one another
3. A chemical change takes place as the copper is dissolved into the solder thereby forming an alloyed
metal
4. A chemical change takes place when the additional materials added to the solder are heated causing a
gluing effect between the solder and the copper

2-18. When you solder electrical connectors, splices, and terminal lugs, what type of solder should you use?
1. 65/35 solder
2. 63/37 solder
3. 60/40 solder
4. 57/43 solder

2-19. Why is flux used in the soldering process?
1. It dilutes the molten solder and allows it to flow
2. It acts as a cleaning agent to remove oxide
3. It acts as the bonding agent between the solder and metal
4. It forms a conductive bond between the metal and the solder

2-20. When electrical and electronic

components are soldered, what type of flux must be used?
1. Hydrochloric acid
2. Sal ammoniac
3. Zinc chloride
4. Rosin

2-21. What two properties must a solvent have?
1. Noncorrosive-nonconductive
2. Corrosive-conductive
3. Noncorrosive-conductive
4. Corrosive-nonconductive

2-22. Why are solvents used in the soldering process?
1. To remove the flux from the metal surface being soldered
2. To remove contaminants from the soldered connection
3. To dilute the flux and allow it to flow freely
4. To improve the conductivity of the flux

2-23. Why are heat shunts used in the soldering process?
1. To conduct heat from the component being soldered back to the iron
2. To increase the temperature of the soldering iron or gun
3. To prevent damage to adjacent heatsensitive components
4. To decrease the temperature to the conductor being soldered

2-24. For which of the following reasons are conductors laced together?
1. To present a neat appearance
2. To help support each other
3. To aid in tracing conductors
4. Each of the above

2-25. Although it may be used, why is the use of round cord discouraged for lacing conductors?
1. It is bulkier than the flat type
2. It is more difficult to handle
3. It is not fungus resistant
4. It has a tendency to cut into wire insulation

2-26. If you are preparing to single lace conductors, what total length must the lacing be in relationship to the longest conductor?
1. One and one-half times the length
2. Twice the length
3. Two and one-half times the length
4. Five times the length

2-27. Why is a lacing shuttle used when conductors are laced in bundles?
1. It helps prevent the conductors from twisting together
2. It helps prevent the cord or tape from fouling
3. It keeps the "lay" of the cord or tape
4. It ensures that hitches are evenly spaced

2-28. Under certain circumstances, it is permissable to twist conductors together prior to lacing.
1. True
2. False

2-29. When coaxial cables are laced, the use of round cord is prohibited. What additional precaution must be observed?
1. Coaxial cables may not be laced with other conductors
2. Bundles containing coaxial cables must be double laced
3. Half hitches must be used in place of marling hitches
4. Coaxial cables must not be tied so tightly as to deform the dielectric

2-30. How should a single lace be started?
1. With a square knot and two marling hitches
2. With a marling hitch and a telephone hitch
3. With a telephone hitch and two half hitches
4. With a square knot and two half hitches

2-31. Under which of the following conditions should a double lace be used?
1. Three coaxial cables form the bundle
2. A maximum of six conductors form the bundle
3. The bundle is larger than one inch in diameter

Prepared by: Harlem A. Agnote

4. The bundle exceeds 10 feet in length

2-32. How should a double lace be started?
1. With a square knot
2. With a half hitch
3. With a marling hitch
4. With a telephone hitch

2-33. How should laced cable groups that run parallel to each other be bound together?
1. With marling hitches
2. With telephone hitches
3. With square knots
4. With half hitches

2-34. What tool or technique should be used to install self-clinching cable straps?
1. Military standard hand tool
2. Circle snips
3. Electrician's pliers
4. Hand installation

2-35. If a bundle of conductors passes through a very high-temperature area, what restraint should be used to tie the bundle?
1. High-temperature pressure-sensitive tape
2. Flat glass fiber tape
3. Self-clinching cable straps
4. Double lacing

2-36. Why do cables and wires require identification?
1. To assist the technician in troubleshooting a circuit
2. To assist the technician in making repairs
3. To permit the tracing of a circuit
4. Each of the above

2-37. Of the following publications, which should be used to determine the wire identification system for a specific piece of equipment?
1. The damage control manual
2. The technical manual for the equipment
3. The maintenance material management manual
4. The illustrated parts breakdown of the equipment

2-38. What is the purpose of the green conductor in a power tool or electric appliance cable?
1. To complete the circuit
2. To act as the "hot" lead
3. To prevent electrical shock to the operator
4. To prevent the motor of the unit from overloading

2-48. When you solder or hot-wire strip fluoroplastic insulated wire, which of the following safety precautions should be observed?
1. Wear a safety mask at all times
2. Wear protective gloves
3. Maintain good ventilation to carry off the fumes
4. Do not allow the resin to touch the insulation

2-49. If a circuit has power restored to it, what meter may be used to test the circuit?
1. An ohmmeter
2. A wattmeter
3. A megohmmeter
4. A voltmeter

2-50. If excess solder adheres to the tip of a soldering iron, how should you remove it?
1. Flow flux over the tip
2. Wipe it off on a clean cloth
3. Dip the tip in water
4. Shake it off

MODULE 5

INTRODUCTION TO GENERATORS AND MOTORS

PREPARED BY:

Robert John Palabasan

1-1. In generators, what principle is used to convert mechanical motion to electrical energy?
1. Atomic reaction
2. Electrical attraction
3. Magnetic repulsion
4. Magnetic induction

1-2. When you use the left-hand rule for generators, what is indicated by the middle finger?
1. Direction of flux
2. Direction of motion
3. Direction of current flow
4. Direction of the magnetic field

1-3. The output voltage of an elementary generator is coupled from the armature to the brushes by what devices?
1. Slip rings
2. Interpoles
3. Terminals
4. Pigtails

1-4. An elementary generator consists of a single coil rotating in a magnetic field. Why is NO voltage induced in the coil as it passes through the neutral plane?
1. Flux lines are too dense
2. Flux lines are not being cut
3. Flux lines are not present
4. Flux lines are being cut in the wrong direction

1-5. What components cause(s) a generator to produce a dc voltage instead of an ac voltage at its output?
1. The brushes
2. The armature
3. The slip rings
4. The commutator

1-6. When two adjacent segments of the commutator on a single-loop dc generator come in contact with the brush
at the same time, which of the following conditions will occur?
1. The output voltage will be zero
2. The output voltage will be maximum negative
3. The output voltage will be maximum positive

1-7. In an elementary, single-coil, dc generator with one pair of poles, what is the maximum number of pulsations
produced in one revolution?
1. One
2. Two
3. Three
4. Four

1-8. If an elementary dc generator has a twocoil armature and four field poles, what is the total number of segments required in the commutator?
1. 8
2. 2
3. 16
4. 4

1-9. How can you vary the strength of the magnetic field in a dc generator?
1. By varying the armature current
2. By varying the speed of armature rotation
3. By varying the voltage applied to the electromagnetic field coils
4. By varying the polarity of the field poles

1-10. Under which of the following conditions does sparking occur between the brushes
and the commutator?
1. When operating under normal conditions
2. When there is improper commutation
3. When there is an excessive load current
4. When commutation is in the neutral plane

1-11. Distortion of the main field by interaction with the armature field defines what term?
1. Commutation
2. Mutual reaction
3. Armature reaction
4. Mutual induction

1-12. Distortion of the main field by interaction with the armature field can be compensated for by the use of
1. slip rings
2. interpoles
3. a commutator

Prepared by: Harlem A. Agnote

4. special brushes

1-13. Motor reaction in a dc generator is a physical force caused by the magnetic interaction between the armature and the field. What effect, if any, does this force have on the operation of the generator?
1. It tends to oppose the rotation of the armature
2. It tends to aid the rotation of the armature
3. It causes the generator to vibrate
4. None

1-14. In dc generators, copper losses are caused by which of the following factors?
1. Reluctance in the field poles
2. Resistance in the armature winding
3. Reactance in the armature and field windings
4. All of the above

1-15. Eddy currents in armature cores are kept low by which of the following actions?
1. Using powdered iron as a core material
2. Limiting armature current
3. Insulating the core
4. Laminating the iron in the core

1-16. What makes the drum-type armature more efficient than the Gramme-ring armature?
1. The drum-type armature has more windings than the Gramme-ring armature
2. The drum-type armature can be rotated faster than the Gramme-ring armature
3. The drum-type armature coils are fully exposed to the magnetic field, while the Gramme-ring armature coils are only partially exposed to the magnetic field
4. The drum-type armature has a laminated core, while the Grammering armature has a solid core

1-17. What type of dc generator application best utilizes the features of the lapwound armature?
1. High-voltage
2. High-current
3. High-speed
4. Variable-speed

1-18. Which of the following is NOT a major classification of dc generators?
1. Compound-wound
2. Series-wound
3. Shunt-wound
4. Lap-wound

1-19. What characteristic of series-wound generators makes them unsuitable for most applications?
1. They require external field excitation
2. The output voltage varies as thespeed varies
3. They are not capable of supplying heavy loads
4. The output voltage varies as the load current varies

1-20. As the load current of a dc generator varies from no-load to full-load, the variation in output voltage is expressed
as a percent of the full-load voltage. What term applies to this expression?
1. Gain
2. Voltage control
3. Voltage regulation
4. Load limit

1-21. When two or more generators are used to supply a common load, what term is applied to this method of operation?
1. Series
2. Compound
3. Split-load
4. Parallel

1-22. What special-purpose dc generator is used as a high-gain power amplifier?
1. Lap-wound
2. Shunt-wound
3. Amplidyne
4. Compound-connected

1-23. The gain of an amplifying device can be determined by which of the following formulas?
1. GAIN = INPUT + OUTPUT
2. GAIN = INPUT ⍰ ⍰UTPUT

3. GAIN = OUTPUT ⍰ INPUT
4. GAIN = OUTPUT + INPUT

1-24. The maximum gain possible from an amplidyne is approximately
1. 100
2. 5,000
3. 10,000
4. 50,000

1-25. What determines the direction of rotation of a dc motor?
1. The type of armature
2. The method of excitation
3. The number of armature coils
4. The polarity of armature current and direction of magnetic flux

1-26. When you use the right-hand rule for motors, what quantity is indicated by the extended forefinger?
1. Direction of flux north to south
2. Direction of flux south to north
3. Direction of current
4. Direction of motion

1-27. Which, if any, of the following situations is a major electrical difference between a dc motor and a dc generator?
1. The armatures are different
2. The shunt connections are different
3. The dc generator requires a commutator, the dc motor does not
4. None of the above

1-28. In a dc motor, what causes counter emf?
1. Improper commutation
2. Armature reaction
3. Generator action
4. Excessive speed

1-29. In a dc motor, how, if at all, does counter emf affect speed?
1. It causes the speed to increase
2. It causes the speed to decrease
3. It causes rapid fluctuations of the speed
4. It does not affect speed

1-30. What is the load on a dc motor?
1. The field current
2. The armature current
3. The mechanical device the motor moves
4. The total current drawn from the source

1-31. When a series dc motor is operated without a load, which of the following conditions occurs?
1. The armature draws excessive current
2. The voltage requirement increases
3. The armature will not turn
4. The armature speeds out of control

1-32. A dc series motor is best suited for which of the following applications?
1. Steady load, low torque
2. Variable load, low torque
3. Steady load, high torque
4. Variable load, high torque

1-33. What is the main advantage of a shunt motor over a series motor?
1. A shunt motor develops higher torque at lower speeds than a series motor
2. A shunt motor can be operated at higher speeds than a series motor
3. A shunt motor draws less current from the source than a series motor
4. A shunt motor maintains a more constant speed under varying load conditions than a series motor

1-34. How can the direction of rotation be changed in a dc motor?
1. Only by reversing the field connections
2. Only by reversing the armature connections
3. By reversing both the armature connections and the field connections
4. 4.By reversing either the armature connections or the field connections

1-35. When the voltage applied to the armature of a dc shunt motor is decreased, what happens to the motor speed?
1. It becomes uncontrollable
2. It decreases
3. It increases
4. The motor stops

Prepared by: Harlem A. Agnote

1-36. In a dc motor, the neutral plane shifts in what direction as the result of armature reaction?
1. Clockwise
2. Counterclockwise
3. In the direction of rotation
4. Opposite the direction of rotation

1-37. The current in the interpoles of a dc motor is the same as the
1. armature current
2. field current
3. total load current
4. eddy current

1-38. In a dc motor, what is the purpose of the resistor placed in series with the armature?
1. To counteract armature reaction
2. To limit armature current
3. To increase field strength
4. To prevent overspeeding

1-39. Magnetic induction in an alternator is a result of relative motion between what two elements?
1. The rotor and the armature
2. The armature and the field
3. The field and the stator
4. The rotor and the field

1-40. Voltage is induced in what part of an alternator?
1. The commutator
2. The brushes
3. The armature
4. The field

1-41. What are the two basic types of alternators?
1. Multiphase and polyphase
2. Alternating current and direct current
3. Rotating field and rotating armature
4. Series-wound and shunt-wound

1-42. Which of the following alternator types is most widely used?
1. Shunt-wound
2. Rotating-armature
3. Series-wound
4. Rotating-field

1-43. The purpose of the exciter in an alternator is to
1. provide dc field excitation
2. compensate for armature losses
3. compensate for counter emf
4. counteract armature reaction

1-44. An alternator using a gas turbine as a prime mover should have what type of rotor?
1. Turbine-driven
2. Salient-pole
3. Armature
4. Geared

1-45. In alternators with low-speed prime movers, only what type of rotor may be used?
1. Geared
2. Armature
3. Salient-pole
4. Turbine-driven

1-46. Alternators are rated using which of the following terms?
1. Volts
2. Watts
3. Amperes
4. Volt-amperes

1-47. What does the term single-phase mean relative to single-phase alternators?
1. All output voltages are in phase with each other
2. The voltage and current are in phase
3. The phase angle is constant
4. Only one voltage is produced

1-48. In a single-phase alternator with multiple armature windings, how must the windings be connected?
1. Series
2. Parallel
3. Wye

4. Delta

1-50. A two-phase, three-wire alternator has what maximum number of output voltages available?
1. One
2. Two
3. Three
4. Four

1-52. What determines the phase relationship between the individual output voltages in a multiphase alternator?
1. The speed of rotation
2. The number of field poles
3. The method of connecting the terminals
4. The placement of the armature coils

1-53. What is the phase relationship between the output voltages of a three-phase alternator?
1. In phase
2. 60º out of phase
3. 90º out of phase
4. 120º out of phase

1-54. The ac power aboard ship is usually distributed as what voltage?
1. 115-volt, three-phase
2. 115-volt, single-phase
3. 230-volt, single-phase
4. 450-volt, three-phase

1-55. The output frequency of an alternator is determined by what two factors?
1. The number of poles and the number of phases
2. The number of poles and the speed of rotation
3. The speed of rotation and the voltampere rating
4. The number of phases and the voltampere rating

1-56. A four-pole, single-phase alternator rotating at 18M rpm will produce what output frequency?
1. 60 Hz
2. 400 Hz
3. 1800 Hz
4. 3600 Hz

1-58. In most alternators, the output voltage is controlled by adjusting the
1. rotor speed
2. field voltage
3. armature resistance
4. electric load

1-59. When alternators are to be operated in parallel, which of the following alternator characteristics must be considered?
1. Voltage
2. Frequency
3. Phase relationship
4. All the above

1-60. Which of the following motors is/are types of ac motor?
1. Series
2. Synchronous
3. Induction
4. All of the above

1-61. Which of the following types of motors is widely used to power small appliances?
1. Universal
2. Synchronous
3. Polyphase
4. Compound

1-62. A universal motor is a special type of
1. synchronous motor
2. series motor
3. parallel motor
4. polyphase motor

1-63. The number of pole pairs required to establish a rotating magnetic field in a multiphase motor stator is determined by which of the following factors?
1. The magnitude of the voltage
2. The magnitude of the current
3. The number of phases
4. The size of the motor

1-64. In a two-phase motor stator, what is the

angular displacement between the field poles?
1. 0º
2. 90º
3. 180º
4. 360º

1-65. Adjacent phase windings of a 3-phase motor stator are what total number of degrees apart?
1. 30º
2. 90º
3. 120º
4. 180º

1-66. Which of the following types of motors has a constant speed from no load to full load?
1. Series
2. Synchronous
3. Induction
4. Universal

1-67. What type of ac motor is the simplest and least expensive to manufacture?
1. Induction
2. Series
3. Synchronous
4. Two-phase

1-68. What term applies to the difference between the speed of the rotating stator field and the rotor speed?
1. Slip
2. Synchronous
3. Rotor error
4. Torque

1-69. The speed of the rotor of an induction motor depends upon which of the following factors?
1. The method of connecting the load
2. The dc voltage applied to the rotor
3. The torque requirements of the load
4. The current in the rotor

1-70. What type of ac motor is most widely used?
1. Series
2. Universal
3. Synchronous
4. Single-phase induction

1-71. What type of ac motor uses a combination of inductance and capacitance to apply out-of-phase currents to the start windings?
1. Three-phase
2. Series
3. Synchronous
4. Split-phase induction

1-72. Why are shaded-pole motors built only in small sizes?
1. They have weak starting torque
2. They are expensive in large sizes
3. They are unidirectional
4. They require large starting current

MODULE 6

INTRODUCTION TO ELECTRONIC EMISSION, TUBES, AND POWER SUPPLIES

PREPARED BY:

Katherine Arabit

1-1. The electrons emitted by a heated conductor come from what source?
1. An external battery
2. An external ac source
3. Both 1 and 2 above
4. The conductor itself

1-2. What is another name for thermionic emission?
1. The gap effect
2. The heat effect
3. The Edison effect
4. The Fleming effect

1-3. Electrons emitted by a hot filament are able to cross the gap between the filament and the plate. What force enables them to do this?
1. Magnetic repulsion
2. Inductive reactance
3. Thermionic emission
4. Electrostatic attraction

1-4. Name the two series circuits that are associated with a diode electron tube.
1. The plate and anode circuits
2. The plate and filament circuits
3. The battery and filament circuits
4. The filament and cathode circuits

1-5. When an ac voltage is applied across the plate and filament of a diode, the current measured will represent what type of waveform?
1. Pulsating dc
2. Dc
3. Pulsating ac
4. Ac

1-6. A filament that uses a one-moleculethick layer of barium and strontium is classified as what type of filament?
1. Tungsten
2. Oxide-coated
3. Tungsten-strontium
4. Thoriated-tungsten

1-7. Which of the following ac filament voltages is most likely to be considered a common voltage?
1. 1.5 volts
2. 3.0 volts
3. 6.3 volts
4. 9.0 volts

1-8. An ac directly heated filament has which of the following advantages?
1. Even spacing relative to the plate
2. Even emission across the filament
3. Constant emission throughout the ac cycle
4. Rapid heating effect

1-9. An indirectly heated cathode always uses what material for its emitting surface?
1. An oxide coating
2. A thorium coating
3. A tungsten coating
4. A graphite coating

1-10. What is the principal advantage of an indirectly heated cathode over a directly heated cathode?
1. It is larger
2. It is immune to ac heater current variations
3. It reaches an operating temperature more quickly
4. It has a lower operating temperature

1-11. When you view an electron tube and its socket connection from the bottom, in what direction are (a) the pins of the tube and (b) the pins of the socket numbered?
1. (a) Counterclockwise
(b) Clockwise
2. (a) Counterclockwise
(b) Counterclockwise
3. (a) Clockwise
(b) Counterclockwise
4. (a) Clockwise
(b) Clockwise

1-12. Electron tubes are identified by a number preceded by which of the following letter designations?

1. T
2. V
3. ET
4. VT

1-13. The getter in an electron tube serves what purpose?
1. It protects the plate from overheating
2. It allows the cathode to emit more electrons
3. It helps to produce a better vacuum
4. It anchors the tube elements in the base

1-24. An electron tube is operated at 300 volts and a plate current of 60 milliamperes. To avoid being damaged, the tube must have what minimum plate dissipation rating?
1. 5000 watts
2. 18 watts
3. 5 watts
4. 0.18 watt

1-25. Under which of the following conditions can a tube be considered operating beyond its peak inverse voltage rating?
1. When the plates glow cherry red
2. When current flows from the plate to the cathode
3. When current flows from the cathode in the form of an arc
4. When current flows from the cathode to the plate and damage occurs

1-26. Why does control grid voltage of a triode exercise greater control than plate voltage over conduction of the tube?
1. The grid is operated at a higher voltage than the plate
2. The grid adds electrons to the electron stream
3. The grid is closer to the plate than the cathode
4. The grid is closer to the cathode than the plate

1-27. The plate load resistor in an electrontube circuit performs what function?
1. It converts variations in plate voltage to current variations
2. It limits the amount of plate voltage that can be applied to the tube
3. It converts variations in plate current to variations in plate voltage
4. It limits the amount of plate current that can flow through the tube

1-29. Most amplifier circuits are designed to operate with the grid negative in relation to the cathode. This is done to avoid which of the following problems?
1. Excessive grid current
2. Excessive plate current
3. Distortion on small signals
4. Distortion on large negative signals

1-30. A triode amplifier has 350 volts applied to its plate across a 25 k Ω load resistor. With no input signal applied and a bias voltage of −9 volts, 4 milliamperes conducts across the tube. What is the
quiescent plate voltage?
1. 0 V
2. 100 V
3. 250 V
4. 350 V

1-31. A triode electron tube is designed to conduct at 15 milliamperes of current when its grid is at 0 volts relative to its cathode. For every volt below this, conduction will decrease by 1.5 milliamperes. If the tube is biased at −3 volts and has a 6-volt peak-to-peak input signal, what is the minimum amount of current that will conduct through the tube?
1. 11.5 milliamperes
2. 6.0 milliamperes
3. 1.5 milliamperes
4. 0 milliamperes

1-32. Overdriving can be considered a form of distortion for which of the following reasons?
1. The output is not in phase with the input
2. The output does not have the same polarity as the input
3. The output is not a faithful reproduction of the input

Prepared by: Harlem A. Agnote

4. The output does not have the same amplitude as the input

1-36. Electronic equipment that uses fixed bias for its tube circuit receives its gridbias voltage from what source?
1. A portion of the plate voltage
2. A power source internal to the circuit
3. Both 1 and 2 above
4. A power source external to the circuit

1-37. The effect of both cathode and grid biasing is to make the cathode (a) what polarity, relative to (b) what other tube element?
1. (a) Positive (b) the plate
2. (a) Negative (b) the plate
3. (a) Positive (b) the grid
4. (a) Negative (b) the grid

1-38. Which of the following types of biasing is most likely to use a battery supply?
1. Self
2. Grid
3. Fixed
4. Cathode

1-39. In an electron tube circuit using cathode biasing, the cathode is made positive in relation to the grid. This is done by a voltage dropped across what circuit
element?
1. RL
2. Rk
3. Cc
4. Ck

1-40. The cathode bias voltage level applied to the cathode is maintained at a constant level by what circuit
component?
1. RL
2. Rk
3. Cc
4. Ck

1-41. Which of the following undesirable characteristics is associated with cathode biasing?
1. Plate voltage is increased by the voltage amount of biasing
2. The cathode is forced to operate at a positive potential
3. The maximum negative output is limited
4. Current must flow in the circuitcontinuously

1-42. Grid-leak biasing develops a biasing voltage from (a) what portion of the input signal and (b) by what type of action?
1. (a) Negative (b) resistive
2. (a) Negative (b) capacitive
3. (a) Positive (b) capacitive
4. (a) Positive (b) resistive

1-43. During the charge cycle in grid-leak biasing, Cc, draws current through what circuit element?
1. Rg
2. rgk
3. RL
4. Rk

1-44. During the discharge cycle in grid-leak biasing, Cc discharges across what circuit element?
1. Rg
2. rgk
3. RL
4. Rk

1-45. The effect of grid-leak biasing is to rectify the input signal. Because of this, the amplitude of the biasing voltage depends upon which of the following factors?
1. Amplitude of the input
2. Frequency of the input
3. Size of Rg and Cc
4. All of the above

1-46. During the charging cycle in grid-leak biasing, the effective size of rgk is decreased. This is caused by what
electronic principle?
1. Electrostatic repulsion between the grid and the plate
2. Electrostatic repulsion between the grid and the cathode

3. Electrostatic attraction between the cathode and the grid
4. Electrostatic attraction between the plate and the cathode

1-47. The charge and discharge of capacitor Cc, used in grid-leak circuits, will be equal when what condition occurs?
1. When Rgk becomes the same value as Rg
2. When Cc reaches its maximum charge-holding capacity
3. When the charge on Cc cuts the tube off
4. When Rg becomes larger than rgk

1-51. A triode amplifier has a load resistor rated at 150 k . A +3-volt signal will cause 4 milliamperes of current to
conduct through the tube. What is the voltage gain of the amplifier?
1. 450
2. 200
3. 100
4. 50

1-52. The amplification factor for an electron tube is identified by what electronic symbol?
1. Ar
2. Vg
3. gm
4. μ

1-53. The grid voltage on an electron tube is increased from 2 volts to 4 volts. This causes plate current to increase from 2 milliamperes to 5.5 milliamperes. This
same increase in plate current can be achieved by keeping the grid at +2 volts and raising the plate voltage from 200 volts to 400 volts. What is the mu of the
tube?
1. 400
2. 200
3. 100
4. 50

1-54. What is the transconductance for the tube described in question 1-53?
1. 175 μmhos
2. 645 μmhos
3. 700 μmhos
4. 1750 μmhos

1-55. Transconductance is identified by what electronic symbol?
1. μ
2. gm
3. rgk
4. tc

1-56. In a triode, what interelectrode capacitance has the greatest effect on tube operation?
1. Cpg
2. Cgk
3. Cpk
4. Csg

1-57. Interelectrode capacitance (Cpg) affects the gain of a triode stage because of what electronic feature?
1. Blocking
2. Feedback
3. Transit time
4. Phase inversion

1-58. The action of the screen grid in reducing interelectrode capacitance can be expressed mathematically as
1. CT = C1+ C2
2. CT = C1 x C2
3. CT = C1+ C2 / C1 x C2
4. CT = C1 x C2 / C1 + C2

1-59. For normal operation, the screen grid of a tetrode is operated at a positive voltage in relation to (a) what tube element, and negative in relation to (b) what other
tube element?
1. (a) Grid (b) plate
2. (a) Grid (b) cathode
3. (a) Plate (b) grid
4. (a) Cathod (b) grid

1-61. Which of the following undesirable characteristics is/are associated with tetrode operation?
1. The plate is isolated from the electron stream

2. The plate emits secondary emission electrons
3. The output is noisy
4. Both 2 and 3 above

1-62. Generally, tetrodes have a lower transconductance than triodes. This is caused by what feature of a tetrode?
1. The plate is isolated from the electron stream
2. The screen grid draws current from the electron steam
3. Secondary emission limits the amount of current the plate can draw from the electron stream
4. The screen grid is operated at a negative potential relative to the plate and electrons are repelled from
the plate

1-63. The suppressor grid of a pentode is operated at what potential relative to
(a) the cathode and (b) the plate?
1. (a) Positive (b) The same potential
2. (a) Negative (b) The same potential
3. (a) The same potential (b) Negative
4. (a) The same potential (b) Positive

1-64. Voltage is supplied to the suppressor grid in a pentode from what source?
1. Through a resistor from the plate source voltage
2. Through a resistor from ground
3. By a separate voltage source
4. By a physical connection from the cathode

1-65. The suppressor grid is able to control the effects of secondary emission by using which of the following electronic actions?
1. By attracting electrons emitted by the plate through electromagnetic attraction
2. By repelling electrons emitted by the plate through electromagnetic repulsion
3. By attracting electrons emitted from the plate through electrostatic attraction
4. By repelling electrons emitted from the plate through electrostatic repulsion

2-1. Which of the following types of tubes would be used as a voltage amplifier in an electronic circuit?
1. Diode
2. Triode
3. Duo-diode
4. Tetrahedral

2-2. Multielectrode tubes are normally classified according to the number of
1. units contained in the tube
2. grids contained in the tube
3. elements contained in the tube
4. filaments contained in the tube

2-3. How many grids are there in a pentagrid tube?
1. Five
2. Six
3. Seven
4. Eight

2-6. What advantage(s) does the in-line grid arrangement of the power pentode have over the staggered grid arrangement ofthe conventional pentode?
1. Higher efficiency
2. Higher power output
3. Both 1 and 2 above
4. Smaller current requirement

2-7. Which of the following is an advantage that a power pentode has over a conventional pentode?
1. Greater opposition to electron flow
2. Higher gain because of staggered grids
3. Greater sensitivity to small signals
4. Smaller plate current obtained from large signals

2-8. What is the primary purpose of the beam-forming plates in the beampower tube?
1. To concentrate the electrons into a beam
2. To catch any stray electrons in the tube
3. To act as an extension of the cathode
4. To give the tube the appearance of a pentode

2-9. Which of the following is a name given to the variable-mu tube?
1. Sharp-cutoff tube
2. Remote-cutoff tube
3. Variable-spaced tube
4. Reversible-bias tube

2-10. What is the symbol for "mu"?
1. μ
2. β
3. I
4. L

2-11. Which of the following is an advantage of the variable-mu tube over conventional tubes?
1. It can be driven into cut-off by remote signals
2. It can be saturated quickly with a small input signal
3. It can amplify small input signals without distortion
4. It can amplify large input signals without distortion

2-12. What is the only difference between a remote-cutoff tube and a sharp-cutoff tube?
1. The spacing of the grid wires
2. The number of grids in each tube
3. The bias voltage used for conduction
4. The potential on the elements of each tube

2-13. Which of the following is the BEST method for reducing transit time in uhf tubes?
1. Placing the elements very close together
2. Increasing the voltage on the electrodes
3. Increasing the velocity of electrons
4. Placing the elements far apart

2-14. Which of the following is a disadvantage of uhf tubes?
1. Interelectrode capacitance is reduced
2. They are manufactured without socket bases
3. All the physical dimensions are scaled small
4. They have reduced power-handling capabilities

2-15. What is the only physical difference between the doorknob tube and the acorn tube?

Prepared by: Harlem A. Agnote

1. Size
2. Base design
3. Filament material
4. Power-handling capability

2-16. How does the construction of a planar tube differ from that of a concentric tube?
1. Concentric tubes use filaments while planar tubes do not
2. Planar tubes use filaments while concentric tubes do not
3. The electrodes of the planar tubes are parallel to each other while those in concentric tubes are not

2-17. Why is the metallic ring of the planar tube grounded?
1. To eliminate shock hazards
2. To eliminate unwanted rf signals
3. To make removing the tube easier
4. To shunt the cathode current to ground

2-18. The metallic shell capacitive ground of a planar tube serves as what kind of capacitor in a cathode-bias circuit?
1. Grid
2. Bypass
3. Coupling
4. Plate-to-cathode

2-19. What is the major difference between the oilcan tube and the lighthouse tube?
1. The oilcan tube has cooling fins; the lighthouse tube does not
2. The oilcan tube functions as a triode
3. The lighthouse tube can handle more power
4. The lighthouse tube is a diode-type tube

2-20. Which of the following is an advantage that an oilcan tube has over a lighthouse tube?
1. The oilcan tube is smaller
2. The oilcan tube has no filaments
3. The oilcan tube can handle more power
4. The oilcan tube can operate at hf and uhf frequencies

2-21. The plate potential at which ionization occurs is known as the ionization point. Which of the following is also a name for this process?
1. Firing potential
2. Saturation potential
3. Extinction potential
4. Deionization potential

2-22. What name is given to the value of plate voltage at which ionization stops?
1. Firing potential
2. Saturation potential
3. Extinction potential
4. High plate potential

2-23. When a gas-filled triode ionizes, the grid loses control and the tube then functions as what type of tube?
1. Diode
2. Triode
3. Duo-diode
4. Trigatron

2-24. After the gas-filled triode ionizes and the grid loses control, which of the following methods is used to stop the conduction of the tube?
1. Increasing the plate potential
2. Increasing the grid potential
3. Removing the plate potential
4. Removing the grid potential

2-25. What is the name given to the gas-filled triode?
1. Variable triode
2. Trigatron
3. Thyristor
4. Thyratron

2-26. For what minimum amount of time must the filaments of a mercury-vapor tube have voltage applied before the plate voltage is applied to the tube?
1. 0.5 minute
2. 1.5 minutes
3. 2.5 minutes
4. 3.0 minutes

Prepared by: Harlem A. Agnote

2-27. Which of the following conditions is/are responsible for the soft, blue glow of the gas-filled triode?
1. The tube is operating normally
2. The tube is gassy
3. The tube is saturated
4. The tube is ionized

2-28. Which of the following types of tubes is normally used as a voltage regulator?
1. Gas-filled triode
2. Gas-filled diode
3. Cold cathode
4. Cold plate

2-29. For a cold-cathode tube, how does the voltage regulator maintain a constant voltage drop across the tube?
1. By changing the current flow of the tube
2. By changing the resistance of the tube as current flow varies
3. By changing the plate potential of the tube as current varies
4. By changing the source voltage of the tube

2-31. The electron gun of the CRT serves which of the following functions?
1. Deflects electrons into the plate
2. Concentrates electrons into a beam
3. Emits electrons
4. Both 2 and 3 above

2-32. Which of the following is a description of the grid in a CRT?
1. A metal cap with a hole in the center
2. A metal cap at ground potential
3. A metal cap with a positive potential
4. A metal cap with a wire screen in the center

2-33. What element of a television CRT is adjusted by the brightness control?
1. Cathode
2. Aquadag
3. Control grid
4. Focusing anode

2-34. Which of the following elements of the CRT helps prevent the beam of electrons from diverging?
1. Cathode
2. Aquadag
3. Focusing anode
4. Decelerating anode

2-35. Which of the following elements of a CRT has the highest positive potential?
1. The focusing anode
2. The electronic lens
3. The accelerating anode
4. The decelerating anode

2-36. What is the name of the florescent material that coats the inside face of a CRT?
1. Posporus
2. Phosphor
3. Flourine
4. Flourese

2-37. What is the purpose of the aquadag coating in the CRT?
1. It is used as a plate
2. It is used to focus the beam
3. It eliminates the space charge
4. It eliminates the effects of secondary emission

2-38. In which of the following equipment would you most likely find a cathode ray tube?
1. Oscillator
2. Oscilloscope
3. Television set
4. Both 2 and 3

2-39. If deflection were not used in the CRT, what would be viewed on the screen of the tube?
1. A solid black screen
2. A solid white screen
3. A large spot on the left
4. A bright spot in the center

2-40. Which of the following types of deflection is used by much of the test equipment in the Navy?
1. Electromagnetic
2. Electrostatic
3. Magnetic
4. Static

2-41. Which of the following elements cause(s) the electron beam to move from left to right on a CRT?
1. Vertical deflection plates
2. Horizontal deflection plates
3. Suppressor grid
4. Control grid

2-46. If a signal is to be viewed on a CRT, the signal should be applied to which of the following elements of the CRT?
1. Control grid
2. Vertical plates
3. Suppressor grid
4. Horizontal plates

2-57. Which of the following actions must you take first before disposing of a cathode-ray tube?
1. Place the CRT carefully in a dumpster
2. Throw the CRT into deep water
3. Return the CRT to supply
4. Render the CRT harmless

2-58. What is the purpose of adding radioactive material to electron tubes?
1. The material reduces secondary emissions
2. The material aids ionization in the tube
3. The material increases therminonic emission
4. The material causes the tube to glow in the dark

2-59. Safety precautions and procedures for working with radioactive electron tubes can be found in which of the following publications?
1. Radiation, Health, and Protection Manual
2. Decontamination of Radioactivity Manual
3. Technical Manual for RF Radiation Hazards
4. Radiation Hazards of Shipboard Equipment Manu

Prepared by: Harlem A. Agnote

3-1. The electronic power supply was developed to fulfill which of the following needs?
1. Reliability
2. Convenience
3. Cost effectiveness
4. All of the above

3-2. Which of the following is NOT one of the four sections of a basic power supply?
1. Transformer
2. Oscillator
3. Rectifier
4. Filter

3-3. The primary purpose of the transformer in an electronic power supply is to isolate the power supply from ground.
1. True
2. False

3-4. What is the primary function of the rectifier section?
1. To convert dc to ac
2. To convert ac to pulsating dc
3. To increase average voltage output
4. To decrease average voltage output

3-5. What is/are the function(s) of the filter section?
1. To eliminate dc voltage
2. To increase the amplitude of the ac
3. To convert pulsating dc to steady dc
4. All of the above

3-6. The separate step-down windings in a transformer provide which of the following functions?
1. Filament voltage for power supply tubes
2. Filament voltage for the electronic load
3. Both 1 and 2 above
4. High voltage for the rectifier

3-7. The purpose of a center tap in a transformer is to provide
1. two separate filament voltages to the rectifier
2. a step-down voltage to the rectifier
3. pulsating dc to the rectifier
4. two outputs from one transformer

3-8. A diode vacuum tube is an ideal rectifier for which, if any, of the following reasons?
1. Current flows through the diode
vacuum tube in one direction only
2. Current flows through the diode vacuum tube in both directions
3. The diode vacuum tube conducts only on the negative alternation of the input voltage
4. None of the above

3-9. When the plate of a diode tube is negative with respect to the cathode, the tube is said to be in what state?
1. Cutoff
2. Remission
3. Saturation
4. Conduction

3-10. In a simple half-wave rectifier, the diode tube will conduct for a maximum of how many degrees of the 360-degree input signal?
1. 45
2. 90
3. 180
4. 270

3-11. What term is used to describe current pulses that flow in the same direction?
1. Average current
2. Secondary current
3. Pure direct current
4. Pulsating direct current

3-12. For a diode to act as a rectifier, how should it be connected in a circuit?
1. In parallel with the input
2. In parallel with the load
3. In series with the input
4. In series with the load

3-13. What is the ripple frequency of a halfwave rectifier with an input line frequency of 60 Hz?
1. 30 Hz
2. 60 Hz
3. 90 Hz
4. 120 Hz

Prepared by: Harlem A. Agnote

3-14. In a half-wave rectifier, what is the average voltage output when the peak voltage is 300 volts?
1. 190.8 volts
2. 95.4 volts
3. 19.08 volts
4. 9.4 volts

3-15. The full-wave rectifier was developed for which of the following reasons?
1. To obtain the highest average voltage and current
2. To increase the number of components
3. To increase the value of the voltage
4. To obtain better regulation

3-16. What is the ripple frequency of a fullwave rectifier with an input line frequency of 60 Hz?
1. 30 Hz
2. 60 Hz
3. 90 Hz
4. 120 Hz

3-17. What is the average voltage output of a full-wave rectifier that has an output of 100 volts peak?
1. 3.18 volts
2. 6.37 volts
3. 31.8 volts
4. 63.7 volts

3-18. The primary disadvantage of the conventional full-wave rectifier is that the peak output voltage is only half that of the half-wave rectifier.
1. True
2. False

3-23. In filter circuits, inductors are used as what kind of impedances?
1. Shunt impedances to oppose changes in current
2. Shunt impedances to oppose changes in voltage
3. Series impedances to oppose changes in current
4. Series impedances to oppose changes in voltage

3-24. To retain its charge, the capacitor in a simple capacitor filter must have a long charge time constant and a short discharge time constant.
1. True
2. False

3-25. If the capacitance in a circuit increases, XC, will increase.
1. True
2. False

3-26. To provide a steady dc output in a simple capacitor circuit, the capacitor must charge almost instantaneously to the value of the applied voltage.
1. True
2. False

3-27. What is the most basic type of filter?
1. Capacitor
2. LC choke input
3. LC capacitor input
4. RC capacitor input

3-28. In a circuit with a capacitor filter, how is the capacitor connected?
1. In series with the load
2. In parallel with the load
3. In parallel with the output
4. Both 2 and 3 above

3-29. Which, if any, of the following factors determines the rate of discharge of the capacitor in a filter circuit?
1. The value of the load resistance
2. The amount of voltage
3. The type of capacitor
4. None of the above

3-30. A half-wave rectifier has an output frequency of 60 hertz, a filter capacitor value of 40 microfarads, and a load resistance of 10 kilohms. What is the value of XC?
1. 132.51 ohms

Prepared by: Harlem A. Agnote

2. 66.25 ohms
3. 33.13 ohms
4. 16.57 ohms

3-31. A full-wave rectifier has an output frequency of 120 hertz, a filter capacitor value of 25 microfarads, and
a load resistance of 10 kilohms.What is the value of XC?
1. 5.3 ohms
2. 53 ohms
3. 106 ohms
4. 1060 ohms

3-32. The LC choke-input filter is used primarily where which of the following types of regulation is/are important?
1. Frequency
2. Current only
3. Voltage only
4. Voltage and current

3-33. In an LC choke-input filter circuit, the capacitor charges only to the average value of the input voltage. Which of the following components inhibits the capacitor from reaching the peak value of the input voltage?
1. Diode
2. Capacitor
3. Filter choke
4. Load resistor

3-34. In an LC choke-input filter, the larger the value of the filter capacitor, the better the filtering action. Which of the following factors represents the major limitation in obtaining the maximum value of the capacitor used?
1. Cost
2. Reliability
3. Availability
4. Physical size

3-35. What is the most common range ofvalues selected for a power supply choke?
1. 1 to 20 henries
2. 5 to 25 henries
3. 25 to 30 henries
4. 10 to 200 henries

3-36. If the impedance of the choke in an LC choke-input filter is increased, the ripple voltage amplitude will
1. decrease
2. increase
3. oscillate
4. remain the same

3-37. A full-wave rectifier has an output frequency of 120 hertz, a filter choke with a value of 10 henries, and a load resistance of 10 kilohms. What is the value of XL?
1. 75.0 ohms
2. 7.5 ohms
3. 75.0 kilohms
4. 7.5 kilohms

3-38. The filter capacitor in the LC chokeinput filter is NOT subject to extreme voltage surges because of the protection provided by which of the following components?
1. Inductor
2. Load resistor
3. Series resistor
4. Shunt capacitor

3-39. Shorted turns in the choke of an LC choke-input filter may reduce the value of inductance below the critical value. When this happens, which of the following problems may occur?
1. Poor voltage regulation
2. Excessive ripple amplitude
3. Abnormally high output voltage
4. Each of the above

3-40. The use of the RC capacitor-input filter is limited to which of the following situations?
1. When the load current is large
2. When the load current is small
3. When the load voltage is large
4. When the load voltage is small

3-45. In a voltage regulator, what percent of regulation would be ideal?
1. 1 percent
2. 0 percent
3. 3 percent

Prepared by: Harlem A. Agnote

4. 5 percent

3-46. If a power supply produces 30 volts with no load and 25 volts under full load, what is the percent of regulation?
1. 5 percent
2. 10 percent
3. 20 percent
4. 30 percent

3-47. If a power supply produces 10 volts with no load and 9 volts under full load, what is the percent of regulation?
1. 8 percent
2. 9 percent
3. 10 percent
4. 11 percent

3-48. If a power supply produces 20 volts with no load and 20 volts under full load, what is the percent of regulation?
1. 1 percent
2. 2 percent
3. 3 percent
4. 0 percent

3-49. The simple series voltage regulator was designed to function as what type of resistance?
1. Fixed resistance in series with the load
2. Fixed resistance in parallel with the load
3. Variable resistance in series with the load
4. Variable resistance in parallel with the load

3-50. In a simple shunt voltage regulator, what is the purpose of the shunt element?
1. To regulate voltage through series resistance RS
2. To regulate voltage through parallel resistance V1
3. To regulate current through series resistance RS
4. To regulate current through parallel resistance V1

3-51. In an electron tube voltage regulator, the electron tube replaces which of the following components?
1. Variable resistor RV
2. Parallel resistor RP
3. Series resistor RS
4. Load resistor RL

3-52. The primary purpose of the amperite regulator is to regulate
1. power
2. voltage
3. current
4. resistance

3-53. What method is used by a manufacturer of electronic equipment to reduce the cost of extensive wiring?
1. Grounding the output of the power supply to the chassis
2. Grounding the return side of the power transformer to the chassis
3. Connecting all components in parallel
4. Connecting all components in series

3-54. When working on electronic equipment, the technician should observe which of the following safety precautions?
1. Make certain that the electronic equipment is properly grounded
2. Make certain that the test equipment is properly grounded
3. Make certain that the rubber mats are in good condition
4. All of the above

3-55. Which of the following is/are the most widely used check(s) for testing electronic equipment?
1. Smoke
2. Visual
3. Signal tracing
4. Both 2 and 3 above

3-56. Any connection that is located close to the chassis or any other terminal should be examined for the possibility of which of the following problems?
1. A short
2. An open
3. A low resistance

4. A high resistance

3-57. What is the condition of a transformer that is discolored or leaking?
1. Operational
2. Shorted
3. Cracked
4. Open

3-58. As a technician, you notice that a resistor is discolored and charred. The resistor has most likely been subjected to which, if any, of the following conditions?
1. Overload
2. Open circuit
3. Ambient temperature
4. None of the above

3-59. You are in the process of energizing a power supply. You hear a boiling or sputtering noise and notice smoke coming from a section of the power
supply. Which, if any, of the following actions should you take first?
1. Secure power immediately
2. Examine the problem area
3. Remove the defective component
4. None of the above

3-60. Which, if any, of the following is the most rapid and accurate method for testing electronic circuits?
1. Smoke test
2. Visual test
3. Signal tracing
4. None of the above

MODULE 7

INTRODUCTION TO SOLID-STATE DEVICES AND POWER SUPPLIES

PREPARED BY:

Florencio De Lemos

Prepared by: Harlem A. Agnote

1-1. Which of the following electronic devices operates by virtue of the movement of electrons within a solid piece of semiconductor material?
1. Transistor
2. Junction diode
3. Solid-state device
4. Each of the above

1-2. Which of the following electronic devices is a minute piece of semiconductor material that can produce complete electronic circuit functions?
1. Zener diode
2. Light-emitting diode
3. Integrated circuit
4. Field effect transistor

1-3. Which of the following terms is used for the decrease in resistance as the temperature of the semiconductor increases?
1. Positive temperature coefficient
2. Negative temperature coefficient
3. Faraday temperature coefficient
4. Zero temperature coefficient

1-4. In addition to rectifying properties, selenium has the property of being light sensitive. How is selenium's resistance affected by light?
1. It decreases with an increase in light intensity
2. It increases with an increase in light intensity
3. It remains constant with variation in light intensity
4. It increases regardless of the variation in light intensity

1-5. One of the most sensitive elements of semiconductor materials is galena. Galena is a crystalline form of what material?
1. Krypton
2. Bismuth
3. Strontium
4. Lead sulfide

1-6. What significant discovery caused a breakthrough in the development of semiconductor devices?
1. The junction diode
2. The junction barrier
3. The extrinsic semiconductor
4. The point-contact transistor

1-7. Which of the following devices is frequently used to regulate power supply voltages at precise levels?
1. Junction diode
2. Tunnel diode
3. Esaki diode
4. Zener diode

1-8. Which of the following solid-state devices has both gain and fast-switching capabilities?
1. Zener diode
2. Tunnel diode
3. Junction diode
4. Point-contact diode

1-9. Which of the following advantages, if any, does a conventional electron tube have over a semiconductor device?
1. It is more efficient
2. It has a longer life
3. It is more economical
4. None of the above

1-10. When compared to an electron tube, the semiconductor device has which of the following limitations?
1. The semiconductor is more sensitive to temperature
2. The semiconductor is used only in radar equipment
3. The semiconductor is difficult to adapt to commercial products
4. Each of the above

1-11. Matter can be found in which of the following forms?
1. Solid
2. Liquid
3. Gas
4. Each of the above

Prepared by: Harlem A. Agnote

1-12. A substance that cannot be reduced to a simpler form by chemical means is called a/an
1. element
2. mixture
3. compound
4. solution

1-13. An atom is the smallest possible particle that retains the characteristics of which of the following substances?
1. An element
2. A mixture
3. A compound
4. A solution

1-14. A molecule is the smallest possible particle that retains the characteristics of which of the following substances?
1. An element
2. A mixture
3. A compound
4. A solution

1-15. Which part of the atom has a negative charge and a small mass?
1. Proton
2. Electron
3. Positron
4. Neutron

1-16. Which part of the atom has a positive charge and a large mass?
1. Proton
2. Electron
3. Positron
4. Neutron

1-17. Which part of the atom has no electrical charge?
1. Proton
2. Electron
3. Positron
4. Neutron

1-18. What name is given to the outermost shell of an atom?
1. First shell
2. M shell
3. Valence shell
4. Subshell

1-19. What term is used to describe an atom which has more than its normal amount of electrons?
1. Ion
2. Ionization
3. Positive ion
4. Negative ion

1-20. Which of the following terms is defined as the process by which an atom gains or loses electrons?
1. Quanta
2. Ionization
3. Loss of energy
4. Remaining energy

1-21. Electrons are NEVER found in which of the following bands?
1. Energy band
2. Valence band
3. Forbidden band
4. Conduction band

1-22. What determines whether a substance is an
insulator, semi-conductor, or conductor?
1. The separation between the valence and forbidden bands
2. The separation between the conduction and valence bands
3. The separation between the conduction and forbidden bands
4. The separation between the forbidden band and the energy gap

1-25. Which of the following terms applies to the
process that holds the atom together in a crystal?
1. Suhl effect
2. Superposition
3. Boundary defect
4. Covalent bonding

Prepared by: Harlem A. Agnote

1-26. The movement of electrons in a semiconductor toward the applied voltage is termed
1. hole flow
2. positive conduction
3. negative conduction
4. electron current flow

1-27. When the theory of semiconductors is discussed, what term(s) is/are used to describe the current that flows in the semiconductor?
1. Hole flow
2. Electron flow
3. Both 1 and 2 above
4. Electromotive flow

1-28. What process takes place within the semiconductor to cause hole flow?
1. The breaking of covalent bonds
2. The combining of valence bands
3. The flexing of the material
4. The splitting of atoms

1-29. A material which has an equal number of electron-hole pairs and conducting electrons is known as what type of semiconductor material?
1. Extrinsic
2. Intrinsic
3. N-type
4. P-type

1-30. The process of adding impurities to crystals
is known by which of the following terms?
1. Charging
2. Doping
3. Honing
4. Processing

1-31. When doping increases the number of free
electrons in a semiconductor, what type of impurity has been added?
1. E-type
2. N-type
3. O-type
4. P-type

1-32. The semiconductor doping impurities—arsenic, antimony, and bismuth—are classified as what type of impurities?
1. Active
2. Neutral
3. Trivalent
4. Pentavalent

1-33. In the P-type semiconductor, what are the majority carriers?
1. The electrons
2. The holes
3. The inactive atoms
4. The inert atoms

1-34. What is/are the purpose(s) of the PN junction diode?
1. To rectify only
2. To amplify only
3. To rectify and amplify
4. To switch

1-35. In a schematic diagram of a PN junction diode, which of the following symbols represents the cathode (N-type material)?
1. The arrow
2. The circle
3. The vertical bar
4. The horizontal line

1-38. The placing of an impurity on a semiconductor of the opposite impurity and fusing the two together produce what type of semiconductor junction?
1. Grown junction
2. Alloy Junction
3. Barrier junction
4. Intrinsic junction

1-39. A perfect bond at the junction of the two diode materials is important for which of the following reasons?
1. It is the point at which rectification takes place
2. It is the point at which amplification takes place

Prepared by: Harlem A. Agnote

3. It is the main structural point from where the diode gets its strength
4. All of the above

1-40. Current flow in a copper wire can be compared to current flow in what type(s) of semiconductor material?
1. N-type only
2. P-type only
3. N- and P-type
4. All types

1-41. What is the overall electrical charge of the N-material in a semiconductor?
1. Zero
2. Some negative value
3. Some positive value
4. Depending upon the balance of electrons, it will be positive or negative

1-42. What is the overall electrical charge of the P-material in a semiconductor?
1. Zero
2. Some negative value
3. Some positive value
4. Depending upon the balance of electrons, it will be positive or negative

1-43. What causes the process called junction recombination to occur when N and P materials are joined together?
1. The diffusion of electrons and holes moving across the junction into the two materials
2. The generation of heat which causes the electrons to bombard the holes at the junction
3. The development of an electrostatic field on each side of the junction
4. The loss of electrons to the depletion region

1-44. After the junction recombination process has reached equilibrium, what is the area that surrounds the junction called?
1. The anode
2. The free ion space
3. The depletion region
4. The electrostatic field

1-45. A voltage applied to a PN junction so that it reduces the junction barrier and aids current flow is what type of bias?
1. Indirect
2. Reverse
3. Forward
4. Direct

1-46. In a forward-biased PN junction, when an electron leaves the negative terminal of the battery and enters the N material, it becomes what type of carrier?
1. Loop
2. Signal
3. Majority
4. Minority

1-48. In the PN junction, which of the following actions will increase the number of majority carriers and increase current flow in a forward-biased condition?
1. Increasing the size of the P material
2. Decreasing the size of the P material
3. Increasing battery voltage
4. Decreasing battery voltage

1-49. A voltage applied to a PN junction so that it will increase the junction barrier and offer a high resistance to current flow is called what type of bias?
1. Direct
2. Forward
3. Reverse
4. Indirect

1-50. When the negative terminal of a battery is connected to the P material, and the positive terminal is connected to the N material, what type of bias is being used?
1. Self
2. Forward
3. Reverse
4. Inverse

1-51. What provides you with information concerning the voltage-current relationship of a PN junction diode?
1. The body color of the diode
2. The color coded bands on the diode

3. The printed information on the diode
4. The characteristic curve graph of the diode

1-58. If the input freq to a half-wave rectifier is 120 Hz, what is the output frequency of the rectified dc?
1. 30 pps
2. 60 pps
3. 120 pps
4. 240 pps

1-59. Why are the units (plates) of the metallic rectifier stacked?
1. To dissipate heat
2. To be used in more than one circuit
3. To prevent inverse voltage breakdown
4. To handle high current applications

1-60. Which of the following types of rectifiers replaces the bulky selenium rectifier?
1. Copper-oxide rectifier
2. Half-wave rectifier
3. Metallic rectifier
4. Silicon rectifier

1-61. Signal diodes are used for which of the following purposes?
1. As mixers
2. As switches
3. As detectors
4. Each of the above

1-62. What type of bias makes a diode act as an open switch?
1. Direct
2. Reverse
3. Forward
4. Switching

1-63. A standard specification sheet for a diode contains which of the following information?
1. A brief description of the diode
2. Major application of the diode
3. Special features of the diode
4. All of the above

1-67. A matching pair of diodes is indicated by which of the following numbers?
1. 2N325
2. 1N325C
3. 2N325M
4. 1N325M

1-68. The number 3N345 identifies which of the following semiconductors, if any?
1. Diode
2. Transistor
3. Tetrode transistor
4. None of the above

1-69. What type of diode has green, blue, and orange bands?
1. 1N463
2. 1N572
3. 1N663
4. 1N563

1-70. One of the prime dangers to the semiconductor diode is heat. Excessive current generated by heat which eventually destroys a diode is called
1. junction overload
2. thermal runaway
3. thermoplastic action
4. thermionic emission

1-71. When replacing a diode in a circuit, which of the following safety precautions should you observe in removing the diode from the circuit?
1. Do not pry the diode from the circuit
2. Do not use excessive heat to remove the diode
3. Do not remove the diode from the circuit while voltage is applied
4. All of the above

1-72. As you make a front-to-back ratio check of a diode with an ohmmeter, your first measurement (forward) is a low resistance reading, and your second measurement (reverse) is also a low reading. What should be your evaluation of the diode?
1. It is open
2. It is shorted
3. It is good
4. It is leaky

Prepared by: Harlem A. Agnote

1-73. What are normally the front-to-back ratio of (a) a power rectifier and (b) a signal diode?
1. (a) 10:1 (b) 50:1
2. (a) 10:1 (b) 300:1
3. (a) 300:1 (b) 10:1
4. (a) 300:1 (b) 50:1

1-74. Of the following tests, which is the most valid for checking a diode?
1. A forward and reverse resistance check with an ohmmeter
2. The substitution of a new diode for the questionable one
3. A dynamic electrical check with a diode test set
4. A forward and reverse resistance check using two different ohmmeters

2-1. What term is used for a semiconductor that has three or more elements?
1. Diode
2. Transistor
3. Duo-diode
4. Point contact

2-2. The term transistor was derived from which of the following words?
1. Resistance and capacitance
2. Transformer and resistor
3. Resistor and transformer
4. Transfer and resistor

2-3. What are the three elements of a transistor?
1. Anode, base, and collector
2. Cathode, base, and collector
3. Emitter, collector, and base
4. Collector, emitter, and cathode

2-4. In a transistor, the flow of current carriers is controlled by which element(s)?
1. Emitter
2. Collector
3. Both 1 and 2 above
4. Base

2-6. Junction transistors have replaced pointcontact transistors for which of the following reasons?
1. Junction transistors generate less noise
2. Junction transistors handle more power
3. Junction transistors provide higher current and voltage gains
4. All of the above

2-7. What is the total number of PN junctions in a transistor?
1. One
2. Two
3. Three
4. Four

2-8. What are the two junctions of a transistor?
1. Emitter-base and emitter-collector
2. Emitter-collector and base-collector
3. Emitter-base and collector-emitter
4. Emitter-base and base-collector

2-9. With proper bias applied to a transistor, what should be the relative resistance of (a) the emitter-base junction and (b) the base-collector junction?
1. (a) High (b) low
2. (a) High (b) high
3. (a) Low (b) low
4. (a) Low (b) high

2-10. For normal operation of a transistor, what is the bias of the (a) emitter-base junction and (b) base-collector junction?
1. (a) Forward (b) reverse
2. (a) Forward (b) forward
3. (a) Reverse (b) forward
4. (a) Reverse (b) reverse

2-16. In a transistor, what percent of the total current flows through the emitter lead?
1. 100
2. 98
3. 60
4. 5

2-17. What are the majority current carriers in (a) the PNP transistor and (b) the NPN transistor?
1. (a) Holes (b) holes
2. (a) Holes (b) electrons
3. (a) Elements (b) holes
4. (a) Electrons (b) electrons

2-18. How will the transistor currents be affected if the forward bias provided by VBB is increased?
1. IB will decrease, IE will decrease, and IC will decrease
2. IB will increase, IE will decrease, and IC will decrease
3. IB will increase, IE will decrease, and IC will increase
4. IB will increase, IE will increase, and IC will increase

2-19. What device provides an increase in

current, voltage, or power of a signal without appreciably altering the original signal?
1. Diode
2. Amplifier
3. Oscillator
4. Power supply

2-20. The resistor that provides forward bias for the emitter-base junction of a transistor is indicated by which of the following symbols?
1. RT
2. Rg
3. RL
4. RB

2-21. The collector load resistor is represented by which of the following symbols?
1. RT
2. Rg
3. RL
4. RB

2-22. In the quiescent state of a transistor circuit, what does the symbol VC indicate?
1. Collector voltage supply
2. Collector voltage
3. Current gain
4. Capacitor voltage

2-27. What type of bias keeps the base bias constant and improves thermal stability?
1. Self-bias
2. Fixed bias
3. Combination bias
4. Each of the above

2-35. Which class of amplifier allows collector current to flow for a full 360 degrees of the input signal?
1. A
2. B
3. C
4. AB

2-36. Which class of amplifier allows collector current to flow for more than 180 degrees of the input signal but less than 360 degrees?
1. A
2. B
3. C
4. AB

2-37. Which class of amplifier has the highest fidelity and lowest efficiency?
1. A
2. B
3. C
4. AB

2-38. Which class of amplifier has the highest efficiency?
1. A
2. B
3. C
4. AB

2-39. What are the three transistor configurations?
1. Common base, common grid, and common output
2. Common anode, common collector, and common base
3. Common emitter, common base, and common collector
4. Common emitter, common base, and common base

2-46. Which of the following is a transistor configuration that provides a phase reversal?
1. Common bias
2. Common input
3. Common emitter
4. Common collector

2-47. What is the symbol for input current in a common-emitter configuration?
1. IE
2. IB
3. IC
4. IT

2-48. What is the symbol for input current in a common-base configuration?
1. IE
2. IB

3. IC
4. IT

2-49. What term is used to indicate current gain in a common-emitter configuration?
1. Alpha
2. Beta
3. Gamma
4. X-ray

2-50. What term is used to indicate current gain in a common-collector configuration?
1. Alpha
2. Beta
3. Gamma
4. X-ray

2-51. What term is used to indicate current gain in a common-base configuration?
1. Alpha
2. Beta
3. Gamma
4. X-ray

2-55. The common collector is also referred to by which of the following terms?
1. Low current gain amplifier
2. Voltage amplifier
3. Emitter follower
4. Grounded emitter

2-56. Which of the following conditions presents the greatest danger to a transistor?
1. Heat
2. High operating voltage
3. Excessive reverse current
4. Handling of the transistor

2-57. What method for checking transistors is cumbersome when more than one transistor is bad in a circuit?
1. Ohmmeter
2. Transistor checker
3. Voltage check
4. Substitution
A. Hybrid IC
B. Monolithic IC
C. Microelectronics
D. Modular Circuitry
E. Integrated Circuit
F. Printed Circuit Board
G. Integrated Circuit Board

Figure 2D.—List of microelectronic terminology.

IN ANSWERING QUESTIONS 2-58 THROUGH 2-62, SELECT FROM FIGURE 2-D THE TERM DEFINED IN THE QUESTION.

2-58. A broad term used to describe the use of integrated circuits to miniaturize electronic equipment.
1. A
2. B
3. C
4. D

2-59. A flat insulating surface upon which printed wires and miniaturized components are connected in a predetermined design and attached to a common base.
1. A
2. B
3. F
4. G

2-60. An assembly technique in which printed circuit boards are stacked and connected to form a module.
1. B
2. C
3. D
4. E

2-61. A device that integrates both active and passive components of a complete electronic circuit in a single chip.
1. D
2. E
3. F
4. G

2-62. A plastic card on which integrated circuits are mounted.
1. A

2. B
3. F
4. G

3-1. What is the total number of connections in a diode?
1. One
2. Two
3. Three
4. Four

3-2. When the PN-junction diode is reversed biased, what happens to the majority carriers?
1. They combine with minority carriers at the junction
2. They move toward the junction
3. Both 1 and 2 above
4. They move away from the junction

3-3. What causes a small leakage current in a reverse-biased PN junction?
1. Holes
2. Electrons
3. Minority carriers
4. Majority carriers

3-4. At some potential, as you increase the reverse bias voltage on a PN junction, the reverse current increases very rapidly. What electronic term is given to this voltage potential?
1. Breakdown voltage
2. Reverse-bias
3. Forward-bias
4. Thermal runaway

3-5. Which of the following is a characteristic of the Zener diode?
1. A PN-junction diode that operates in the reverse-bias breakdown region
2. A PN-junction diode that uses the avalanche effect
3. A PN-junction diode that uses the Zener effect
4. Each of the above

3-6. What determines whether a solid material will act as a conductor, a semiconductor, or an insulator?
1. The energy level of the valence band
2. The energy level of the conductor band
3. The energy difference across the forbidden gap
4. The actual construction of the valence electrons

3-7. In comparing a conductor and an insulator, what is the relative dimension of the forbidden gap of (a) the conductor and (b) the insulator?
1. (a) Wide (b) wide
2. (a) Wide (b) narrow
3. (a) Narrow (b) narrow
4. (a) Narrow (b) wide

3-8. What is the "tunneling phenomenon" within the Zener diode?
1. An action where the minority carriers tunnel across the junction to form the current that occurs at breakdown
2. An action where the majority carriers tunnel across the junction to form the current that occurs at breakdown
3. An action that separates the conduction band and the valence band by a large gap
4. An action that removes all the electrons from the conduction band energy level

3-9. Which breakdown theory explains the action that takes place in a heavily doped PN junction with a reverse bias above 5 volts?
1. Zener effect
2. Avalanche breakdown
3. Energy band effect
4. Valence band gap crossing

3-10. Which breakdown theory explains the action that takes place in a heavily doped PN junction with a reverse bias below 5 volts?
1. Zener effect
2. Avalanche breakdown
3. Energy band effect
4. Valence band gap crossing

3-11. What happens to a Zener diode that has a reverse bias slightly higher than the breakdown voltage?
1. The Zener cuts off
2. The Zener acts like a short circuit

Prepared by: Harlem A. Agnote

3. The Zener acts like an open circuit
4. The Zener conduction does not change

3-14. Why is the Zener diode an ideal voltage regulator?
1. It compensates for low supply voltage
2. It uses an unlimited number of carriers
3. Operating in the breakdown region does not harm it
4. The voltage across the diode remains almost constant after breakdown

3-15. In the construction of the tunnel diode, what is the ratio of impurity atoms to semiconductor atoms?
1. 10,000,000: 1000
2. 1,000:10,000,000
3. 10,000: 100,000
4. 100,000: 10,000

3-19. The varactor operates like which of the following electronic components?
1. A capacitor
2. An inductor
3. A variable capacitor
4. A variable inductor

3-20. An increase in reverse bias of a varactor will have what effect on the width of the depletion region?
1. It will stabilize
2. It will fluctuate
3. It will decrease
4. It will increase

3-21. What happens to the capacitance of a varactor diode as the reverse bias is increased?
1. It decreases
2. It increases
3. It remains the same

3-22. In electronic circuits, how is the varactor used?
1. As a tuning device
2. As a balancing device
3. As an amplifier
4. As a rectifier

3-23. What is/are the basic purpose(s) of the silicon controlled rectifier (SCR)?
1. To function as a switch
2. To function as a regulator
3. To function as a rectifier
4. All of the above

3-24. The SCR is equivalent to what electronic device?
1. Diode
2. Tetrode
3. Thyratron
4. Beam power tube

3-25. Which of the following circuits uses an SCR in its electronic circuitry?
1. Computer logic circuit
2. Voltage comparator circuit
3. Antenna power amplifier circuit
4. Each of the above

3-28. Once an SCR is turned on by a positive pulse of current applied to the gate lead, what action turns the SCR off?
1. Removing the positive pulse from the gate lead
2. Inserting a negative pulse of current on the gate lead
3. Reducing the collector current to a value below that necessary to maintain conduction
4. Increasing the collector current to a point that the SCR will go into saturation and cut off

3-29. What is the total number of terminals in a TRIAC?
1. One
2. Two
3. Three
4. Four

3-30. What is the main difference between the TRIAC and the SCR?
1. The SCR requires a higher input voltage than the TRIAC
2. The TRIAC requires a higher input voltage than the SCR
3. The TRIAC controls and conducts current during both alternations of an

ac cycle, while the SCR controls and conducts current during only one alternation
4. The SCR controls and conducts current during both alternations of an ac cycle, while the TRIAC controls and conducts currents during only one alternation

3-31. What name is given to a group of devices that either produce light or use light in their operation?
1. Optoelectronic
2. Ophthalmology
3. Optokenetic
4. Optometry

3-32. In optoelectronic devices, what do the initials LED stand for?
1. Low-emitting diode
2. Low-emitting device
3. Light-emitting diode
4. Light-emitting device

3-33. What determines the color of light emitted by an LED?
1. The type of incandescent bulb used
2. The type of material used
3. The type of bias used
4. The type of fluorescent bulb used

3-34. What is the standard schematic symbol used to designate LEDs?
1. An incandescent bulb with arrows pointing toward the light
2. An incandescent bulb with arrows pointing away from the light
3. A diode with two arrows pointing toward the cathode
4. A diode with two arrows pointing away from the cathode

3-35. The circuit symbols for all optoelectronic devices have arrows pointing either toward them or away from them. When the arrows point toward the symbol, what does this indicate?
1. The device produces light
2. The device uses light
3. The device requires current flow
4. The device produces current flow

3-38. When replacing LED displays, which of the following methods should you use to ensure that the replacement display is of the same type as the faulty display?
1. A visual inspection
2. A check of the schematic symbols
3. Both 1 and 2 above
4. A check of the manufacturer's number

3-39. The photodiode acts as what type of electronic device?
1. Variable inductor
2. Variable resistor
3. Nonvariable inductor
4. Nonvariable resistor

3-40. When the photodiode is exposed to an external light, what happens to (a) resistance and (b) current?
1. (a) Increase (b) decreases
2. (a) Increases (b) increases
3. (a) Decreases (b) increases
4. (a) Decreases (b) decreases

3-41. To conduct, how must a photodiode be biased?
1. Reverse biased
2. Forward biased
3. Either 1 or 2 above, depending on light intensity

3-42. Photodiodes are useful in which of the following applications?
1. Computer card readers
2. Photographic light meters
3. Optic scanning equipment
4. Each of the above

3-43. Which of the following optoelectronic devices provides increased, conduction for a given light intensity?
1. LED
2. SCR
3. Phototransistor
4. Phototransformer

Prepared by: Harlem A. Agnote

3-44. To compensate for ambient light, a phototransistor must have a total number of how many leads?
1. One
2. Two
3. Three
4. Four

3-48. Which of the following devices is similar in operation to a photodiode?
1. Phototransistor
2. Photocell
3. LED
4. SCR

3-49. Which of the following is a typical light to dark resistance ratio of a photocell?
1. 1: 10
2. 1: 100
3. 1: 1000
4. 1:10,000

3-50. Photocells are used in which of the following circuits?
1. Controller
2. Oscillator
3. Amplifier
4. Detector

3-51. How should photovoltaic cells be coupled together to produce a relatively high voltage?
1. Series coupling
2. Parallel coupling
3. Inductive coupling
4. Mechanical coupling

3-52. What is the total number of terminals in a unijunction transistor (UJT)?
1. One
2. Two
3. Three
4. Four

3-53. The UJT has which of the following advantages over the conventional transistor?
1. Fewer terminals
2. Larger bandpass
3. Less bias is required
4. Increased temperature stability

3-54. How does the UJT differ from a conventional transistor?
1. The UJT has a second base instead of a collector
2. The UJT has a second emitter instead of a collector
3. The UJT has two collectors

3-55. When properly biased, what area(s) of the UJT act(s) as a resistor?
1. The area between base 1 and base 2
2. The area between emitter 1 and emitter 2
3. The area between collector 1 and collector 2
4. All of the above

3-56. The emitter of the UJT may be compared to what electronic component?
1. A fully charged capacitor
2. The wiper arm of a variable resistor
3. The collector of a conventional transistor
4. The secondary winding of a step-down transformer

3-57. What determines the level of voltage gradient at the emitter-base material contact point of a UJT?
1. The bias voltage
2. The manufacturer's specifications
3. The base area of the emitter
4. The voltage potential between base 2 and emitter

3-58. The UJT conducts from base 1 to (a) what point when it is forward biased and from (b) what point to bass 2 when it is reversed biased?
1. (a) Emitter (b) base 1
2. (a) Emitter (b) emitter
3. (a) Base 2 (b) base 1
4. (a) Base 1 (b) emitter

3-59. UJTs may be used in which of the following circuits?

1. Switching
2. Waveshaping
3. Oscillating
4. Each of the above

3-60. The field-effect transistor (FET) combines what desired characteristic of the vacuum tube with the many other advantages of the transistor?
1. Low output impedance
2. High output impedance
3. Low input impedance
4. High input impedance

3-61. What does the FET use to control the electrostatic field within the transistor?
1. Current
2. Voltage
3. Low input impedance
4. High input impedance

3-62. The junction field-effect transistor's (JFET) gate element corresponds very closely in operation with (a) what part of a conventional transistor and (b) what part of the vacuum tube?
1. (a) Emitter (b) cathode
2. (a) Base (b) grid
3. (a) Base (b) cathode
4. (a) Collector (b) plate

3-63. In the JFET, the portion of the bar between the deposit of gate material is of a smaller cross section than the rest of the bar. What does this cross section form?
1. A gate
2. A drain
3. A source
4. A channel

3-64. If a P-type material is used to construct the
gate of a JFET, what material should be used to construct the remaining part of the JFET?
1. N-type
2. P-type
3. Mica type
4. Junction type

3-65. What is the key to FET operation?
1. The control of the effective crosssectional area of the channel
2. The control of the effective crosssectional area of the gate
3. Both 1 and 2 above
4. The low input impedance compared with the high output impedance

3-66. When reverse bias is applied to the gate lead of a JFET, what happens to
(a) source-to-drain resistance of the device and (b) current flow?
1. (a) Decreases (b) decreases
2. (a) Decreases (b) increases
3. (a) Increases (b) decreases
4. (a) Increases (b) increases

3-67. What is the "pinch off" voltage of an FET?
1. The voltage required for the FET to conduct
2. The voltage required to overcome the FET reverse bias
3. The voltage required to reduce drain current to zero
4. The voltage required to reduce gate voltage to zero

3-70. The MOSFET has which of the following advantages over the JFET?
1. Less bias
2. Higher input impedance
3. Higher output impedance
4. All of the above

3-71. The MOSFET is normally constructed so that it operates in either the depletion mode or the enhancement mode. The depletion mode MOSFET (a) uses what type of bias and (b) has what type of doped channel to cause a depletion of current carriers in the channel?
1. (a) Reverse (b) lightly
2. (a) Forward (b) lightly
3. (a) Reverse (b) heavily
4. (a) Forward (b) heavily

3-72. The enhancement mode MOSFET (a) uses what type of bias and (b) has what type of

doped channel to enhance the current carriers in the channel?
1. (a) Reverse (b) lightly
2. (a) Forward (b) lightly
3. (a) Reverse (b) heavily
4. (a) Forward (b) heavily

3-74. What type metal is used in the construction of a MOSFET?
1. Oxide
2. Copper
3. Silver
4. Aluminum

3-75. What is the purpose of the shorting spring in a MOSFET?
1. To shunt the substrate to either the source or gate during operation
2. To protect the device from static electricity during replacement
3. To shunt the gates of a dual-gate MOSFET to make it operate like a single-gate MOSFET
4. To change the gain characteristics of the MOSFET

4-1. Which of the following is NOT one of the four sections of a basic power supply?
1. Transformer
2. Oscillator
3. Rectifier
4. Filter

4-2. The primary purpose of the transformer in an electronic power supply is to isolate the power supply from ground.
1. True
2. False

4-3. What is the primary function of the rectifier section?
1. To convert dc to ac
2. To convert ac to pulsating dc
3. To increase average voltage output
4. To decrease average voltage output

4-4. What is/are the functions of the filter section?
1. To eliminate dc voltage
2. To increase the amplitude of ac
3. To convert pulsating dc to steady dc
4. All of the above

4-5. The purpose of a center tap in a transformer is to provide
1. two separate dc voltages to the rectifier
2. a step-down voltage to the rectifier
3. pulsating dc to the rectifier
4. two equal voltages from one transformer

4-6. A diode is an ideal rectifier for which, if any, of the following reasons?
1. Current flows through the diode in one direction only
2. Current flows through the diode in both directions
3. Current will not flow through a diode
4. None of the above

4-7. When the anode of a diode is negative with respect to the cathode, the diode is said to be in what state?
1. Conduction
2. Saturation
3. Remission
4. Cutoff

4-8. In a simple half-way rectifier, the diode will conduct for a maximum of how many degrees of the 360-degree input signal?
1. 45
2. 90
3. 180
4. 270

4-9. What term is used to describe current pulses that flow in the same direction?
1. Average current
2. Secondary current
3. Pure direct current
4. Pulsating direct current

4-10. What is the ripple frequency of a half-wave rectifier with an input line frequency of 60 Hz?
1. 30 Hz
2. 60 Hz
3. 90 Hz
4. 120 Hz

4-11. In a half-wave rectifier, what is the average voltage output when the peak voltage is 300 volts?
1. 190.8 volts
2. 95.4 volts
3. 19.08 volts
4. 9.4 volts

4-14. What is the ripple frequency of a fullwave rectifier with an input line frequency of 60 Hz?
1. 30 Hz
2. 60 Hz
3. 90 Hz
4. 120 Hz

4-15. The full-wave rectifier has which of the following advantages over the halfwave?
1. Higher average voltage and current
2. Larger number of components
3. Higher value of voltage
4. Better regulation

Prepared by: Harlem A. Agnote

4-16. What is the average voltage output of a full-wave rectifier that has an output of 100 volts peak?
1. 3.18 volts
2. 6.36 volts
3. 31.8 volts
4. 63.7 volts

4-17. The primary disadvantage of the conventional full-wave rectifier is that the peak output voltage is only one-half that of the half-wave rectifier.
1. True
2. False

4-20. In filter circuits, inductors are used as what type of impedance(s)?
1. Shunt impedance to oppose changes in current
2. Shunt impedances to oppose changes in voltage
3. Series impedances to oppose changes in current
4. Series impedances to oppose changes in voltage

4-21. To retain its charge, the capacitor in a simple capacitor filter must have a long charge time constant and a short discharge time constant.
1. True
2. False

4-22. If you increase the value of a capacitor, the XC will increase.
1. True
2. False

4-23. To obtain a steady dc output in a simple capacitor circuit, the capacitor must charge almost instantaneously to the value of the applied voltage.
1. True
2. False

4-24. Which of the following factors, if any, determines the rate of discharge of the capacitor in a filter circuit?
1. The value of the load resistance
2. The amount of voltage
3. The type of capacitor
4. None of the above

4-25. A half-wave rectifier has an output frequency of 60 hertz, a filter capacitor value of 40 microfarads, and a load resistance of 10 kilohms. What is the value of XC?
1. 133.3 ohms
2. 26.5 ohms
3. 66.3 ohms
4. 40.0 ohms

4-26. A full-wave rectifier has an output frequency of 120 hertz, a filter capacitor value of 25 microfarads, and a load resistance of 10 kilohms.What is the value of XC?
1. 5.3 ohms
2. 53 ohms
3. 106 ohms
4. 1060 ohms

4-27. What type of filter is the most basic power supply filter?
1. Capacitor
2. LC choke-input
3. LC capacitor-input
4. RC capacitor-input

4-28. In a circuit with a capacitor filter, how is the capacitor connected?
1. In series with the load
2. In parallel with the load
3. In series with the input
4. Both 2 and 3 above

4-29. The LC choke-input filter is used primarily where which of the following types of regulation is/are important?
1. Frequency
2. Current only
3. Voltage only
4. Voltage and Current

4-30. In an LC choke-input filter circuit, the

capacitor charges only to the average value of the input voltage. What component inhibits the capacitor from reaching the peak value of the input voltage?
1. The diode
2. The capacitor
3. The filter choke
4. The load resistor

4-31. In an LC choke-input filter, the larger the value of the filter capacitor, the better the filtering action. Which of the following factors represents the major limitation in obtaining the maximum value of the capacitor used?
1. Cost
2. Reliability
3. Availability
4. Physical size

4-32. What is the most common range of values, in henries, for a power supply choke?
1. 1 to 20
2. 5 to 25
3. 25 to 30
4. 10 to 200

4-33. If the impedance of the choke in an LC choke-input filter is increased, the ripple will
1. increase
2. decrease
3. oscillate
4. remain the same

4-34. A full-wave rectifier has an output frequency of 120 hertz, a filter choke with a value of 10 henries, and a load resistance of 10 kilohms. What is the value of XL?
1. 75 ohms
2. 7.5 ohms
3. 75 kilohms
4. 7.5 kilohms

4-35. The filter capacitor in the LC chokeinput filter is NOT subject to extreme voltage surges because of the protection provided by what component?
1. Shunt capacitor
2. Series resistor
3. Load resistor
4. Inductor

4-36. Shorted turns in the choke of an LC choke-input filter may reduce the value of inductance below the critical value. When this happens, which of the following problems may occur?
1. Poor voltage regulation
2. Excessive ripple amplitude
3. Abnormally high output voltage
4. Each of the above

4-37. The use of the RC capacitor-input filter is limited to which of the following situations?
1. When the load current is large
2. When the load current is small
3. When the load voltage is large
4. When the load voltage is small

4-42. In a voltage regulator, what percent of regulation would be ideal?
1. 1 %
2. 5 %
3. 3 %
4. 0 %

4-43. If a power supply produces 30 volts with no load and 25 volts under full load, what is the percent of regulation?
1. 5
2. 10
3. 20
4. 30

4-44. If a power supply produces 10 volts with no load and 9 volts under full load, what is the percent of regulation?
1. 8
2. 9
3. 10
4. 11

4-45. If a power supply produces 20 volts with no load and 20 volts under full load, what is the percent of regulation?
1. 1
2. 2

3. 3
4. 0

4-46. Basic voltage regulators are classified as either series or shunt. Their classification is determined by which of the following factors?
1. The type of regulating device used
2. The type of regulation required
3. The amount of regulation required
4. The position of the regulating device in relation to the load (RL)

4-47. The simple series voltage regulator was designed to function as what type of resistance?
1. Fixed resistance in series with the load
2. Fixed resistance in parallel with the load
3. Variable resistance in series with the load
4. Variable resistance in parallel with the load

4-48. A series voltage regulator is designed so that what total percentage of current flows through the regulating device?
1. 25
2. 50
3. 75
4. 100

4-49. When a series voltage regulator is used to control output voltages, any increase in input voltage results in a/an
1. decrease in the voltage drop across the load resistance
2. increase in the voltage drop across the Zener diode
3. decrease in the resistance of the regulating device
4. increase in the resistance of the regulating device

4-53. What type of ammeter reading indicates that current regulator is functioning properly?
1. Constant
2. Deflection in the negative direction
3. Deflection in the positive direction
4. Fluctuation around the center line

4-54. A major disadvantage of having good current regulation is that good voltage regulation is lost.
1. True
2. False

4-55. To maintain a constant current flow when there is an increase in the load resistance (RL), variable resistance (RV) must compensate for this change by
1. increasing its resistance
2. decreasing its resistance
3. remaining the same

4-56. A decrease in the forward bias of a baseemitter junction has which of the following effects on the resistance of a transistor?
1. It increases
2. It deceases
3. It remains the same

4-57. Voltage multipliers are used primarily to develop what type of voltage?
1. Low voltage where low current is required
2. Low voltage where high current is required
3. High voltage where low current is required
4. High voltage where high current is required

4-58. The classification of voltage multipliers depends on which of the following ratios?
1. Input current to output current
2. Input current to output voltage
3. Output voltage to input voltage
4. Input voltage to output current

4-59. A half-wave voltage doubler consists of what total number of half-wave rectifiers?
1. One
2. Two
3. Three
4. Four

4-60. If a half-wave rectifier circuit is added to a half-wave voltage doubler circuit, what will be the resulting circuit?
1. A voltage doubler
2. A voltage tripler

Prepared by: Harlem A. Agnote

3. A voltage quadruplet
4. A voltage quintuplet

4-61. Which of the following methods is used by manufacturers of electronic equipment to reduce the cost of extensive wiring?
1. Grounding the output of the power supply to the chassis
2. Grounding the return side of the power transformer to the chassis
3. Connecting all components in parallel
4. Connecting all components in series

4-62. When working on electronic equipment, the technician should observe which of the following safety precautions?
1. Make certain that the electronic equipment is properly grounded
2. Make certain that the test equipment is properly grounded
3. Make certain that the rubber mats are in good condition
4. All of the above

4-63. Which of the following is/are the most widely used check(s) for testing electronic equipment?
1. Smoke
2. Visual
3. Signal tracing
4. Both 2 and 3 above

4-64. Any connection that is located close to the chassis or to any other terminal should be examined for the possibility of which of the following problems?
1. An open
2. A short
3. A low resistance
4. A high resistance

4-65. Which of the following statements applies to a transformer that is discolored or leaking?
1. It is operational
2. It is cracked
3. It is shorted
4. It is open

4-66. As a technician, you notice that a resistor is discolored and charred. Which, if any, of the following conditions most likely caused the damage?
1. Overload
2. Open circuit
3. Ambient temperature
4. None of the above

4-67. You are in the process of energizing a power supply. You hear a boiling or sputtering noise and notice smoke coming from a section of the power supply. Which, if any, of the following
actions should you take first?
1. Secure the power immediately
2. Examine the problem area
3. Remove the defective component
4. None of the above

4-68. Which, if any, of the following is the most rapid and accurate method for testing electronic circuits after completing visual inspection?
1. Smoke test
2. Current test
3. Signal tracing
4. None of the above

MODULE 8

INTRODUCTION TO AMPLIFIERS

PREPARED BY:

Angelo Sevillano

1-1. The control of an output signal by an input signal resulting in the output signal having some (or all) of the characteristics of the input signal is known by which of the following terms?
1. Multiplication
2. Magnification
3. Amplification
4. Addition

1-2. Which of the following statements describes the relationship of input and output signals in a amplifier?
1. The input signal is actually changed into the output signal
2. Both the input and output signal are unchanged; neither is affected by the other
3. The input signal is controlled by the output signal and the output signal remains unchanged
4. The input signal remains unchanged and the output signal is controlled by the input signal

1-3. Why are amplifiers used in electronic devices?
1. To provide signals of usable amplitude
2. To "pick up" broadcast signals
3. To select the proper broadcast signal
4. To change the broadcast signal to an audio signal

1-4. Most amplifiers can be classified in which of the following ways?
1. Function and size
2. Power requirements and size
3. Function and frequency response
4. Frequency response and power requirements

1-5. The speaker system of a record player should be driven by which of the following types of amplifier?
1. An audio power amplifier
2. A video voltage amplifier
3. A direct-current voltage amplifier
4. An alternating-current rf amplifier

1-6. The signal from a radio antenna should be amplified by which of the following types of amplifier?
1. An rf voltage amplifier
2. A video power amplifier
3. A direct-current audio amplifier
4. An alternating-current power amplifier

1-7. The class of operation of an amplifier is determined by which of the following factors?
1. The gain of the stage
2. The efficiency of the amplifier
3. The amount of time (in relation to the input signal) that current flows in the output circuit
4. The amount of current (in relation to the input-signal current) that flows in the output circuit

1-8. Which of the following is NOT a class of operation for an amplifier?
1. A
2. C
3. AB
4. AC

1-9. If the output of a circuit should be a representation of less than one-half of the input signal, what class of operation should be used?
1. A
2. C
3. AB
4. AC

1-10. What class of operation is the most efficient?
1. A
2. C
3. AB
4. AC

1-11. What class of operation has the highest fidelity?
1. A
2. C
3. AB
4. AC

Prepared by: Harlem A. Agnote

1-12. What is the purpose of an amplifier coupling network?
1. To "block" d.c.
2. To provide gain between stages
3. To separate one stage from another
4. To transfer energy from one stage to another

1-13. Which of the following is NOT a method of coupling amplifier stages?
1. RC
2. Resistor
3. Impedance
4. Transformer

1-14. What is the most common form of coupling?
1. RC
2. Resistor
3. Impedance
4. Transformer

1-15. Which of the following types of coupling is usually used to couple the output from a power amplifier?
1. RC
2. Resistor
3. Impedance
4. Transformer

1-16. Which of the following types of amplifiers have both high and low frequency response limitations?
1. RC
2. Resistor
3. Impedance
4. Transformer

1-17. Which of the following types of coupling is most effective at high frequencies?
1. RC
2. Resistor
3. Impedance
4. Direct

1-18. For maximum power transfer between circuits, what impedance relationship should there be between the two circuits?
1. The output impedance of circuit number one should be higher
2. The input impedance of circuit number one should be higher than the output impedance of circuit .number two
3. The output impedance of circuit number one should be lower than the input impedance of circuit number two
4. The output impedance of circuit number one should be equal to the input impedance of circuit number two

1-19. For maximum current at the input to a circuit, what should the relationship of the input impedance be to the output impedance of the previous stage?
1. Higher than
2. Lower than
3. Equal to
4. The impedance relationship is immaterial

1-20. What is the (a) input impedance and (b) output impedance of a common-base transistor configuration?
1. (a) Low (b) low
2. (a) Low (b) high
3. (a) High (b) low
4. (a) High (b) high

1-21. What transistor configuration should be used to match a high output impedance to a low input impedance?
1. Common collector
2. Common emitter
3. Common gate
4. Common base

1-22. What type of coupling is most useful for impedance matching?
1. RC
2. Resistor
3. Impedance

4. Transformer

1-23. What is feedback?
1. The control of a circuit output signal by the input signal
2. The control of a circuit input signal by the output signal
3. The coupling of a portion of the output signal to the input of the circuit
4. The coupling of a portion of the input signal to the output of the circuit

1-24. Which of the following terms describe the two types of feedback?
1. Positive and negative
2. Degenerative and regenerative
3. Both 1 and 2 above
4. Bypassed and unbypassed

1-25. What type of feedback provide an increased amplitude output signal?
1. Positive
2. Negative
3. Bypassed
4. Unbypassed

1-26. Distortion caused by amplifier saturation can be reduced by using which of the following types of feedback?
1. Positive
2. Negative
3. Regenerative
4. Unbypassed

1-27. What type feedback is provided if the feedback signal is out of phase with the input signal?
1. Unbypassed
2. Bypassed
3. Negative
4. Positive

1-28. What type of feedback is provided by a capacitor connected across the emitterresistor in a common-emitter transistor amplifier?
1. Bypassed
2. Positive
3. Negative
4. Unbypassed

1-29. What are the (a) inputs and (b) outputs of a phase splitter?
1. (a) Two signals in phase (b) One signal
2. (a) Two signals out of phase (b) One signal
3. (a) One signal (b) Two signals in phase
4. (a) One signal (b) Two signals out of phase

1-30. A single-stage, two transistor amplifier that uses a phase splitter input is classified as what type of amplifier?
1. Inverse
2. Push-pull
3. Phase splitter
4. Regenerative

1-31. Which of the following is a common use for a push-pull amplifier?
1. The first stage of a video amplifier
2. The amplifier stage connected directly to an antenna
3. The second stage in a four stage rf amplifier
4. The final stage in an audio amplifier

1-32. What is the advantage of a push-pull amplifier as compared to a single transistor amplifier?
1. Lower cost
2. Fewer parts
3. Higher gain
4. Less power usage

1-33. To provide good fidelity output signals, which of the following classes of operation CANNOT be used by a pushpull amplifier?
1. A
2. B
3. C
4. AB

1-34. What is the bandwidth of an amplifier?
1. The actual frequencies the amplifier is effective in amplifying
2. The difference between the high and low frequencies seen at the input of the amplifier
3. The width, in inches, between the

half-power points on a frequencyresponse curve
4. The difference between the lowest and highest frequency shown on a frequency-response curve

1-37. Which of the following limit(s) the frequency response of a transistor amplifier?
1. The inductance
2. The transistor
3. The capacitance
4. All of the above

1-38. What type of feedback is caused by interelectrode capacitance?
1. Bypassed
2. Negative
3. Positive
4. Regenerative

1-39. What happens to capacitive reactance as frequency decreases?
1. It increases
2. It decreases
3. It remains the same
4. It cannot be determined

1-40. What happens to inductive reactance as frequency increases?
1. It increases
2. It decreases
3. It remains the same
4. It cannot be determined

1-41. What is the major factor that limits the high frequency response of an amplifier?
1. Inductance
2. Resistance
3. Capacitance
4. Transformer reactance

1-42. What components can be used to increase the high-frequency response of an amplifier?
1. Diodes
2. Inductors
3. Resistors
4. Capacitors

1-43. What determines whether a peaking component is considered "series" or "shunt"?
1. The relationship of the component to the power supply
2. The relationship of the component to the input signal path
3. The relationship of the component to the amplifying device
4. The relationship of the component to the output signal path

1-44. What is the arrangement of both "series" and "shunt" peaking components called?
1. Coordinated
2. Combination
3. Combined
4. Complex

1-45. Which of the following components in a transistor amplifier circuit tends to limit the low-frequency response of the amplifier?
1. The transistor
2. The load resistor
3. The coupling capacitor
4. The input-signal-developing resistor

1-53. What is the effect of the gain of an amplifier if the input-signal developing impedance is decreased?
1. It decreases
2. It increases
3. It remains the same
4. It cannot be determined

1-54. What is the effect on the gain of an amplifier if the output-signal-developing impedance is increased?
1. It decreases
2. It increases
3. It remains the same
4. It cannot be determined

1-55. What is/are the purpose(s) of a frequency-determining network in an rf amplifier?
1. To create a large bandpass
2. To compensate for low-frequency losses
3. To provide maximum impedance at a

given frequency
4. All of the above

1-56. Of the following networks, which could be used as a frequency-determining network for an rf amplifier?
1. A parallel-resistor network
2. A series-resistor network
3. A parallel RC network
4. A parallel LC network

1-57. Which of the following methods may be used to tune an LRC frequencydetermining network to a different frequency?
1. Vary the capacitance
2. Vary the inductance
3. Both 1 and 2 above
4. Vary the resistance

1-58. What is the most common form of coupling for an rf amplifier?
1. RC
2. Resistor
3. Impedance
4. Transformer

1-59. Which of the following advantages are provided by transformer coupling?
1. Simpler power supplies can be used
2. The circuit is not affected by frequency
3. Low-frequency response is improved
4. Fewer parts are used

1-60. If a current gain is desired, which of the following elements/networks should be used as an output-coupling device?
1. An RC network
2. A resistive network
3. A step-up transformer
4. A step-down transformer

1-61. Which of the following techniques would cause a too-narrow bandpass in an rf amplifier?
1. An overcoupled transformer
2. A loosely coupled transformer
3. The use of a swamping resistor
4. The use of a frequency-determining network

1-62. Which of the following techniques would cause low gain at the center frequency of an rf amplifier?
1. An overcoupled transformer
2. A loosely coupled transformer
3. The use of a swamping resistor
4. The use of a frequency-determining network

1-63. What type of transformer coupling should be used in an rf amplifier?
1. Ideal
2. Loose
3. Optimum
4. Overcoupling

1-64. Which of the following methods provides the widest band-pass in an rf amplifier?
1. A swamping resistor
2. A loosely coupled amplifier
3. A large input-signal-developing resistor
4. A small output-signal-developing resistor

1-65. Which of the following methods will compensate for the problem that cause low gain in an rf amplifier?
1. Using rf transformers
2. Taking advantage of the interelectrode capacitance
3. Both 1 and 2 above
4. Using audio transformers

1-66. Which of the following types of feedback is usually caused by the base-to-collector interelectrode capacitance?
1. Regenerative
2. Decoupled
3. Positive
4. Negative

1-67. In an rf amplifier an unwanted signal is coupled through the base-to-collector interelectrode capacitance. This problem

can be solved by providing feedback out of phase with the unwanted signal. What is this technique called?

1. Neutralization

2. Compensating
3. Decoupling
4. Swamping

2-1. What is the maximum number of possible inputs in a differential amplifier?
1. One
2. Two
3. Three
4. Four

2-2. What is the maximum number of possible outputs in an differential amplifier?
1. One
2. Two
3. Three
4. Four

2-25. Which of the following is NOT a requirement for an operational amplifier?
1. Very high gain
2. Very high input impedance
3. Very high output impedance
4. Very low output impedance

2-26. Which of the following types of components are used in most operational amplifiers?
1. Transistor circuits
2. Electron tube circuits
3. Both 1 and 2 above
4. Integrated circuits

2-30. If degenerative feedback is used in an operational-amplifier circuit, which of the following terms describes the circuit configuration?
1. Open loop
2. Closed loop
3. Full circle
4. Neutralized

2-31. Which of the following signals determines the stability of the output signal from an operational-amplifier circuit in which degenerative feedback is used?
1. The input signal only
2. The feedback signal only
3. Both 1 and 2 above
4. The detected signal

2-39. Which of the following is a difference between a summing amplifier and an adder circuit?
1. The amount of gain
2. The number of inputs
3. The type of operational amplifier
4. The placement of resistors in the circuit

2-42. If the amplitude of the signal at E1 is +5 volts and the amplitude of the signal at E2 is +2 volts, what is the amplitude of the signal at the inverting (−) input of the operational amplifier?
1. 0 volts
2. +7 volts
3. +21 volts
4. +54 volts

2-43. Which of the following is a difference between a difference amplifier and a subtractor?
1. The amount of gain
2. The number of inputs
3. The type of operational amplifier
4. The placement of resistors in thecircuit

2-44. How many inputs can a (a) difference amplifier and (b) summing amplifier have?
1. (a) Two only (b) Two only
2. (a) Two only (b) More than two
3. (a) More than two (b) Two only
4. (a) More than two (b) More than two

2-49. A magnetic amplifier can be classified as which of the following types of amplifier?
1. RF amplifier
2. Audio amplifier
3. Video amplifier
4. Voltage amplifier

2-50. Which of the following statements describes the basic operating principle of a magnetic amplifier?
1. Any power amplifier will create a magnetic field which can be used to increase the gain of the power amplifier
2. The inductance of an air-core

Prepared by: Harlem A. Agnote

inductor will change as the power used by the load changes
3. A changing inductance can be used to control the current in a load
4. Magnetism can be increased (amplified) by changing the voltage amplitude

2-51. What happens to the true power in a series LR circuit if the inductance is decreased?
1. It increases
2. It decreases
3. It remains the same
4. It increases initially and then decreases rapidly

2-52. If the permeability of the core of a coil decreases, what happens to the (a) inductance and (b) true power in the circuit?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) increases
4. (a) Decreases (b) decreases

2-53. If the current in an iron-core coil is increased to a large value (from the operating point) what happens to the permeability of the core?
1. It increases
2. It decreases
3. It remains the same
4. It increases initially and then decreases rapidly

2-54. If two coils are wound on a single iron core, a change in current in one coil (a) will or will not cause a change in inductance and (b) will or will not cause a change in current in the other coil.
1. (a) Will (b) will
2. (a) Will (b) will not
3. (a) Will not (b) will
4. (a) Will not (b) will not

2-56. A magnetic amplifier should be operated on what portion of the magnetization curve?
1. The positive peak
2. The negative peak
3. The mid-point
4. The knee

2-57. A toroidal core is used in a saturable-core reactor to counteract which of the following effects?
1. Hysteresis
2. Copper loss
3. Both 1 and 2 above
4. The effect of load flux on control flux

2-58. Why is a rectifier used in a magnetic amplifier?
1. To decrease current
2. To eliminate hysteresis loss
3. To increase the power-handling capability
4. To convert the magnetic amplifier from an a.c. device to a d.c. device.

2-59. What can be used to set a magnetic amplifier to the proper operating point and leave the control winding free to accept input signals?
1. A filter
2. A bias winding
3. A d.c. power source
4. A feedback network

2-60. A magnetic amplifier would not be used in which of the following devices?
1. A servo system
2. A d.c. power supply
3. Temperature indicators
4. A wideband audio power amplifier system

MODULE 9

INTRODUCTION TO WAVE-GENERATION AND WAVE-SHAPING

PREPARED BY:

Klaudine Marie Ramirez and John Driel Bogar

1-1. An inductor presents which of the following types of electrical opposition to ac current flow?
1. Reactance inductive
2. Resistance
3. Inductance
4. Capacitance

1-2. Which of the following electrical characteristics determines the magnitude of inductive reactance?
1. Resistance
2. Frequency only
3. Inductance only
4. Frequency and inductance

1-3. Which of the following values represents an inductive reactance?
1. XC = 2,220 ohms
2. XL = 220 ohms
3. L = 22 millihenries
4. C = 22 microfarads

1-4. What formula is used to calculate inductive reactance?
2. $X_L = 2\pi fL$

1-5. In an ac circuit, how does inductive reactance respond to an increase in applied frequency?
1. Inductive reactance increases
2. Inductive reactance decreases
3. Inductive reactance remains the same

1-6. What term describes the opposition to ac that causes current to lead voltage?
1. Resistance
2. Conductance
3. Inductive reactance
4. Capacitive reactance

1-7. In an ac circuit, how does capacitive reactance respond to an increase in applied frequency?
1. Capacitive reactance increases
2. Capacitive reactance decreases
3. Capacitive reactance remains the same

1-8. In an ac circuit, what is the term that describes the TOTAL opposition to current flow?
1. Impedance
2. Inductance
3. Resistance
4. Capacitance

1-9. In an ac circuit that contains an inductive reactance of 7,250 ohms and a capacitive reactance of 9,775 ohms, what is the resultant reactance?
1. - 2,525 ohms
2. -10,250 ohms
3. 2,525 ohms
4. 10,250 ohms

1-10. When an ac circuit is at resonance, what is the relationship between XL and XC
1. XL is equal to XC
2. XL is less than XC
3. XL is greater than XC
4.

1-11. What formula is used to calculate resonant frequency?
4. $f_r = \frac{1}{2\pi\sqrt{LC}}$

1-12. In a tank circuit, how does the resonant frequency of the circuit respond to an

increase in (a) capacitance and (b) inductance?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

1-13. In a resonant circuit, what is the phase angle between voltage and current?
1. 0 degrees
2. 90 degrees
3. 180 degrees
4. 270 degrees

1-14. In a resonant circuit, how does resistance
change, if at all, in response to an increase in frequency?
1. Increases
2. Decreases
3. Remains the same

1-15. In a series-LC circuit, which of the following component characteristics describes circuit action (a) below the resonant frequency and (b) above the resonant frequency?
1. (a) Inductive (b) Capacitive
2. (a) Inductive (b) Resistive
3. (a) Capacitive (b) Inductive
4. (a) Capacitive (b) Resistive

Figure 1A.—Series-resonant circuit.

IN ANSWERING QUESTIONS 1-16 THROUGH 1-21, REFER TO FIGURE 1A.

1-16. What is the resonant frequency for the circuit?
1. 1.592 MHz
2. 92 MHz
3. 159.2 MHz
4. 1,592 MHz
15.9 MHz

1-17. What is the value of inductive reactance?
1. 1.97 ohms
2. 97 ohms
3. 199.7 ohms
4. 1,997 ohms

1-18. If the resonant frequency is 7.96 MHz, what is the value of capacitive reactance?
1. 500 ohms
2. 1,000 ohms
3. 2,000 ohms
4. 4,000 ohms

IN ANSWERING QUESTIONS 1-19 THROUGH 1-21, ASSUME THE SOURCE FREQUENCY IN FIGURE 1A IS ABOVE THE RESONANT FREQUENCY. SELECT THE ANSWERS THAT DESCRIBE HOW AN ABOVE-RESONANCE FREQUENCY WILL CAUSE THE CIRCUIT CHARACTERISTICS IN THE QUESTIONS TO RESPOND WHEN COMPARED TO THEIR VALUES AT RESONANCE.

1-19. Impedance.
1. Increases
2. Decreases
3. Remains the same

1-20. Current.
1. Increases
2. Decreases
3. Remains the same

1-21. Voltage drops across the reactance.
1. Increases

2. Decreases
3. Remains the same

Figure 1B.—Series-resonant circuit curves.
IN ANSWERING QUESTIONS 1-22 AND 1-23, REFER TO FIGURE 1B.

1-22. Response curve B for a series-resonant circuit represents which of the following circuit characteristics?
1. Power
2. Voltage
3. Current
4. Impedance

1-23. At resonance, which of the following series-resonant circuit values is at a maximum value?
1. Circuit current
2. Voltage across L
3. Voltage across C
4. Circuit impedance

1-24. In a series-resonant circuit operating at fr,
what term describes the impedance of the circuit?
1. Resistive
2. Inductive only
3. Capacitive only
4. Capacitive-inductive

Figure 1C.—Parallel-resonant circuit.
IN ANSWERING QUESTIONS 1-25 THROUGH 1-27, REFER TO FIGURE 1C.

1-25. In the parallel-resonant circuit, what is the phase relationship between the current in the inductor and the current in the capacitor?
1. Inductor current is in phase with capacitor current
2. Inductor current is 45 degrees out of phase with capacitor current
3. Inductor current is 90 degrees out of phase with capacitor current
4. Inductor current is 180 degrees out of phase with capacitor current

1-26. In the parallel-resonant circuit, what is the phase relationship between voltage in the inductor and the voltage in the capacitor.
1. Inductor voltage is in phase with capacitor voltage
2. Inductor voltage is 45 degrees out of phase with capacitor voltage
3. Inductor voltage is 90 degrees out of phase with capacitor voltage
4. Inductor voltage is 180 degrees out of phase with capacitor voltage

1-27. In the parallel-resonant circuit, which of the following circuit conditions is NOT normal?
1. XC equals XL
2. IC equals IL
3. Iline is minimum
4. Iline is maximum

Figure 1D.—Parallel-resonant circuit curves.
IN ANSWERING QUESTIONS 1-28 AND 1-29, REFER TO FIGURE 1D.

1-28. In the figure, what does response curve A
represent?
1. Current
2. Impedance
3. Reactance
4. Resistance

1-29. What does response curve B represent?
1. Power
2. Impedance
3. Reactance
4. Resistance

1-30. As a parallel-resonant circuit approaches resonance, which of the following circuit actions takes place?
1. Impedance decreases
2. Oscillating current increases
3. Inductance increases
4. Capacitance decreases

1-31. When a parallel-resonant circuit operates
BELOW resonance, which of the following component characteristics describes circuit action?
1. Inductive
2. Capacitive
3. Resistive

1-32. When a parallel-resonant circuit operates
ABOVE resonance, which of the following component characteristics describes circuit actions?
1. Inductive
2. Capacitive
3. Resistive

1-33. In a parallel-resonant circuit, which of the following circuit conditions is observed?
1. Oscillating current is less than line current
2. Oscillating current is greater than line current
3. Line current is maximum
4. Impedance is minimum

1-34. What is the level of impedance offered at
resonance in (a) a series-resonant circuit and (b) a parallel-resonant circuit?
1. (a) High (b) high
2. (a) High (b) low
3. (a) Low (b) low
4. (a) Low (b) high

1-35. The ability of a resonant circuit to separate currents of desired frequencies from those of undesired frequencies makes them useful in which of the following circuit applications?
1. Filters
2. Counters
3. Amplifiers
4. Voltage dividers

1-36. The Q of a circuit is a measure of circuit
1. quality *quality factor
2. permeance
3. conductance
4. inductive reactance

1-37. Which of the following circuit values has the greatest effect on the figure of merit of the circuit?
1. Reactance
2. Inductance
3. Resistance
4. Capacitance

1-38. What formula is used to figure the Q of a
coil?
4. $Q = \frac{X_L}{R}$

1-39. On which of the following coil characteristics is the Q of a coil dependent?
1. Size
2. Length
3. Material
4. All of the above

THIS SPACE LEFT BLANK INTENTIONALLY.

1-40. A series-resonant circuit, which of the following conditions results in a voltage gain?
1.
2.
3.
4.

1-41. In a parallel-resonant circuit, Q is used to
figure which of the following circuit values?
1. Voltage gain
2. Voltage loss
3. Circulating tank current
4. Circulating line current

1-42. To determine bandwidth, you would use which of the following mathematical expressions?
1. 1. $BW = \frac{f_r}{Q}$

1-43. To calculate (figure) the half-power points of a resonant circuit, which of the following mathematical expressions should you use?
1. .707 x Imin
2. .707 x Imax
3. .637 x Imin
4. .637 x Imax

Figure 1E.—Response curve.
IN ANSWERING QUESTIONS 1-44 THROUGH 1-46, REFER TO FIGURE 1E.

1-44. In the response curve, what is the resonant frequency?
1. 50 kHz
2. 70 kHz
3. 100 kHz
4. 140 kHz

1-45. What is the bandwidth?
1. 10 kHz
2. 20 kHz
3. 30 kHz
4. 40 kHz

1-46. If the Q of the circuit represented by the response curve is 100, what is the bandwidth?
1. 1 kHz
2. 10 kHz
3. 20 kHz
4. 30 khz

Figure 1F.—Filter circuit.
IN ANSWERING QUESTION 1-47, REFER TO FIGURE 1F.

1-47. If the applied frequency to the circuit is increased, what is the response of (a) XC and (b) XL
1. (a) XC increases (b) XL increases
2. (a) XC increases (b) XL decreases
3. (a) XC decreases (b) XL decreases
4. (a) XC decreases (b) XL increases

TO ANSWER QUESTIONS 1-48 THROUGH 1-50, SELECT FROM COLUMN B THE CIRCUIT WHICH DESCRIBES THE CIRCUIT OPERATION IN COLUMN A. CHOICES IN COLUMN B MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

A. CIRCUIT OPERATION

B. CIRCUIT

1-48. Passes the majority of current below a specific frequency and opposes current above that frequency. Low-pass filter

1-49. Passes the majority of current above a specific frequency and opposes current below that frequency. High-pass filter

1-50. Passes a narrow band of frequencies and opposes all others. Band-pass filter

1-51. The action of a filter circuit that reduces the amplitude of unwanted frequencies below the amplitude of the desired frequency is known as

1. attenuation
2. amplification
3. discrimination
4. impedance matching

1-52. The frequency beyond which a filter circuit no longer passes current is referred to as the

1. filter frequency
2. cutoff frequency
3. resonant frequency
4. response frequency

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 1G.—Filter circuits.

TO ANSWER QUESTIONS 1-53 AND 1-54, SELECT FROM FIGURE 1G THE CIRCUIT DIAGRAM WHICH MATCHES THE CIRCUIT NAME IN EACH QUESTION. CHOICES IN THE FIGURE MAY BE USED

ONCE, MORE THAN ONCE, OR NOT AT ALL.

1-53. Band-reject filter.
1. A
2. B
3. C
4. D

1-54. High-pass filter.
1. A
2. B
3. C
4. D

Figure 1H.—Filter circuit.

IN ANSWERING QUESTIONS 1-55 AND 1-56, REFER TO THE CIRCUIT IN FIGURE 1H.

1-55. L1 and C1 in the circuit offer what type of opposition to (a) frequencies near resonance and (b) all other frequencies?
1. (a) Minimum (b) minimum
2. (a) Minimum (b) maximum
3. (a) Maximum (b) maximum
4. (a) Maximum (b) minimum

1-56. In the type of filter circuit in the figure, what is/are the "cutoff point(s)?"
1. Upper frequency limit only
2. Lower frequency limit only
3. Both upper and lower frequency limits

1-57. In a series-resonant circuit that is operating at resonance, what is the amplitude of the applied voltage compared to (a) inductor voltage and (b) capacitor voltage?
1. (a) Lower (b) lower
2. (a) Lower (b) higher
3. (a) Higher (b) higher
4. (a) Higher (b) lower

Figure 1I.—Series-RCL circuit at resonance.

IN ANSWERING QUESTIONS 1-58 THROUGH 1-60, REFER TO FIGURE 1I.

1-58. With the circuit in the figure at resonance, what is the circuit current?
1. 1 ampere
2. 2 amperes
3. 3 amperes
4. 0.5 ampere

1-59. If Ea were increased to 60 volts at the resonant frequency, what would be the voltage drop across the capacitor?
1. 10 volts
2. 20 volts
3. 30 volts
4. 60 volts

1-60. If the circuit is at resonance, what is circuit impedance?
1. 10 ohms
2. 20 ohms
3. 30 ohms
4. 40 ohms

6 Things you need to know about LCR Series Circuits.

- 1. **AT RESONANCE (f_r)** V_C is equal to, but in anti-phase to V_L
- 2.; **AT RESONANCE (f_r)** Impedance (Z) is at minimum and equal to the RESISTANCE (R)
- 3. **AT RESONANCE (f_r)** Circuit current (I_S) is at a maximum.
- 4. **AT RESONANCE (f_r)** The circuit is entirely resistive.
- 5. **BELOW RESONANCE (f_r)** The circuit is capacitive.
- 6. **ABOVE RESONANCE (f_r)** The circuit is inductive.

6 Things you need to know about LCR Parallel Circuits.

(and that are different to the Series Circuit.)

- 1. **AT RESONANCE (f_r)** V_C is not necessarily exactly equal to V_L but V_S and I_S are IN PHASE
- 2.; **AT RESONANCE (f_r)** Impedance (Z) is at maximum and is called the Dynamic Resistance (R_D)
- 3. **AT RESONANCE (f_r)** Circuit current (I_S) is at a minimum.
- 4. **AT RESONANCE (f_r)** The circuit is entirely resistive.
- 5. **BELOW RESONANCE (f_r)** The circuit is inductive.
- 6. **ABOVE RESONANCE (f_r)** The circuit is capacitive.

ASSIGNMENT 2

2-1. A sinusoidal oscillator can be regarded as which of the following types of amplifiers?
1. One that produces a trapezoidal wave
2. One that produces a sine wave
3. One that produces a square wave
4. One that produces a sawtooth wave

2-2. Wave generators are classified according to the
1. input wave shape
2. output wave shape
3. current in the output
4. voltage in the output

2-3. An IDEAL sinusoidal oscillator would produce which of the following outputs?
1. A square wave of constant frequency and amplitude
2. A square wave of varying frequency and amplitude
3. A sine wave of constant frequency and amplitude
4. A sine wave of varying frequency and constant amplitude

2-4. What three circuits are most commonly used as frequency determining devices?
1. Class C amplifier, class B amplifier, and class A amplifier
2. Crystal-controlled oscillator, RC oscillator, and LC oscillator
3. Common-emitter amplifier, commonbase amplifier, and common-collector amplifier
4. Transformer coupler, RC coupler, and direct coupler

2-5. Which of the following circuits is NOT a relaxation oscillator?
1. A multivibrator
2. A sawtooth generator
3. A blocking oscillator
4. A sinusoidal oscillator

2-6. Which of the following definitions describes the basic oscillator?

1. A nonrotating device producing alternating current
2. A rotating device producing alternating current
3. A nonrotating device producing direct current
4. A rotating device producing direct current

2-7. Amplitude stability in an oscillator is the ability to
1. produce an increased amplitude in the output
2. produce a variable amplitude in the output
3. maintain a constant frequency in the output
4. maintain a constant amplitude in the output

2-8. Frequency stability in an oscillator refer to
its ability to
1. maintain a constant operating frequency
2. maintain a variable operating amplitude
3. maintain a constant amplitude
4. vary operating frequency

2-9. What is the purpose of a buffer amplifier?
1. To provide a direct connection between the oscillator and the load
2. To amplify the output signal of the oscillator
3. To remove frequency distortion from the oscillator
4. To prevent load variations from affecting the oscillator

2-10. Why is class A bias used in oscillators?
1. To develop low power
2. To develop maximum power
3. To maintain low distortion
4. To maintain high efficiency

2-11. When a group of RC networks is used for regenerative feedback, which of the following waveform actions takes place in each successive stage?
1. Waveform is rectified
2. Amplitude is decreased
3. Amplitude is increased
4. Amplitude is held constant

2-12. When RC networks are connected in cascade (series), what amount of phase shift should you see?
1. The sum of the phase shifts of each RC network
2. The difference between the phase shifts of each RC network
3. The product of the phase shifts of each RC network
4. The square of the phase shifts of each RC network

2-13. Which of the following terms describes the gradual amplitude reduction in an oscillator?
1. Damping
2. Phase shift
3. Regeneration
4. Flywheel effect

2-14. Which of the following formulas can be used to figure frequency in an LC tank circuit?
2. $f_r = \frac{1}{2\pi\sqrt{LC}}$

2-15. Which of the following actions best

describes the piezoelectric effect?
1. Produces an dc output voltage for a given ac input voltage
2. Produces an output voltage for a given mechanical input
3. Produces a mechanical output for a given input voltage
4. Both 2 and 3 above

2-16. The piezoelectric effect is the property of a
crystal which produces which of the following electrical characteristics?
1. Resistance
2. Inductance
3. Capacitance
4. Each of the above
13

2-17. What is the schematic symbol for a crystal?
1.
2.
3.
4.

2-18. What electrical characteristic makes the frequency stability of a crystal better than that of an LC tank circuit?
1. Higher Q
2. Higher inductance
3. Higher resistance
4. Higher capacitance

2-19. How is feedback described?
1. Control of a circuit output signal by the input signal
2. Control of a circuit input signal by the output of the previous circuit
3. Transfer of a portion of the output circuit energy to control the input of the circuit
4. Transfer of a portion of the input circuit energy to control the output circuit

2-20. Which of the following terms describes the types of feedback?
1. Degenerative and regenerative
2. Negative and positive
3. Both 1 and 2 above
4. Bypassed and unbypassed

2-21. What type of feedback aids an input signal?
1. Positive
2. Negative
3. Bypassed
4. Degenerative

2-22. What type of feedback opposes an input signal?
1. Positive
2. Unbypassed
3. Degenerative
4. Regenerative

2-23. What type of feedback is used to sustain oscillations?
1. Bypassed
2. Negative
3. Degenerative
4. Regenerative

2-24. What oscillator uses a tickler coil for feedback?
1. Hartley
2. Colpitts
3. Armstrong
4. RC phase-shift

2-25. What oscillator uses a tapped coil for

feedback?
1. Hartley
2. Colpitts
3. Armstrong
4. RC phase-shift
14

2-26. What oscillator uses split capacitors for feedback?
1. Hartley
2. Colpitts
3. Armstrong
4. RC phase-shift

2-27. Voltage gain is less than unity 4. Common-collector

2-28. Low power gain 1. Common-base ←high dapat diba?

2-29. Feedback signal requires phase shift 3. Common-emitter

2-30. Which of the following statements best describes tank current in a series-fed oscillator?
1. The dc path is through the tank circuit
2. The dc path does not go through the tank circuit
3. The ac path is through the tank circuit
4. The ac path does not go through the tank circuit

2-31. In a shunt-fed, tuned-collector Armstrong
oscillator, what blocks the dc component from the tank circuit?
1. A resistor
2. A capacitor
3. An inductor
4. A transistor

2-32. Which of the following circuit arrangements aid in the frequency stability of an oscillator?
1. A regulated power supply
2. A common bias source for the emitter and collector
3. Both 1 and 2 above
4. Separate bias sources

Figure 2A.—Tuned-base Armstrong oscillator.

IN ANSWERING QUESTIONS 2-33 THROUGH 2-37, REFER TO FIGURE 2A.

2-33. The frequency of the output signal of the oscillator is determined by what components?
1. R1 and L1
2. L2 and C1
3. L3 and C4
4. R3 and C3

2-34. Forward bias for the amplifier is developed by what component?
1. R1
2. R2
3. R3
4. L1
15

2-35. The resonant frequency is tuned to the desired value by what component?
1. C1
2. C2
3. L3
4. L1

2-36. What is the maximum degree of phase shift provided between the base and collector of Q1?
1. 0 degrees
2. 90 degrees
3. 120 degrees
4. 180 degrees

2-37. Temperature stability of the oscillator is improved by what component?
1. R1
2. R2
3. R3
4. C4

2-38. What feature in a Hartley oscillator differs
from an Armstrong oscillator?
1. Tickler coil
2. Split inductor
3. Split coupling
4. Split capacitance

Figure 2B.—Series-fed, tuned-base Hartley oscillator.

IN ANSWERING QUESTIONS 2-39 THROUGH 2-42, REFER TO FIGURE 2B.

2-39. What components are part of the frequency-determining device of this oscillator?
1. C1, L1, and L2
2. C2, L1, and L2
3. C3, L1, and L2
4. CE, RE, and RB

*2-40. What circuit component prevents thermal
runaway?*
1. L1
2. CE
3. RB
4. RE

2-41. The low resistance of L2 could place a short across the emitter-to-base junction network of Q1 and RE. What component in the circuit prevents this from happening?
1. C1
2. C2
3. C3
4. CE

2-42. When a positive signal is coupled to the base of Q1, what happens to (a) collector current and (b) emitter current?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

2-43. A tuned-base Hartley oscillator is described as "shunt fed" when
1. ac flows through the tank circuit
2. dc flows through the tank circuit
3. ac does not flow through the tank circuit
4. dc does not flow through the tank circuit

2-44. Which of the following advantages does the Colpitts oscillator have over the Armstrong and Hartley oscillators?
1. Easier to tune
2. Wider frequency range
3. Better frequency stability
4. All of the above

IN ANSWERING QUESTIONS 2-45 THROUGH 2-47, REFER TO FIGURE 2C.

2-45. What type of oscillator is shown in the figure?
1. Common-base Hartley
2. Common-base Colpitts

3. Common-emitter Colpitts
4. Common-collector Hartley

2-46. What component is the collector load resistor?
1. R1
2. R2
3. R3
4. R4

2-47. What resistors provide the base bias?
1. R1, R2
2. R2, R3
3. R3, R4
4. R2, R4

2-48. What class of biasing does the RC oscillator use?
1. A
2. B
3. C
4. AB

2-49. In an RC network, (a) what type of impedance is presented and (b) does the current lead or lag?
1. (a) Inductive (b) leads
2. (a) Inductive (b) lags
3. (a) Capacitive (b) lags
4. (a) Capacitive (b) leads

2-50. In the phase-shift oscillator, a phase shift
of 180 degrees for regenerative feedback is provided by what minimum number of RC networks?
1. One
2. Two
3. Three
4. Four

2-51. What determines the phase angle of an RC
network?
1. Input voltage
2. Output voltage
3. Values of resistance and inductance
4. Values of resistance and capacitance

IN ANSWERING QUESTIONS 2-52 THROUGH 2-56, REFER TO FIGURE 2D.

2-52. What is the maximum amount of phase shift provided by Q1 in the figure?
1. 0 degrees
2. 60 degrees
3. 90 degrees
4. 180 degrees

2-53. What type of feedback is provided through
the RC networks to the base of Q1?
1. Neutral
2. Negative
3. Regenerative
4. Degenerative

2-54. At any other than the desired frequency, what type of feedback is provided by the circuit?
1. Neutral
2. Positive
3. Regenerative
4. Degenerative

2-55. What components make up the frequencydetermining
device?
1. C1, C2, CE, R1, R2, RB
2. C2, C3, CE, R2, RB, RE
3. C1, C2, C3, R1, R2, RB
4. Cout, C1, C2, R1, R2, RE

2-56. What is the maximum amount of phase shift provided by the C3-RB network?
1. 90 degrees
2. 80 degrees
3. 70 degrees
4. 60 degrees

2-58. Which of the following oscillators is used to provide a highly stable output at a very precise frequency?
1. Crystal
2. Hartley
3. Colpitts
4. Armstrong

2-59. The frequency of a crystal-controlled oscillator is determined by which of the following physical actions?
1. Type of cut
2. Accuracy of cut
3. Thickness of grinding
4. All of the above

2-60. Why is the crystal in a crystal-controlled oscillator often installed in a temperature controlled
oven?
1. To increase frequency without changing the crystal
2. To decrease frequency without changing the crystal
3. To provide better amplitude stability
4. To provide better frequency stability

Figure 2E.—Frequency response of a crystal.

IN ANSWERING QUESTIONS 2-61 THROUGH 2-64, REFER TO FIGURE 2E. THE LETTERS A, B, C, D, AND E ARE POINTS ON THE FREQUENCY-RESPONSE CURVE FROM WHICH YOU SHOULD SELECT ANSWERS TO THE QUESTIONS.

2-61. At what point on the curve does a crystal act as a series-tuned circuit?
1. A
2. B
3. C
4. D

2-62. At what point does the crystal act inductively?
1. A
2. B
3. C
4. D

2-63. Below series resonance, a crystal acts capacitively at what point on the curve?
1. A
2. B
3. C
4. E

2-64. At what point does the crystal act purely as a parallel-resonant circuit?
1. B
2. C
3. D
4. E

2-65. How is the Q of a crystal determined?
1. Type of cut used
2. Type of holder used
3. Accuracy of the grinding
4. All of the above

2-66. An oscillator that is turned ON for a specific period of time, then is turned OFF and remains OFF until required at a later time, is which of following types?
1. LC
2. Pierce

3. Pulsed
4. Crystal

Figure 2F.—Oscillator circuit.

IN ANSWERING QUESTIONS 2-67 THROUGH 2-70, REFER TO FIGURE 2F.

2-67. What circuit is shown in the figure?
1. Pierce oscillator
2. Pulsed oscillator
3. Colpitts oscillator
4. Armstrong oscillator

2-68. Sine waves are generated in the emitter circuit of Q1 during which of the following time periods of the input gate?
1. T0 to T1 and T1 to T2
2. T0 to T1 and T2 to T3
3. T1 to T2 and T3 to T4
4. T1 to T3 and T0 to T4

2-69. The frequencies in the output are determined by what two circuit parameters?
1. Input gate time and the time the circuit is turned OFF
2. Output gate time and the time the circuit is turned ON
3. Input gate time and the resonant frequency of the tank circuit
4. Output gate time and the resonant frequency of the tank circuit,

2-70. If the resonant frequency of the tank circuit were 5 megahertz and transistor Q1 were cut off for 500 microseconds, what maximum number of cycles of the tank frequency would be present in each pulse of the output?
1. 500 cycles
2. 1,500 cycles
3. 2,500 cycles
4. 3,500 cycles

2-71. What is the fourth harmonic of a 2-megahertz signal?
1. 6 megahertz
2. 2 megahertz
3. 8 megahertz
4. 4 megahertz

2-72. What is the highest multiplication factor normally used in frequency multipliers?
1. One
2. Two
3. Three
4. Four

2-73. As the multiplication factor in a frequency multiplier circuit is increased, what happens to the output signal (a) amplitude and (b) frequency?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

2-74. In a buffer amplifier, what is the impedance in the (a) input and (b) output?
1. (a) Low (b) low
2. (a) Low (b) high
3. (a) High (b) high
4. (a) High (b) low

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Waveforms and Wave Generators," pages 3-1 through 3-56.

3-1. A waveform that repeats the same pattern of changes is a/an

1. periodic wave
2. sporadic wave
3. aperiodic wave
4. transverse wave

3-2. Which of the following waveforms is sinusoidal?

1. Sine wave
2. Square wave
3. Sawtooth wave
4. Rectangular wave

3-4. What term(s) describes the number of times in one second that a square wave repeats itself?

1. The pulse-repetition frequency (prf)
2. The pulse-repetition rate (prr)
3. Both 1 and 2 above
4. The pulse-repetition time (prt)

3-3. The time required to complete one full cycle of a square wave is referred to as the

1. pulse-repetition rate
2. pulse-repetition time
3. pulse-repetition cycle
4. pulse-repetition frequency

3-5. A square wave with a prf of 1,250 hertz has a prt of

1. 8 microseconds
2. 80 microseconds
3. 800 microseconds
4. 8,000 microseconds

THIS SPACE LEFT BLANK INTENTIONALLY.

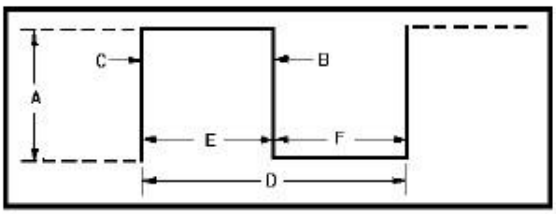


Figure 3A.—Square wave.

IN ANSWERING QUESTIONS 3-6 THROUGH 3-10, SELECT THE CORRESPONDING LETTER IN FIGURE 3A WHICH DESCRIBES THE PORTION OF THE WAVEFORM IN EACH OF THE FOLLOWING QUESTIONS.

3-6. The leading edge of the pulse.

1. C
2. D
3. E
4. F

3-7. The trailing edge of the pulse.

1. A
2. B
3. C
4. D

3-8. The positive alternation.

1. C
2. D
3. E
4. F

3-9. The amplitude of the pulse.

1. A
2. B
3. C
4. D

3-10. The pulse-repetition time of the pulse.

1. C
2. D
3. E
4. F

3-11. What type of waveform is used to furnish a linear rise in current for electromagnetic cathode ray tubes?

1. Square wave
2. Sawtooth wave
3. Trapezoidal wave
4. Rectangular wave

3-12. Which of the following multivibrators must have a signal applied (triggered) to change states?

1. Astable
2. Bistable
3. Monostable
4. Both 2 and 3 above

3-13. Which of the following multivibrators is also called a free running multivibrator?

1. Astable
2. Bistable
3. Monostable
4. Both 2 and 3 above

3-14. Which of the following waveforms could be the output of the astable multivibrator?

1. Sine wave
2. Sawtooth wave
3. Rectangular wave
4. Trapezoidal wave

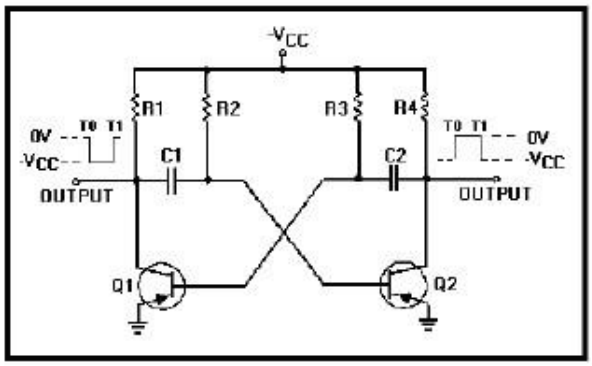


Figure 3B.—Multivibrator.

IN ANSWERING QUESTIONS 3-15 AND 3-16, REFER TO FIGURE 3B.

3-15. The time necessary for Q2 in the circuit to become saturated is controlled by what RC network?

1. R1, C1
2. R2, C1
3. R3, C2
4. R4, C2

3-16. Which of the following conditions exist in the outputs of the figure from T0 to T1?

1. Q1 saturated, Q2 saturated
2. Q1 saturated, Q2 cutoff
3. Q1 cutoff, Q2 cutoff
4. Q1 cutoff, Q2 saturated

3-17. What multivibrator is a square or rectangular-wave generator with only one stable condition?

1. Astable
2. Bistable
3. Monostable
4. Eccles-Jordan

3-18. What is the primary use for the monostable multivibrator circuit?

1. Filter
2. Amplifier
3. Oscillator
4. Pulse stretcher

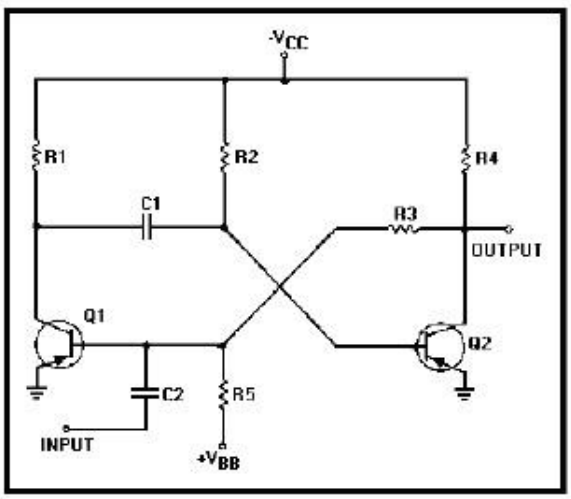


Figure 3C.—Monostable multivibrator circuit.

IN ANSWERING QUESTIONS 3-19 AND 3-20, REFER TO FIGURE 3C.

3-19. In the stable state of the circuit, what will be the condition of (a) Q1 and (b) Q2?

1.	(a) Cutoff	(b) cutoff
2.	(a) Cutoff	(b) saturated
3.	(a) Saturated	(b) saturated
4.	(a) Saturated	(b) cutoff

3-20. What is the discharge path for C1?

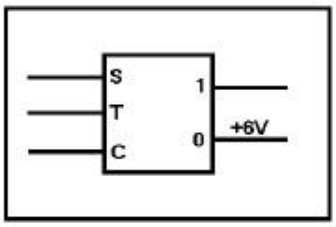
1. C1, Q2, ground, $-V_{CC}$, Q1, and C1
2. C1, Q2, ground, $+V_{BB}$, R5, Q1, and C1
3. C1, Q2, R4, R2, $+V_{BB}$, $-V_{CC}$, R2, and C1
4. C1, Q1, ground, $-V_{CC}$, R2, and C1

3-21. In a bistable multivibrator, what minimum number of triggers is required to produce one gate?

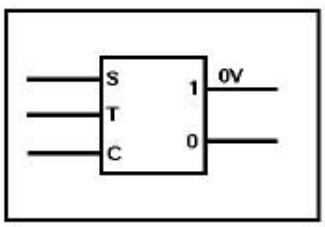
1. One
2. Two
3. Three
4. Four

3-22. Which of the flip flops shown below is in the SET state?

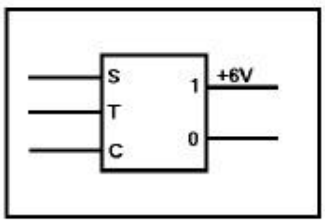
1.



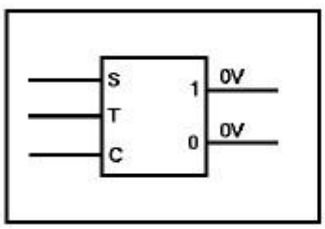
2.



3.

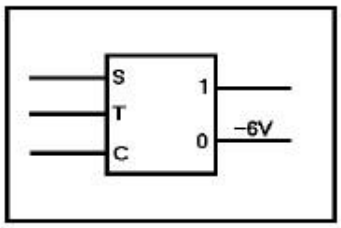


4.

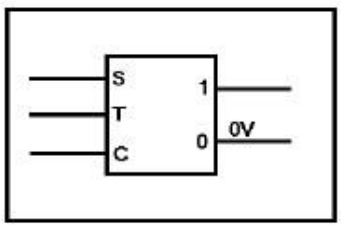


3-23. Which of the flip flops shown below is in the CLEAR state?

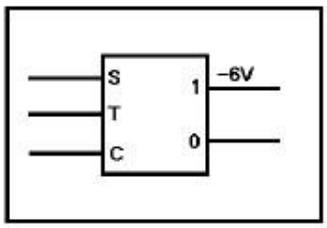
1.



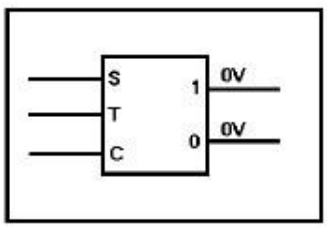
2.



3.



4.



3-24. Which of the following pulses is used to change states in a flip flop?

1. A trigger pulse
2. A clipping pulse
3. A modulating pulse
4. An interference pulse

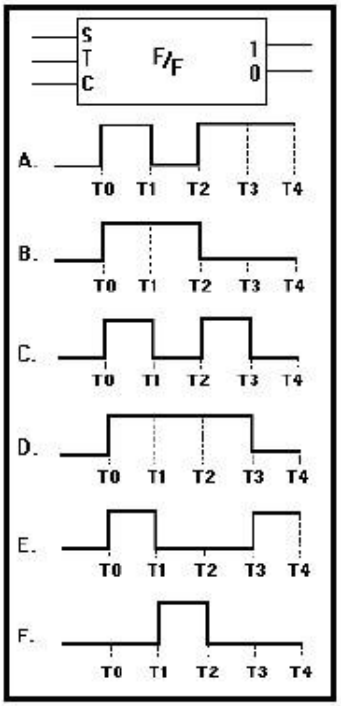
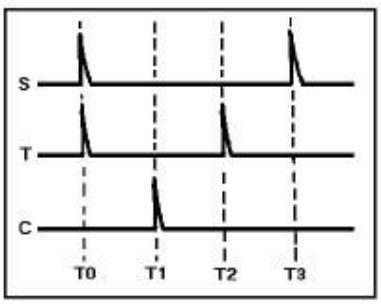


Figure 3D.—Flip-flop output 1 waveforms.

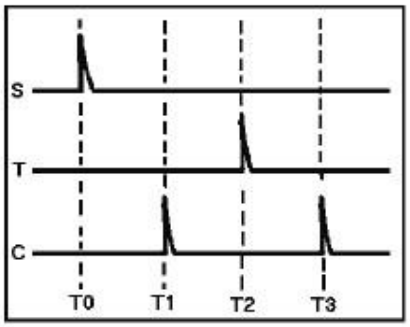
IN ANSWERING QUESTIONS 3-25 THROUGH 3-29, REFER TO FIGURE 3D. ASSUME THE FLIP-FLOP IS INITIALLY IN THE CLEAR STATE. SELECT THE WAVEFORM AT THE "1" OUTPUT IN THE FIGURE THAT WILL RESULT FROM THE INPUT PULSES SHOWN IN THE QUESTIONS. SOME CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

3-25.



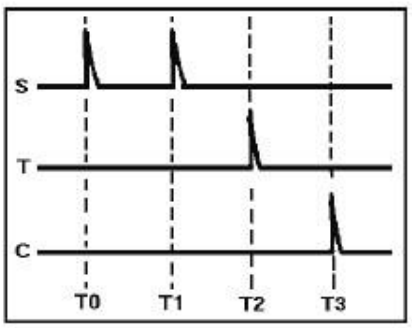
1. A
2. B
3. C
4. D

3-26.



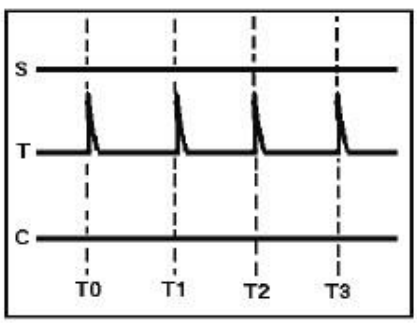
1. A
2. B
3. C
4. D

3-27.



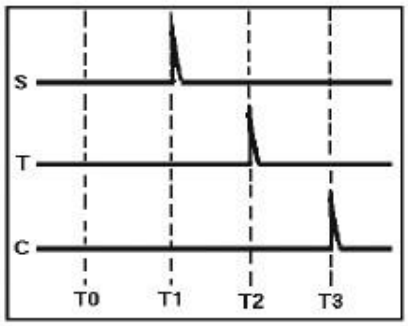
1. A
2. B
3. D
4. E

3-28.



1. B
2. C
3. D
4. F

3-29.



1. A
2. B
3. E
4. F

3-30. The toggle input on a flip flop is used to cause which of the following circuit actions?

1. SET the flip flop
2. CLEAR the flip flop
3. Both 1 and 2 above
4. Sample the condition of the flip flop

3-31. The blocking oscillator is NOT suitable for which of the following circuit applications?

1. Counter circuit
2. Frequency divider
3. Switching circuit
4. Sine-wave generator

THIS SPACE LEFT BLANK INTENTIONALLY.

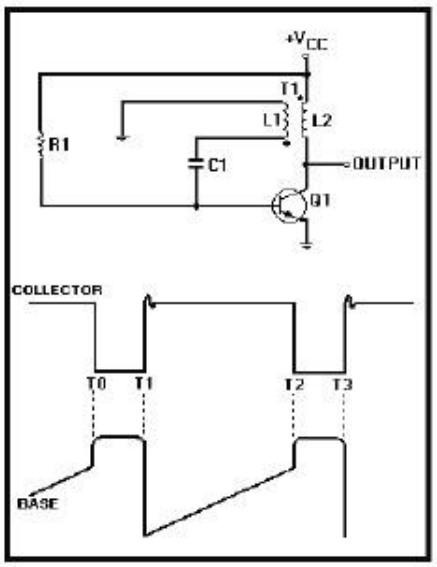


Figure 3E.—Blocking oscillator.

IN ANSWERING QUESTIONS 3-32 THROUGH 3-37, REFER TO FIGURE 3E.

3-32. What is indicated by the dots at each end of T1 in the figure?

1. 0-degree phase shift
2. 90-degree phase shift
3. 160-degree phase shift
4. 180-degree phase shift

3-33. Regenerative feedback to the base of Q1 is provided by what circuit component(s)?

1. L1 only
2. L2 only
3. L1 and L2 only
4. L1, L2, and C1

3-34. What circuit action is taking place from T0 to T1?

1. C1 is charging
2. C1 is discharging
3. L1 is discharging
4. I_C is decreasing

3-35. THIS QUESTION HAS BEEN DELETED.

3-36. During what total time period is Q1 blocked?

1. T0 to T1
2. T1 to T2
3. T0 to T2
4. T2 to T3

3-37. In the blocking oscillator, which of the following circuit actions is the primary cause of parasitic oscillations?

1. Collapse of the magnetic field of L1
2. Expansion of the magnetic field of L1
3. Inductive coupling between L1 and L2
4. C1 discharging through Q1

3-38. Which of the following circuit actions is a result of critical damping?

1. Rapid transient response without overshoot
2. Rapid transient response with overshoot
3. Slow transient response without overshoot
4. Slow transient response with overshoot

3-39. What type of damping is caused by (a) high resistance and (b) low resistance?

1. (a) Overdamping
   (b) Underdamping
2. (a) Underdamping
   (b) Overdamping
3. (a) Critical damping
   (b) Underdamping
4. (a) Overdamping
   (b) Critical damping

3-40. Applying synchronizing triggers with a frequency that is SLIGHTLY higher than the free-running frequency will cause a synchronized blocking oscillator to

1. divide in frequency
2. double in frequency
3. lock in at the higher frequency
4. stay locked at the free-running frequency

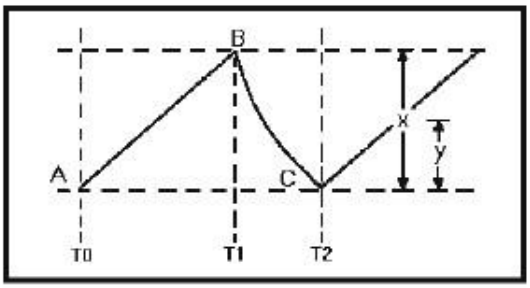


Figure 3F.—Sawtooth waveform.

IN ANSWERING QUESTIONS 3-41 THROUGH 3-46, REFER TO FIGURE 3F AND MATCH THE WAVEFORM POINTS (OR TIME REFERENCES) TO THE TERMS IN THE QUESTIONS. SOME CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

3-41. Linear slope.

1. A to B
2. B to C
3. T0 to T2
4. T1 to T2

3-42. Physical length.

1. A to B
2. B to C
3. X
4. Y

3-43. Sweep time.

1. A to B
2. B to C
3. T0 to T1
4. T1 to T2

3-44. Fall time.

1. A to C
2. T0 to T1
3. T1 to T2
4. T0 to T2

3-45. Electrical length.

1. B to C
2. T0 to T1
3. T1 to T2
4. T0 to T2

3-46. Amplitude.

1. A to B
2. B to C
3. X
4. Y

3-47. The linearity of the rise voltage in a sawtooth wave is determined by which of the following circuit timing actions?

1. The time the capacitor is allowed to charge
2. The time it takes the capacitor to fully charge
3. The time the capacitor is allowed to discharge
4. The time it takes the capacitor to fully discharge

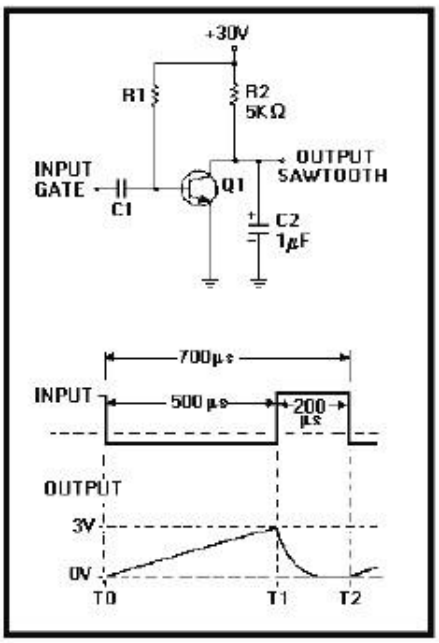


Figure 3G.—Transistor sawtooth generator.

IN ANSWERING QUESTIONS 3-48 THROUGH 3-53, REFER TO FIGURE 3G.

3-48. What component in the circuit develops the output sawtooth waveform?

1. R1
2. R2
3. C1
4. C2

3-49. What is the purpose of Q1?

1. Acts as a switch
2. Allows C2 to charge
3. Inverts the negative gate
4. Serves as a common-collector amplifier

3-50. What is the maximum length of time C2 is allowed to charge?

1. 200 microseconds
2. 500 microseconds
3. 700 microseconds
4. 900 microseconds

3-51. If V_{CC} were increased to 40 volts, which of the following parameters in the output sawtooth wave would increase?

1. Fall time
2. Amplitude
3. Sweep time
4. Linearity

3-52. What would be the effect on C2 if the negative gate length were increased?

1. Charge to V_{CC}
2. Discharge to V_{CC}
3. Charge to a larger percentage of V_{CC}
4. Charge to a smaller percentage of V_{CC}

3-53. What is the prf of the circuit?

1. 1,428 pulses per second
2. 1,450 pulses per second
3. 1,470 pulses per second
4. 1,482 pulses per second

3-54. In a sawtooth generator, a change in which of the following parameters will NOT affect the linearity of the output?

1. V_{CC}
2. Resistance
3. Capacitance
4. Gate length

THIS SPACE LEFT BLANK INTENTIONALLY.

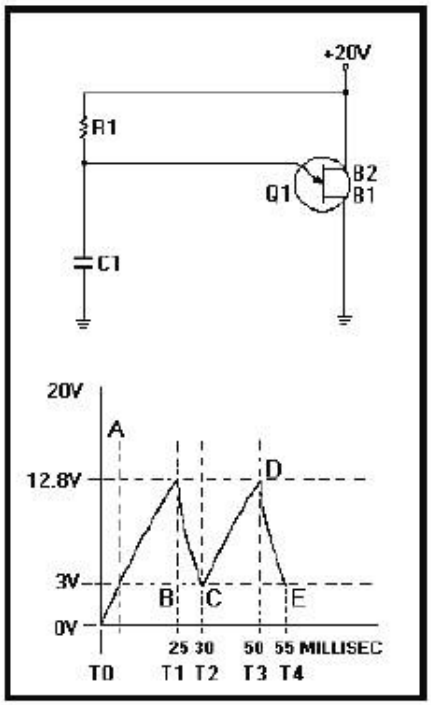


Figure 3H.—Unijunction sawtooth generator.

IN ANSWERING QUESTIONS 3-55 THROUGH 3-59, REFER TO FIGURE 3H.

3-55. The output in the circuit is taken across what component.

1. R1
2. B2
3. R1
4. C1

3-56. What is the discharge path for C1?

1. C1, R1, V_{CC}, ground, and C1
2. C1, emitter B2, V_{CC}, ground, and C1
3. C1, B1, emitter, and C1
4. C1, B1, B2, V_{CC}, ground, and C1

3-57. What part of the waveform is sweep time?

1. A to D
2. B to C
3. C to D
4. C to E

3-58. What is the action of C1 when the emitter-to-B1 junction is (a) reverse biased and (b) forward biased?

1. (a) Charging (b) Discharging
2. (a) Discharging (b) Charging
3. (a) Charging (b) Charging
4. (a) Discharging (b) Discharging

3-59. To obtain a more stable output frequency, you could modify the circuit by applying (a) what type of triggers to (b) what circuit element.

1. (a) Positive (b) B1
2. (a) Positive (b) B2
3. (a) Negative (b) B2
4. (a) Negative (b) B1

THIS SPACE LEFT BLANK INTENTIONALLY.

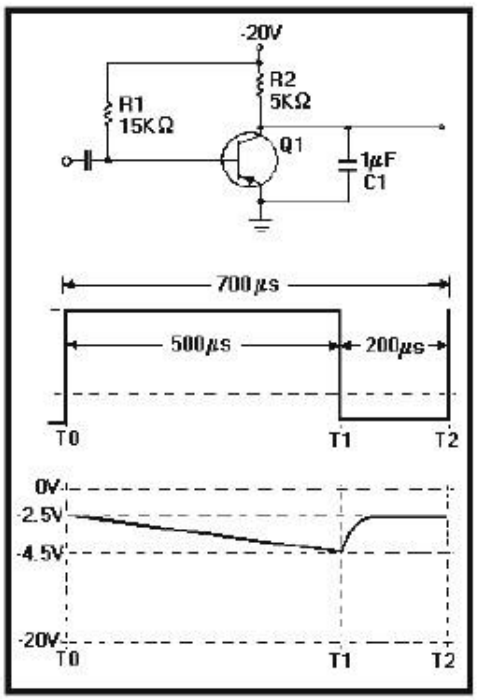


Figure 3I.—Transistor sawtooth generator.

IN ANSWERING QUESTIONS 3-60 THROUGH 3-64, REFER TO FIGURE 3I.

3-60. With no input voltage applied to the circuit, what voltage should you read at the collector?

1. -20 volts
2. -17.5 volts
3. -2.5 volts
4. 0 volts

3-61. To what voltage is C1 allowed to charge?

1. 0 volts
2. -2.5 volts
3. -4.5 volts
4. -20 volts

3-62. To determine the percent of charge on C1, what formula is used?

1. $\frac{E_C\ max - V_{CC}}{E_C\ min - E_C\ max} \times 100$
2. $\frac{E_C\ max - V_{CC}}{E_C\ min + E_C\ max} \times 100$
3. $\frac{E_C\ max + E_C\ min}{V_{CC} - E_C\ min} \times 100$
4. $\frac{E_C\ max - E_C\ min}{V_{CC} - E_C\ min} \times 100$

3-63. Which of the following actions will improve the linearity of the sawtooth?

1. Increasing the value of C1
2. Increasing the value of R1
3. Increasing the gate length
4. Each of the above

3-64. What is the maximum amplitude of the output sawtooth signal?

1. 1.75 volts
2. 2.0 volts
3. 2.5 volts
4. 4.5 volts

3-65. If applied to a coil, what voltage waveform will cause a linear rise in current?

1. Square wave
2. Sawtooth wave
3. Rectangular wave
4. Trapezoidal wave

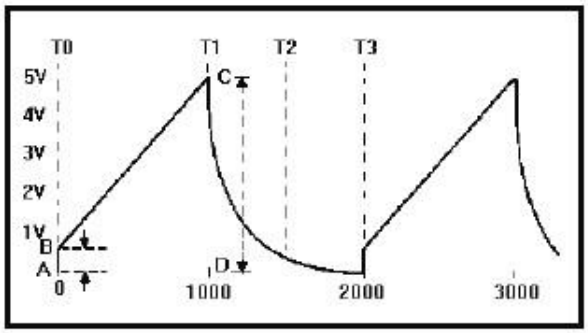


Figure 3J.—Trapezoidal waveform.

IN ANSWERING QUESTIONS 3-66 THROUGH 3-70, REFER TO FIGURE 3J AND MATCH THE WAVEFORM POINTS (OR TIME REFERENCES) TO THE TERMS IN THE QUESTIONS. SOME CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

3-66. Pulse-repetition time (prt).

1. T1 to T2
2. T0 to T3
3. A to B
4. B to C

3-67. Physical length.

1. T0 to T3
2. A to B
3. B to C
4. C to D

3-68. Electrical length.

1. T0 to T1
2. T1 to T2
3. T0 to T3
4. A to B

3-69. Jump voltage.

1. T0 to T1
2. T1 to T2
3. T0 to T3
4. A to B

3-70. Linear slope.

1. C to D
2. B to C
3. A to B
4. T0 to T3

THIS SPACE LEFT BLANK INTENTIONALLY.

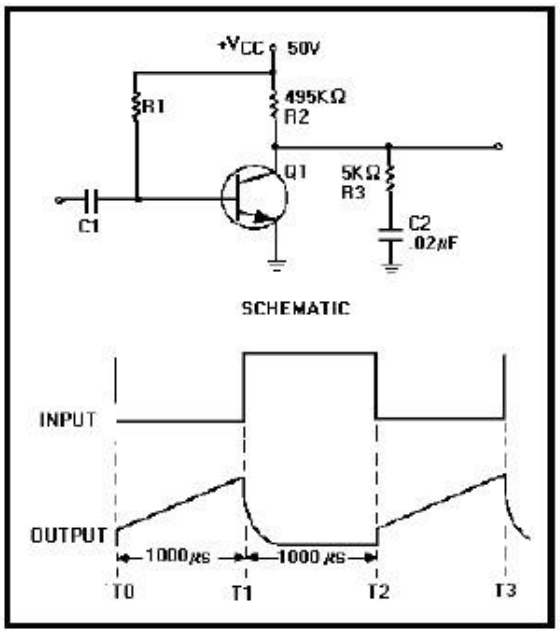


Figure 3K.—Trapezoidal-wave generator with input and output waveforms.

IN ANSWERING QUESTIONS 3-71 THROUGH 3-74, REFER TO FIGURE 3K.

3-71. The amplitude of the jump voltage is approximately

(a)
0.5V, 5V

and the amplitude of the trapezoidal wave is

(b)
0.5V, 5V.

1. (a) 0.5 volts (b) 5 volts
2. (a) 0.5 volts (b) 0.5 volts
3. (a) 5 volts (b) 0.5 volts
4. (a) 5 volts (b) 5 volts

3-72. Which of the following components and/or value(s) determines the amplitude of the jump voltage?

1. V_{CC} only
2. R2 and V_{CC} only
3. R3 and V_{CC} only
4. R2, R3, and V_{CC}

3-73. What is the minimum discharge time for C2?

1. 50 microseconds
2. 500 microseconds
3. 1,000 microseconds
4. 2,000 microseconds

3-74. Increasing which of the following values will NOT affect linearity of the circuit?

1. Resistance of R2
2. Capacitance of C2
3. Gate width
4. V_{CC}

ASSIGNMENT 4

Textbook assignment: Chapter 4, "Wave Shaping," pages 4-1 through 4-61.

4-1. A wave-shaping circuit which restricts some portion of a waveform from exceeding a specified value is known as a/an

1. divider
2. clamper
3. limiter
4. oscillator

4-2. Limiting circuits are used in which of the following circuit applications?

1. Counting
2. Amplification
3. Wave generation
4. Circuit protection

4-3. In a series limiter, the diode is connected in

(a)
parallel, series

With the

(b)
input, output

1. (a) Parallel (b) output
2. (a) Parallel (b) input
3. (a) Series (b) input
4. (a) Series (b) output

4-4. In a series limiter, a voltage is developed across the output resistor when

1. the anode of the diode is negative with respect to the cathode
2. the anode of the diode is positive with respect to the cathode
3. the cathode of the diode is positive with respect to the anode
4. no current flows through the diode

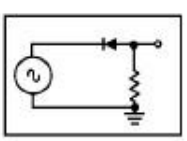
4-5. The diode in a series-positive limiter is (a) forward biased by what portion of the input signal and (b) reverse biased by what portion of the input signal?

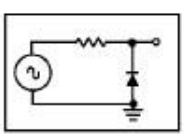
1. (a) Positive (b) positive
2. (a) Positive (b) negative
3. (a) Negative (b) negative
4. (a) Negative (b) positive

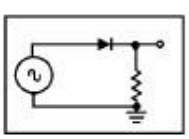
4-6. How does the value of diode resistance compare to that of the resistor (a) during the limiting portion of the input and (b) during the nonlimiting portion?

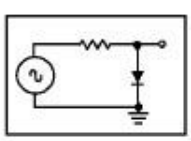
1. (a) High (b) high
2. (a) High (b) low
3. (a) Low (b) low
4. (a) Low (b) high

4-7. Which of the following circuits is a series-positive limiter?

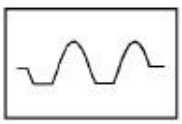
1. 

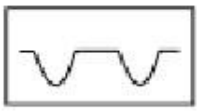
3. 

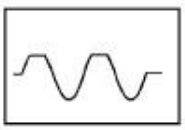
2. 

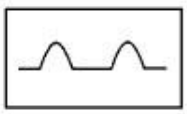
4. 

4-8. If a sine wave is applied to the input of a series-positive limiter, which of the following waveforms describes the output?

1. 

3. 

2. 

4. 

4-9. The amplitude of the output of a series-diode limiter is figured using which of the following formulas?

1. $E_{out} = \frac{R + R_{ac}}{R} \times E_{in}$

2. $E_{out} = \frac{R}{R + R_{ac}} \times E_{in}$

3. $E_{out} = \frac{R_{ac}}{R_{ac} + R} \times E_{in}$

4. $E_{out} = \frac{R_{ac} + R}{R_{ac}} \times E_{in}$

IN ANSWERING QUESTIONS 4-10 AND 4-11, ASSUME YOU ARE FIGURING OUTPUT AMPLITUDES FOR SERIES-POSITIVE LIMITERS AND CIRCUIT CONDITIONS ARE AS FOLLOWS:

E_{in} = 30 vac
R1 = 20,000&
R_{ac} = 100 & (forward bias)
R_{ac} = 150,000& (reverse bias)

4-10. With forward bias, what is the output amplitude?

1. 28.95 volts
2. 29 volts
3. 29.85 volts
4. 29.95 volts

4-11. With reverse bias, what is the output amplitude?

1. .175 volt
2. 1.75 volts
3. 3.53 volts
4. 3.75 volts

4-12. In a series-positive limiter, where is the input signal applied?

1. Directly to the anode of the diode
2. Directly to the cathode of the diode
3. To the anode of the diode through a series input resistor
4. To the cathode of the diode through the output resistor

4-13. With a sine wave applied, which of the following circuits limits only a portion of the positive input signal?

1. Series-negative limiter with negative bias
2. Series-negative limiter with positive bias
3. Series-positive limiter with negative bias
4. Series-positive limiter with positive bias

4-14. With a sine-wave input, which of the following types of series limiter allows only a portion of the negative input to be developed in the output?

1. Series-positive limiter without bias
2. Series-positive limiter with negative bias
3. Series-positive limiter with positive bias
4. Series-negative limiter without bias

4-15. In a series-negative limiter, how is the diode biased (a) by the positive half of the input sine wave and (b) by the negative half?

1. (a) Reverse (b) forward
2. (a) Reverse (b) reverse
3. (a) Forward (b) reverse
4. (a) Forward (b) forward

THIS SPACE LEFT BLANK INTENTIONALLY.

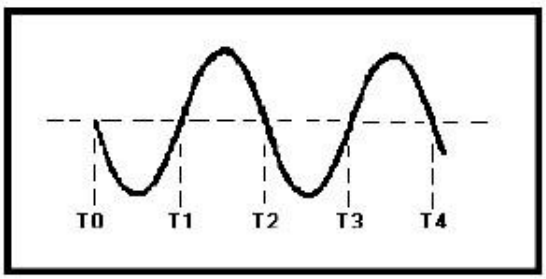
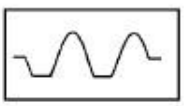
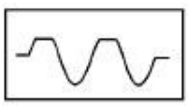
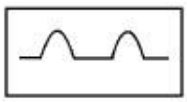
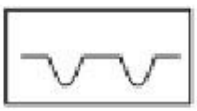


Figure 4A.—Sine-wave input.

IN ANSWERING QUESTION 4-16, REFER TO FIGURE 4A.

4-16. If the input waveform shown in the figure is applied to a series-negative limiter, which of the following waveforms will be the output?

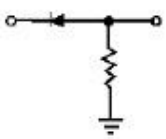
1. 
2. 
3. 
4. 

4-17. In a series-negative limiter with positive bias, which of the following output circuit actions takes place?

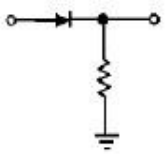
1. Both positive half cycles are eliminated
2. Both negative half cycles are eliminated
3. All of the positive half cycles and a portion of the negative half cycles are eliminated
4. All of the negative half cycles and a portion of the positive half cycles are eliminated

IN QUESTIONS 4-18 THROUGH 4-22, MATCH THE LIMITER CIRCUIT IN COLUMN A TO THE CIRCUIT DESCRIPTION IN COLUMN B. CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

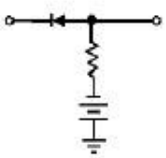
A. LIMITER CIRCUIT	B. CIRCUIT DESCRIPTION
	A. Series-positive limiter with no bias
	B. Series-negative limiter with no bias
	C. Series-positive limiter with negative bias
	D. Series-positive limiter with positive bias
	E. Series-negative limiter with negative bias
	F. Series-negative limiter with positive bias

4-18. 

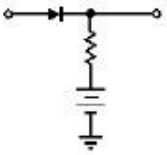
1. A
2. B
3. C
4. D

4-19. 

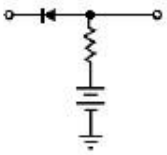
1. A
2. B
3. E
4. F

4-20. 

1. C
2. D
3. E
4. F

4-21. 

1. C
2. D
3. E
4. F

4-22. 

1. C
2. D
3. E
4. F

4-23. In a parallel-diode limiter, (a) how is the output taken and (b) under what diode condition is it developed?

1. (a) Across the resistor
   (b) When the diode is cut off
2. (a) Across the resistor
   (b) When the diode is conducting
3. (a) Across the diode
   (b) When the diode is conducting
4. (a) Across the diode
   (b) When the diode is cut off

4-24. In a parallel-positive limiter, where is the input sine wave applied?

1. At the anode of the diode
2. At the cathode of the diode
3. Through a series resistor to the anode of the diode
4. Through a series resistor to the cathode of the diode

4-25. Which of the following formulas is used to figure the output amplitude of a parallel-diode limiter?

1. $E_{out} = \frac{R_{ac} + R}{R_{ac}} \times E_{in}$

2. $E_{out} = \frac{R}{R_{ac} + R} \times E_{in}$

3. $E_{out} = \frac{R_{ac}}{R_{ac} + R} \times E_{in}$

4. $E_{out} = \frac{R_{ac} + R}{R_{ac} - R} \times E_{in}$

4-26. THIS QUESTION HAS BEEN DELETED.

4-27. THIS QUESTION HAS BEEN DELETED.

4-28. In a parallel-negative limiter, how is the diode biased (a) by the positive half of the input sine wave and (b) by the negative half?

1. (a) Forward (b) forward
2. (a) Forward (b) reverse
3. (a) Reverse (b) reverse
4. (a) Reverse (b) forward

4-29. If a sine wave is applied to a parallel-negative limiter with positive bias, what is the polarity of the output voltage?

1. Positive at all times
2. Negative at all times
3. Positive during the positive portion of the input cycle and negative during the negative portion
4. Negative during the positive portion of the input cycle and positive during the negative portion

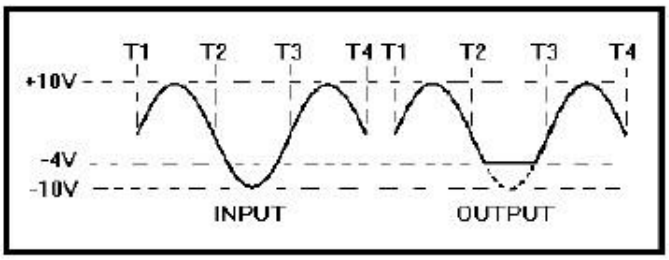


Figure 4B.—Parallel-limiter input and output waveforms.

IN ANSWERING QUESTION 4-30, REFER TO FIGURE 4B.

4-30. If the diode in the parallel limiter were reversed, what portions of the input waveform would be limited?

1. Positive peaks only
2. Negative peaks only
3. All hut the positive peaks would be limited
4. All but the negative peaks would be limited

4-31. Which of the following circuits would be used to fix the upper or lower extremity of a waveform at a specific value?

1. Clamper
2. Limiter
3. Counter
4. Amplifier

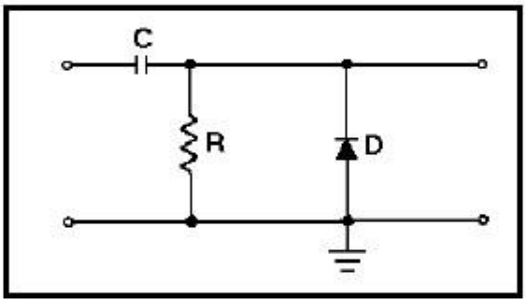


Figure 4C.—Positive clamper.

IN ANSWERING QUESTIONS 4-32 AND 4-33, REFER TO FIGURE 4C.

4-32. When a negative input signal is present, what components provide(s) the charge path for the capacitor?

1. Diode only
2. Resistor only
3. Both the resistor and diode

4-33. How does the length of time required for the capacitor to charge compare to the time for it to discharge?

1. Charge time is longer than discharge time
2. Charge time is shorter than discharge time
3. Charge and discharge times are the same

4-34. In a positive clamper with positive bias, (a) what extremity of the waveform is clamped and (b) to what potential is it clamped?

1. (a) Upper (b) positive
2. (a) Upper (b) negative
3. (a) Lower (b) positive
4. (a) Lower (b) negative

4-35. In a positive clamper with negative bias, (a) what extremity of the waveform is clamped and (b) to what potential is it clamped?

1. (a) Upper (b) positive
2. (a) Upper (b) negative
3. (a) Lower (b) negative
4. (a) Lower (b) positive

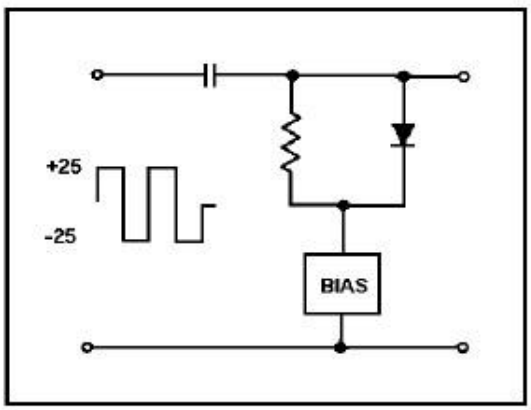


Figure 4D.—Clamper with bias.

IN ANSWERING QUESTIONS 4-36 AND 4-37, REFER TO FIGURE 4D.

4-36. With +10 volts of bias in the circuit, what is the maximum negative output voltage?

1. -15 volts
2. -25 volts
3. -40 volts
4. -50 volts

4-37. With -15 volts of bias, to what voltage level is the output clamped?

1. +75 volts
2. +45 volts
3. -15 volts
4. -75 volts

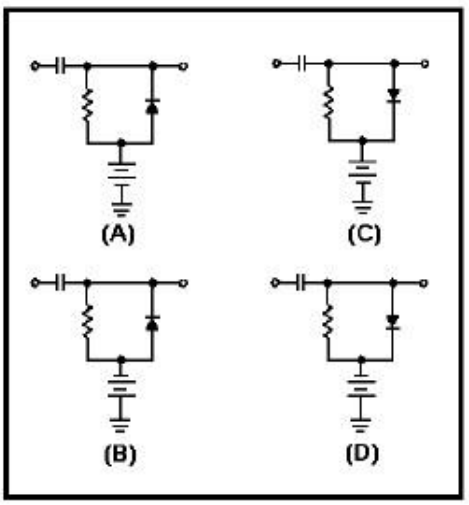


Figure 4E.—Clamper circuits.

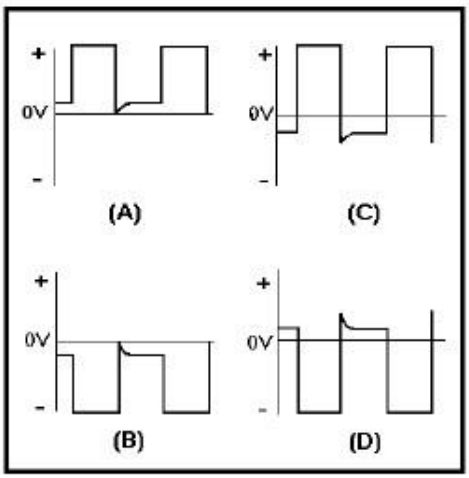


Figure 4F—Clamper circuit outputs.

IN ANSWERING QUESTIONS 4-38 THROUGH 4-40, SELECT THE CIRCUIT IN FIGURE 4E THAT MATCHES THE CIRCUIT NAMED IN THE QUESTIONS. CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

4-38. Positive clamper with negative bias.

1. A
2. B
3. C
4. D

4-39. Negative clamper with negative bias.

1. A
2. B
3. C
4. D

4-40. Positive clamper with positive bias.

1. A
2. B
3. C
4. D

IN ANSWERING QUESTIONS 4-41 THROUGH 4-43, SELECT THE OUTPUT IN FIGURE 4F WHICH IS PRODUCED BY THE CIRCUITS IN THE QUESTIONS. CHOICES MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.

4-41. Positive clamper with positive bias.

1. A
2. B
3. C
4. D

4-42. Negative clamper with positive bias.

1. A
2. B
3. C
4. D

4-43. Negative clamper with negative bias.

1. A
2. B
3. C
4. D

4-44. Which of the following waves is NOT a complex wave?

1. Sine wave
2. Square wave
3. Rectangular wave
4. Trapezoidal wave

4-45. What is the harmonic content of a square wave?

1. A combination of odd harmonics only
2. A combination of even harmonics only
3. Both even and odd harmonic combinations

4-46. What is the harmonic composition within a sawtooth wave?

1. Odd harmonics only
2. Even harmonics only
3. Both even and odd harmonics

4-47. With a square wave applied to a resistive network, the circuit values of what components will NOT affect either the phases or amplitudes of the harmonics within the square wave?

1. Inductors
2. Resistors
3. Capacitors
4. Transformers

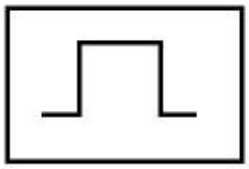
4-48. The time constant for full integration in an RC circuit should be what minimum number of times greater than the input-pulse duration?

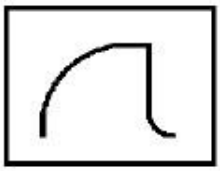
1. 1
2. 5
3. 10
4. 20

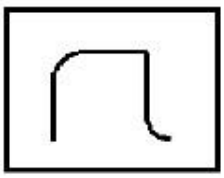
4-49. Integration in a circuit takes place when the output is taken (a) across the capacitor in what type of circuit and (b) across the resistor in what type of circuit?

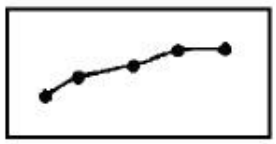
1. (a) Resistive only
   (b) Resistive only
2. (a) Resistive only
   (b) Resistive-inductive
3. (a) Resistive only
   (b) Resistive-capacitive
4. (a) Resistive-capacitive
   (b) Resistive-inductive

4-50. In an RC integrator, which of the following waveforms has the longest time constant?

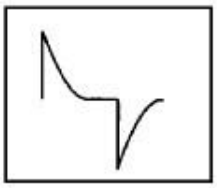
1. 

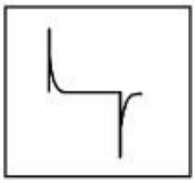
3. 

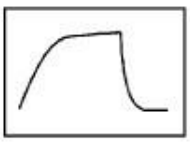
2. 

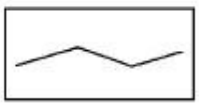
4. 

4-51. In an RC differentiator, which of the following waveforms has the shortest time constant?

1. 

2. 

3. 

4. 

4-52. In a short time-constant integrator circuit, the maximum amplitude of the input pulse is 100 volts and the time constant of the circuit is 1/10 the duration of the input pulse. At the end of three time constants, what is the maximum voltage across the capacitor?

1. 36.8 volts
2. 63.2 volts
3. 86.5 volts
4. 95 volts

4-53. In a medium time-constant circuit, the maximum amplitude of the input pulse is 100 volts and the pulse length is one time constant. At the end of two time constants, what is the maximum voltage across the capacitor?

1. 23.3 volts
2. 48.4 volts
3. 71.7 volts
4. 100 volts

4-54. In a short time-constant differentiator circuit, the maximum amplitude of the input pulse is 100 volts and the time constant of the circuit is 1/10 that of the input pulse. At the end of four time constants, what is the maximum voltage across the resistor?

1. 5 volts
2. 2 volts
3. 23.3 volts
4. 48.4 volts

4-55. In an RC differentiator circuit, the time constant for the circuit and the input pulse are equal. At the end of one time constant, to what maximum percentage of the applied voltage is the capacitor charged?

1. 5 percent
2. 13.5 percent
3. 36.8 percent
4. 63.2 percent

4-56. In an RC network that is used as a coupling circuit, (a) across what component is the output normally taken and (b) what is the relative length of the time constant?

1. (a) Capacitor (b) short
2. (a) Capacitor (b) long
3. (a) Resistor (b) long
4. (a) Resistor (b) short

4-57. In a positive-diode counter that provides accurate counting, what is the only variable allowed in the input signal?

1. Pulse width
2. Pulse duration
3. Pulse amplitude
4. Pulse-repetition frequency

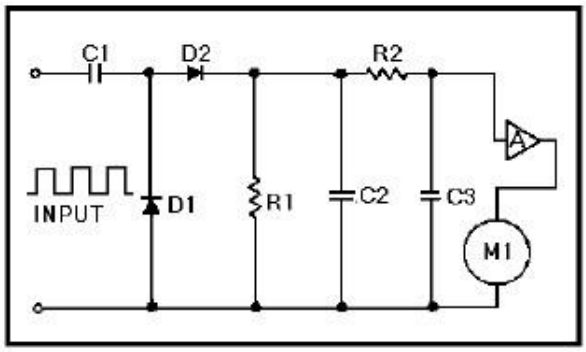


Figure 4G.—Basic frequency counter.

IN ANSWERING QUESTIONS 4-58 THROUGH 4-60, REFER TO FIGURE 4G.

4-58. An input signal to the counter will cause (a) what capacitor to charge through R1 and D2 and (b) what capacitor to discharge through D1?

1. (a) C1 (b) C1
2. (a) C1 (b) C2
3. (a) C2 (b) C1
4. (a) C2 (b) C2

4-59. What components produce the smooth dc output-voltage level?

1. C1, D1, and R1
2. C1, D2, and R1
3. C1, C2, and R1
4. C2, C3, and R2

4-60. When the input frequency is increased, what is the effect on (a) the input interval, (b) the number of pulses per given time and (c) the dc output voltage?

1. (a) Longer (b) less (c) higher
2. (a) Longer (b) more (c) lower
3. (a) Shorter (b) less (c) higher
4. (a) Shorter (b) more (c) higher

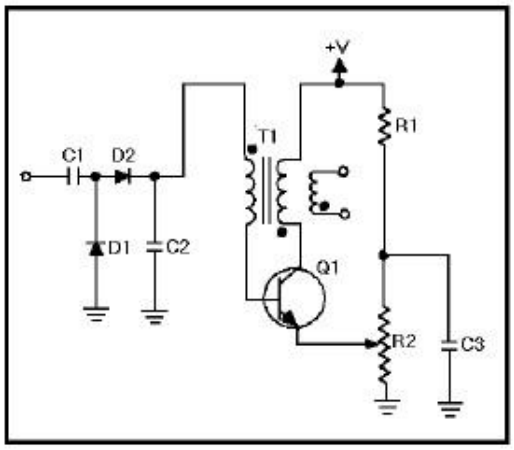


Figure 4H.—Step-counter frequency divider.

IN ANSWERING QUESTIONS 4-61 AND 4-62, REFER TO FIGURE 4H.

4-61. An output pulse will occur when the charge on C2

1. builds a magnetic field in the base winding
2. drops below the cutoff-bias level of Q1
3. exceeds the bias level of Q1
4. reaches the source potential of the voltage applied

4-62. What component develops the bias for Q1?

1. R1
2. R2
3. C2
4. T1

MODULE 10

INTRODUCTION TO WAVE PROPAGATION, TRANSMISSION LINES AND ANTENNAS

PREPARED BY:

Russell Hababag and John Kenneth De Guzman

ASSIGNMENT 1

"Wave Propagation

1-1. What is the major advantage of the telegraph over earlier methods of communication?

1. Range
2. Speed
3. Security
4. Reliability

1-2. The spreading out of radio waves is referred to as propagation and is used in which of the following Navy equipment?

1. Detection
2. Communication
3. Radar and navigation
4. Each of the above

1-3. Radio-frequency waves CANNOT be seen for which of the following reasons?

1. Because radio-frequency energy is low powered
2. Because radio-frequency waves are below the sensitivity range of the human eye
3. Because the human eye detects only magnetic energy
4. Because radio-frequency waves are above the sensitivity range of the human eye

1-4. Radio waves travel at what speed?

1. Speed of sound
2. Speed of light
3. Speed of the Earth's rotation
4. Speed of the Earth's orbit around the sun

1-5. Which of the following types of energy CANNOT be seen, heard, or felt?

1. Radio waves
2. Sound waves
3. Heat waves
4. Light waves

1-6. A stone dropped into water creates a series of expanding circles on the surface of the water. This is an example of which of the following types of wave motion?

1. Transverse
2. Concentric
3. Longitudinal
4. Compression

1-7. A sound wave that moves back and forth in the direction of propagation is an example of which of the following types of wave motion?

1. Composite
2. Concentric
3. Transverse
4. Longitudinal

1-8. Which of the following terms is used for the vehicle through which a wave travels from point to point?

1. Medium
2. Source
3. Detector
4. Receiver

1-9. Which of the following is NOT an element necessary to propagate sound?

1. Medium
2. Source
3. Detector
4. Reference

1-10. If a wave has a velocity of 4,800 feet per second and a wave-length of 5 feet, what is the frequency of the wave?

1. 9.6 Hz
2. 96 Hz
3. 960 Hz

4. 9,600 Hz

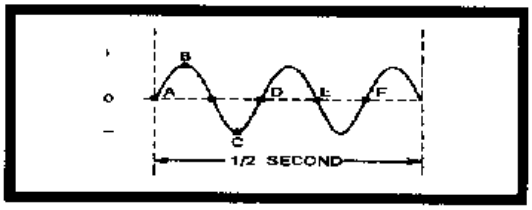


Figure 1-A.—Waveform.

IN ANSWERING QUESTIONS 1-11 THROUGH 1-15, REFER TO FIGURE 1-A.

1-11. The waveform in the figure is what type of wave?

1. Sine
2. Square
3. Sawtooth
4. Trapezoidal

1-12. The distance between which of the following points represents the completion of a full cycle of alternating current?

1. A to C
2. B to D
3. C to E
4. D to F

1-13. The distance between which of the following points represents a full wavelength?

1. A to D
2. A to E
3. D to E
4. E to F

1-14. What is the frequency of the wave?

1. 0.5 Hz
2. 2.5 Hz
3. 5.0 Hz
4. 7.5 Hz

1-15. What is the period of the wave?

1. 100 milliseconds
2. 200 milliseconds
3. 250 milliseconds
4. 500 milliseconds

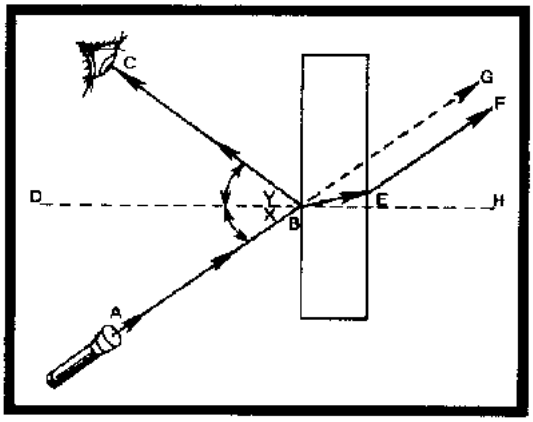


Figure 1-B.—Wave angles.

IN ANSWERING QUESTIONS 1-16 THROUGH 1-19, REFER TO FIGURE 1-B.

1-16. What line in the figure indicates the incident wave?

1. A to B
2. B to E
3. C to B
4. D to H

1-17. Angle "x" is which of the following angles?

1. Normal
2. Incidence
3. Reflection
4. Refraction

1-18. Line E to F represents which of the following waves?

1. Normal
2. Incident
3. Refracted
4. Reflected

1-19. Line D to H represents which of the following references?

1. Normal
2. Perpendicular
3. Both 1 and 2 above
4. Reflected line

1-20. Which of the following statements about a wave is the law of reflection?

1. The angle of incidence is equal to the refracted wave
2. The angle of incidence is not equal to the refracted wave
3. The angle of incidence is equal to the angle of reflection
4. The angle of incidence is not equal to the angle of reflection

1-21. If a wave passes first through a dense medium and then through a less dense medium, which of the following angleof-refraction conditions exists?

1. The angle of refraction is greater than the angle of incidence
2. The angle of refraction is less than the angle of incidence
3. The angle of refraction is equal to the angle of incidence
4. The wave will pass through in a straight line

1-22. The reception of an AM-band radio signal over mountains can be explained by which of the following principles of wave propagation?

1. Reflection
2. Refraction
3. Diffraction
4. Doppler effect

1-23. What wave propagation principle accounts for the apparent increase in frequency as a train whistle approaches and the apparent decrease in frequency as it moves away?

1. Refraction
2. Reflection
3. Diffraction
4. Doppler effect

1-24. Longitudinal wave disturbances that travel through a medium are known as what type of waves?

1. Air
2. Sound
3. Radio
4. Light

1-25. What are the three audible frequency ranges?
1. Subsonic, sonic, and supersonic
2. Infrasonic, sonic, and ultrasonic
3. Infrasonic, subsonic, and ultrasonic
4. Infrasonic, subsonic, and supersonic

1-26. If a bell is placed in a jar and the air in the jar is replaced with a gas of a higher density, what is the effect, if any, on the speed of the sound when the bell is rung?

1. The sound stops
2. The sound travels faster
3. The sound travels slower
4. The sound is not affected

1-27. Varying which of the following wave characteristics will cause the length of sound waves to vary?

1. Phase
2. Quality
3. Amplitude
4. Frequency

1-28. What are the three basic characteristics of sound?

1. Amplitude, intensity, and quality
2. Amplitude, pitch, and tone

3. Pitch, intensity, and quality
4. Pitch, frequency, and quality

1-29. If several musical instruments are playing the same note, you should be able to distinguish one instrument from another because of which of the following characteristics of sound?

1. Quality
2. Overtones
3. Frequency
4. Intensity

1-30. Through which of the following mediums will sound travel fastest, at the indicated temperature?

1. Air at 68º F
2. Lead at 20º C
3. Steel at 32º F
4. Steel at 20º C

1-31. In sound terminology, which of the following terms is the same as a wave reflection?

1. Echo
2. Image
3. Acoustics
4. Refraction

1-32. Multiple reflections of sound waves are referred to as

1. noise
2. acoustics
3. interference
4. reverberation

1-33. Two out-of-phase waves of the same frequency that are moving through the same medium are said to present which of the following types of interference?

1. Additive
2. Constructive
3. Both 1 and 2 above
4. Subtractive

1-34. A cavity that vibrates at its own natural frequency and produces a sound that is louder than at other frequencies is demonstrating which of the following sound characteristics?

1. Noise
2. Quality
3. Resonance
4. Reverberation

1-35. Energy in the form of light can be produced through which of the following means?

1. Chemical
2. Electrical
3. Mechanical
4. Each of the above

1-36. The scientist, J. C. Maxwell, developed the theory that small packets of electromagnetic energy called photons produce

1. sound
2. noise
3. echoes
4. light

1-37. A large volume of light radiating in a given direction is referred to as a

1. ray
2. beam
3. shaft
4. pencil

1-38. Which of the following units of measurement is/are used to measure very short wavelengths of light?

1. Angstrom
2. Millimicron
3. Both 1 and 2 above

4. Millimeter

1-39. What are the primary colors of light?

1. Red, blue, and yellow
2. Red, blue, and green
3. Red, violet, and indigo
4. Blue, green, and violet

1-40. What are the secondary colors of light?

1. Orange, yellow, and blue-green
2. Magenta, yellow, and cyan
3. Purple, yellow, and black
4. Red, white, and blue

1-41. What causes sunlight to separate into different wavelengths and display a rainbow of colors when passed through a prism?

1. Refraction
2. Reflection
3. Dispersion
4. Diffraction

1-42. The sun, gas flames, and electric light filaments are visible because they are

1. opaque
2. transparent
3. nonluminous
4. self-luminous

1-43. Substances that transmit almost all of the light waves falling upon them possess which of the following properties?

1. Opaqueness
2. Transparence
3. Translucence
4. Self-lumination

1-44. Some substances are able to transmit light waves but objects cannot be seen through them. Which of the following properties does this statement describe?

1. Opaqueness
2. Transparence
3. Translucence
4. Self-lumination

1-45. The speed of light depends on the medium through which light travels. For which of the following reasons does light travel through empty space faster than through an object such as glass?

1. Space is less dense than glass
2. Space is more dense than glass
3. Glass reflects the light back to the source
4. Glass refracts the light, causing the light to travel in all directions

1-46. If a light wave strikes a sheet of glass at a perpendicular angle, what is the effect, if any, on the light wave?

1. The wave is completely absorbed
2. The wave is reflected back toward the source
3. The wave is refracted as it passes through the glass
4. The wave is unchanged and continues in a straight line

1-47. The amount of absorption of the light that strikes an object is determined by the object's

1. color
2. purity
3. density
4. complexity

1-48. In a comparison of waves of light and sound as they travel from an air into water, how is the speed of (a) light waves and (b) sound waves affected?

1. (a) Increased (b) increased
2. (a) Increased (b) decreased
3. (a) Decreased (b) decreased
4. (a) Decreased (b) increased

1-49. Which of the following waves are NOT a form of electromagnetic energy?

1. Heat waves
2. Sound waves
3. Light waves
4. Radio waves

1-50. The electromagnetic spectrum represents the entire range of electromagnetic waves arranged in the order of their

1. color
2. frequency
3. visibility
4. application

1-51. Which of the following portions of the frequency spectrum contains the highest frequency?

1. X-ray
2. Radar
3. Light
4. Cosmic

1-52. Which of the following electronic devices is used to radiate and/or collect electromagnetic waves?

1. Antenna
2. Receiver
3. Transmitter
4. Transmission line

1-53. The electric field and magnetic field combine to form which of the following types of waves?

1. Spherical
2. Elliptical
3. Electromagnetic
4. Each of the above

1-54. The magnetic field radiated from an antenna is produced by what electrical property?

1. Voltage
2. Current
3. Reactance
4. Resistance

1-55. The electric field radiated from an antenna is produced by what electrical property?

1. Voltage
2. Current
3. Reactance
4. Resistance

1-56. Applying rf energy to the elements of an antenna results in what phase relationship between voltage and current?

1. Voltage lags current by 90 degrees
2. Voltage leads current by 90 degrees
3. Voltage and current are 180 degrees out of phase
4. Voltage and current are in phase

1-57. What field exists close to the conductor of an antenna and carries the current?

1. Electric
2. Magnetic
3. Induction
4. Radiation

1-58. What field travels through space after being detached from the current-carrying rod of an antenna?

1. Electric
2. Magnetic
3. Induction
4. Radiation

1-59. Electric and magnetic fields on an

antenna reach their maximum intensity at which of the following times?

1. When they are a full cycle apart
2. When they are three-quarter cycle apart
3. When they are a half-cycle apart
4. When they are a quarter-cycle apart

ASSIGNMENT 2

Radio Wave Propagation

2-1. The induction field is made up of which of the following fields?

1. E field only
2. H field only
3. Both E and H fields

2-2. After the radiation field leaves an antenna, what is the relationship between the E and H fields with respect to (a) phase and (b) physical displacement in space?

1. (a) In phase (b) 90 degrees
2. (a) Out of phase (b) 90 degrees
3. (a) In phase (b) 180 degrees
4. (a) Out of phase (b) 180 degrees

2-3. What is the first harmonic of a radio wave that has a fundamental frequency of 2,000 kHz?

1. 6,000 kHz
2. 2,000 kHz
3. 3,000 kHz
4. 4,000 kHz

2-4. In a radio wave with a fundamental frequency of 1.5 kHz, which of the following frequencies is NOT a harmonic?

1. 6,000 kHz
2. 5,000 kHz
3. 3,000 kHz
4. 4,000 kHz

2-5. A radio wave with a frequency of 32 kHz is part of which of the following frequency bands?

1. The lf band
2. The mf band
3. The hf band
4. The vhf band

2-6. A frequency of 3.5 GHz falls into what rf band?

1. High
2. Very high
3. Super high
4. Extremely high

2-7. A radio wavelength expressed as 250 meters may also be expressed as how many feet?

1. 410
2. 820
3. 1,230
4. 1,640

2-8. An increase in the frequency of a radio wave will have what effect, if any, on the velocity of the radio wave?

1. Increase
2. Decrease
3. None

2-9. An increase in frequency of a radio wave will have what effect, if any, on the wavelength of the radio wave?

1. Increase
2. Decrease
3. None

2-10. What is the frequency, in kiloHertz, of a radio wave that is 40 meters long?

1. 75
2. 750
3. 7,500
4. 75,000

2-11. What is the approximate wavelength, in feet, of a radio wave with a frequency of 5,000 kHz?

1. 197 feet
2. 1,970 feet
3. 19,700 feet
4. 197,000 feet

2-12. The polarity of a radio wave is determined by the orientation of (a) what moving field with respect to (b) what reference?

1. (a) Electric (b) earth
2. (a) Electric (b) antenna
3. (a) Magnetic (b) antenna
4. (a) Magneti (b) earth

2-13. Energy radiated from an antenna is considered horizontally polarized under which of the following conditions?

1. If the wavefront is in the horizontal plane
2. If the magnetic field is in the horizontal plane
3. If the electric field is in the horizontal plane
4. If the induction field is in the horizontal plane

2-14. The ability of a reflecting surface to reflect a specific radio wave depends on which of the following factors?

1. Striking angle
2. Wavelength of the wave
3. Size of the reflecting area
4. All of the above

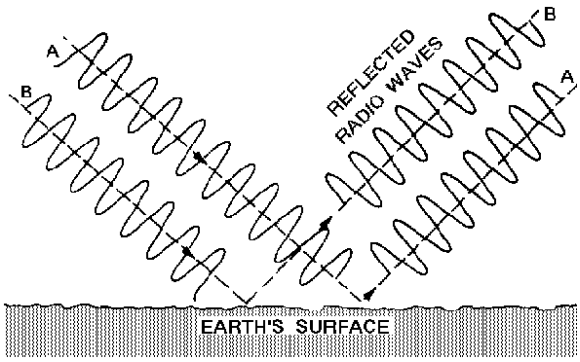


Figure 2-A.—Reflected radio waves.

IN ANSWERING QUESTION 2-15, REFER TO FIGURE 2-A.

2-15. If the two reflected radio waves shown in the figure are received at the same instant at the receiving site, what will be the effect, if any, on signal quality?

1. A stronger signal will be produced
2. A weak or fading signal will be produced
3. The signal will be completely canceled out
4. None

2-16. The bending of a radio wave because of a change in its velocity through a medium is known as

1. refraction
2. reflection
3. deflection
4. diffraction

2-17. Radio communications can be diffracted to exceptionally long distances through the use of (a) what frequency band at (b) what relative power level?

1. (a) Very low frequency
   (b) Low power
2. (a) Very high frequency
   (b) Low power
3. (a) Very low frequency
(b) High power
4. (a) Very high frequency
   (b) High power

2-18. Electrically charged particles that affect the propagation of radio waves are found in what atmospheric layer?

1. Troposphere
2. Ionosphere
3. Chronosphere
4. Stratosphere

2-19. Most weather phenomena take place in

which of the following region of the atmosphere?

1. Troposphere
2. Ionosphere
3. Chronosphere
4. Stratosphere

2-20. Radio wave propagation has the least effect because of its constancy on which of the following atmospheric layers?

1. Troposphere
2. Ionosphere
3. Chronosphere
4. Stratosphere

2-21. Long range, surface-wave communications are best achieved when the signal is transmitted over seawater with (a) what polarization at (b) what relative frequency?

1. (a) Vertical (b) Low
2. (a) Vertical (b) High
3. (a) Horizontal (b) High
4. (a) Horizontal (b) Low

2-22. The Navy's long-range vlf broadcasts are possible because of the advantages of which of the following types of propagation?

1. Diffraction
2. Ionospheric refraction
3. Repeated reflection and refraction
4. Both 2 and 3 above

2-23. A space wave (a) is primarily a result of refraction in what atmospheric layer and (b) extends approximately what distance beyond the horizon?

1. (a) Ionosphere
   (b) One-tenth farther
2. (a) Ionosphere
   (b) One-third farther
3. (a) Troposphere
4. (a) Troposphere
   (b) One-tenth farther

2-24. The signal of a space wave is sometimes significantly reduced at the receiving site because of which of the following interactions?

1. Space-wave refraction
2. Space-wave reflections
3. Ground-wave diffraction
4. Ground-wave reflections

2-25. For long-range communications in the hf band, which of the following types of waves is most satisfactory?

1. Sky wave
2. Space wave
3. Surface wave
4. Reflected ground wave

2-26. Ionization in the atmosphere is produced chiefly by which of the following types of radiation?

1. Alpha radiation
2. Cosmic radiation
3. Infrared radiation
4. Ultraviolet radiation

2-27. Ultraviolet waves of higher frequencies produce ionized layers at what relative altitude(s)?

1. Lower
2. Higher
3. Both 1 and 2 above

2-28. The density of ionized layers is normally greatest during which of the following periods?

1. At night
2. Before sunrise
3. Between early morning and late afternoon

4. Between afternoon and sunset

2-29. Compared to the other ionospheric layers at higher altitudes, the ionization density of the D layer is

1. about the same
2. relatively low
3. relatively high

2-30. What two layers in the ionosphere recombine and largely disappear at night?

1. D and F
2. D and E
3. E and F2
4. F1 and F2

2-31. For hf-radio communications covering long distances, what is the most important layer of the ionosphere?

1. C
2. D
3. E
4. F

2-32. Refraction of a sky wave in the ionosphere is influenced by which of the following factors?

1. Ionospheric density
2. Frequency of the wave
3. Angle of incidence of the wave
4. All of the above

2-33. A 10-MHz wave entering the ionosphere at an angle greater than its critical angle will pass through the ionosphere and be lost in space unless which of the following actions is taken?

1. The ground wave is canceled
2. The frequency of the wave is increased
3. The frequency of the wave is decreased
4. The ground wave is reinforced

2-34. The distance between the transmitter and the nearest point at which refracted waves return to earth is referred to as the

1. skip distance
2. return distance
3. reception distance
4. ground-wave distance

2-35. When ground-wave coverage is LESS than the distance between the transmitter and the nearest point at which the refracted waves return to earth, which of the following reception possibilities should you expect?

1. No sky-wave
2. Weak ground wave
3. A zone of silence
4. Strong ground wave`

2-36. The greatest amount of absorption takes place in the ionosphere under which of the following conditions?

1. When sky wave intensity is the greatest
2. When collision of particles is least
3. When the density of the ionized layer is the greatest
4. When precipitation is greatest

2-37. Which of the following layers provide the greatest amount of absorption to the ionospheric wave?

1. D and E
2. D and F1
3. E and F1
4. F1 and F2

2-38. If the signal strength of an incoming signal is reduced for a prolonged period, what type of fading is most likely involved?

1. Selective
2. Multipath
3. Absorption
4. Polarization

2-39. Radio waves that arrive at a receiving site along different paths can cause signal fading if these waves have different

1. velocities
2. amplitudes
3. phase relationships
4. modulation percentages

2-40. The technique of reducing multipath fading by using several receiving antennas at different locations is known as what type of diversity?

1. Space
2. Receiver
3. Frequency
4. Modulation

2-41. The amount of rf energy lost because of ground reflections depends on which of the following factors?

1. Angle of incidence
2. Ground irregularities
3. Frequency of the wave
4. Each of the above

2-42. Receiving sites located near industrial areas can expect to have exceptionally large losses in signal quality as a result of which of the following propagation situations?
1. Absorption
2. Multihop refraction
3. Natural interference
4. Man-made interference

2-43. Which of the following ionospheric variation causes densities to vary with the axial rotation of the sun?

1. Daily variation
2. Seasonal variation
3. 27-day sunspot cycle
4. 11-year sunspot cycle

2-44. Which of the following ionospheric variation causes densities to vary with the position of the earth in its orbit around the sun?

1. Daily variation
2. Seasonal variation
3. 27-day sunspot cycle
4. 11-year sunspot cycle

2-45. Which of the following ionospheric variation causes densities to vary with the time of the day?

1. Daily variation
2. Seasonal variation
3. 27-day sunspot cycle
4. 11-year sunspot cycle

2-46. What relative range of operating frequencies is required during periods of maximum sunspot activity?

1. Lower
2. Medium
3. Higher

2-47. What factor significantly affects the frequency of occurrence of the sporadic-E layer?

1. Seasons
2. Latitude
3. Weather conditions
4. Ionospheric storms

2-48. What effect can the sporadic-E layer have on the propagation of sky waves?

1. Causes multipath interference
2. Permits long distance communications at unusually high frequencies
3. Permits short-distance communications in the normal skip zone
4. Each of the above

2-49. A sudden and intense burst of ultraviolet light is especially disruptive to

communications in which of the following frequency bands?

1. Hf
2. Mf
3. Lf
4. Vlf

2-50. The density of what ionosphere layer increases because of a violent eruption on the surface of the sun?

1. D
2. E
3. F1
4. F2

2-51. Which irregular variation in ionospheric conditions can cause a waiting period of several days before communications return to normal?

1. Sporadic E
2. Ionospheric storms
3. Sudden ionospheric disturbance
4. Each of the above

2-52. For a radio wave entering the atmosphere of the earth at a given angle, the highest frequency at which refraction will occur is known by which of the following terms?

1. Usable frequency
2. Refraction frequency
3. Maximum usable frequency
4. Optimum working frequency

2-53. The most consistent communications can be expected at which of the following frequencies?

1. Critical frequency
2. Maximum usable frequency
3. Maximum working frequency
4. Optimum working frequency

2-54. If the optimum working frequency for a communications link is 4,250 kHz, what is the approximate maximum usable frequency? *diko lam formula*

1. 4,500 kHz
2. 5,000 kHz
3. 5,500 kHz
4. 6,000 kHz

2-55. In determining the success of radio transmission, which of the following factors is the LEAST predictable?

1. Antenna capabilities
2. Weather conditions along the path of communication
3. Density of ionized layers
4. Presence of ionized layers

2-56. At frequencies above 100 MHz, the greatest attenuation of rf energy from raindrops is caused by which of the following factors?

1. Ducting
2. Heat loss
3. Scattering
4. Absorption

2-57. Under certain conditions, such as ducting, line-of-sight radio waves often propagate for distances far beyond their normal ranges because of which of the following factors?

1. Low cloud masses
2. Ionospheric storms
3. Temperature inversions
4. Frequency fluctuations

2-58. When ducting is present in the atmosphere, multihop refraction of line-of-sight transmission can occur because of which of the following factors?

1. Operating frequency of the transmitter
2. Height of the transmitting antenna
3. Angle of incidence of the radio wave
4. Each of the above

2-59. A propagation technique used to extend uhf transmission range beyond the horizon uses which of the following propagation characteristics?

1. Ground reflection
2. Ionospheric scatter
3. Tropospheric scatter
4. Atmospheric refraction

2-60. Communications by tropospheric scatter can be affected by which of the following conditions?

1. Sunspot activity
2. Atmospheric conditions
3. Ionospheric disturbances
4. All of the above

2-61. What effect, if any, does the radiation angle of a transmitting antenna have on the reception of communications by tropospheric scatter?

1. The lower the angle, the weaker the signal
2. The lower the angle, the stronger the signal

3. The lower the angle, the more susceptible the signal is to distortion
4. None

2-62. Which of the following descriptions of tropospheric scatter signal reception is NOT true?

1. Receiver signal strength decreases as the turbulence height is increased
2. The level of reception depends on the number of turbulences causing scatter
3. The energy received is the portion of the wave reradiated by the turbulence
4. Increased communications distance enables more turbulence to act on the signal, thereby raising the received signal level

2-63. The tropospheric scatter signal is often characterized by very rapid fading caused by which of the following factors?

1. Extreme path lengths
2. Multipath propagation
3. Turbulence in the atmosphere
4. Angle of the transmitted beam

2-64. For which of the following communications situations would turbulence in the troposphere scatter transmission?

1. 10 MHz, range 200 miles
2. 30 MHz, range 800 miles
3. 50 MHz, range 600 miles
4. 100 MHz, range 400 miles

ASSIGNMENT 3
PRINCIPLES OF TRANSMISSION LINES

3-1. A transmission line is designed to perform which of the following functions?

1. Disperse energy in all directions
2. Detune a transmitter to match the load
3. Guide electrical energy from point to point
4. Replace the antenna in a communications system

3-2. All transmission lines must have two ends, the input end and the output end. What other name is given to the input end?

1. Sending end
2. Generator end
3. Transmitter end
4. Each of the above

3-3. A measurement of the voltage to current ratio (Ein/Iin) at the input end of a transmission line is called the

1. input-gain rate
2. input impedance
3. output impedance
4. voltage-gain ratio

3-4. Which of the following lines is NOT a transmission medium?

1. Load line
2. Coaxial line
3. Two-wire line
4. Twisted-pair line

3-5. Electrical power lines are most often made of which of the following types of transmission lines?

1. Twin-lead line
2. Shielded-pair line
3. Two-wire open line
4. Two-wire ribbon line

3-6. Uniform capacitance throughout the length of the line is an advantage of which of the following transmission lines?

1. Coaxial line
2. Twisted pair
3. Shielded pair
4. Two-wire open line

3-7. What is the primary advantage of a rigid coaxial line?

1. Low radiation losses
2. Inexpensive construction
3. Low high-frequency losses
4. Each of the above

3-8. Which of the following wave-guides is seldom used because of its large energy loss characteristics?

1. Metallic
2. Dielectric
3. Elliptical
4. Cylindrical

3-9. To some degree, transmission lines always exhibit which of the following types of losses?

1. I2R
2. Inductor
3. Dielectric
4. Each of the above

3-10. Skin effect is classified as which of the following types of loss?

1. Copper
2. Voltage
3. Induction
4. Dielectric

3-11. **What transmission-line loss is caused by magnetic lines of force not returning to the conductor?**

1. Copper
2. Radiation
3. Induction
4. Dielectric

3-12. **What is the electrical wave-length of 1 cycle if the frequency is 60 hertz?**

1. 125,000 meters
2. 1,250,000 meters
3. 5,000,000 meters
4. 20,000,000 meters

3-13. **A transmission line 10 meters in length is considered to be electrically long at which of the following frequencies?**

1. 60 kilohertz
2. 600 kilohertz
3. 6 megahertz
4. 60 megahertz

3-14. **The conductance value of a transmission line represents which of the following values?**

1. Expected value of current flow through the insulation
2. Expected value of voltage supplied by the transmitter
3. Value of the lump and distributed constants of the line divided by impedance
4. Value of the lump and distributed constants of the line divided by impedance

3-15. **Electrical constants in a transmission line are distributed in which of the following ways?**

1. Into a single device
2. Along the length of the line
3. According to the thickness of the line
4. According to the cross-sectional area of the line

3-16. **Leakage current in a two-wire transmission line is the current that flows through what component?**

1. The resistor
2. The inductor
3. The insulator
4. The conductor

3-17. **Conductance is the reciprocal of what electrical property?**

1. Inductance
2. Resistance
3. Capacitance
4. Reciprocity

3-18. **A transmission line that has current flowing through it has which, if any, of the following fields about it?**

1. Electric field only
2. Magnetic field only
3. Both electric and magnetic fields
4. None of the above

3-19. **Maximum transfer of energy from the source to the transmission line takes place when what impedance relationship exists between the source and the transmission line?**

1. When the load impedance equals source impedance
2. When the load impedance is twice the source impedance
3. When the load impedance is half the source impedance
4. When the load impedance is one-fourth the source impedance

3-20. **The characteristic impedance (Z0) of a transmission line is calculated by using which of the following ratios?**

1. Rs to Rload of the line
2. Imax to Imin at every point along the line
3. E to I at every point along the line
4. Ein to Eo of the line

3-21. **For a given voltage, what determines the amount of current that will flow in a transmission line?**

1. Conductance
2. Spacing of the wires
3. Diameter of the wires
4. Characteristic impedance

3-22. **When the impedance of a transmission line is measured, which of the following values frequently is NOT considered?**

1. Inductance
2. Resistance
3. Conductance
4. Capacitance

3-23. **The characteristic impedance of a long transmission line may be determined by using which of the following methods?**

1. Trial and error
2. Calculating the impedance of the entire line
3. Calculating the impedances at each end of the line
4. Adding the impedances of successive short sections

3-24. **When should lumped values for transmission-line constants be used to calculate characteristic impedance?**

1. When the line is short compared to one wavelength
2. When the line is long compared to one wavelength
3. When the line is infinitely long

3-25. **In actual practice, the characteristic impedance of a transmission line is usually within which of the following resistance ranges?**

1. 0 to 0.9 ohm
2. 1 to 49 ohms
3. 50 to 600 ohms
4. 601 to 1,000 ohms

3-26. **The input impedance of a transmission line is affected by which of the following properties?**

1. Radiation loss
2. Series inductance
3. Parallel capacitance
4. Each of the above

3-27. **When a dc voltage is applied to a transmission line and the load absorbs all the energy, what is the resulting relationship between current and voltage?**

1. They are in phase with each other
2. They are equal to Z0 of the line
3. They are out of phase with each other
4. They are evenly distributed along the line

3-28. **The initial waves that travel from the source to the load of a transmission line are referred to as what type of waves?**

1. Incident
2. Refracted
3. Reflected
4. Diffracted

3-29. **Waves that travel from the output end to the input end of a transmission line are referred to as what type of waves?**

1. Incident
2. Refracted

3. Reflected
4. Diffracted

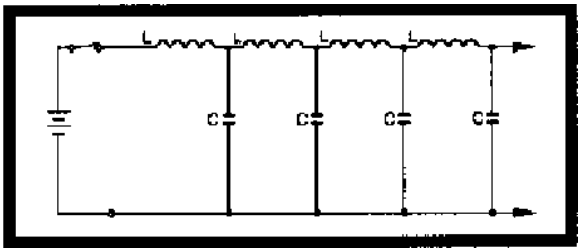


Figure 3-A.—Equivalent infinite transmission line.

IN ANSWERING QUESTION 3-30, REFER TO FIGURE 3-A.

3-30. **When a dc voltage is applied to the equivalent infinite line in the figure, which of the following conditions occurs along the length of the line?**

1. Standing waves of voltage form
2. Standing waves of current form
3. Current flows indefinitely
4. Voltage appears for a short time

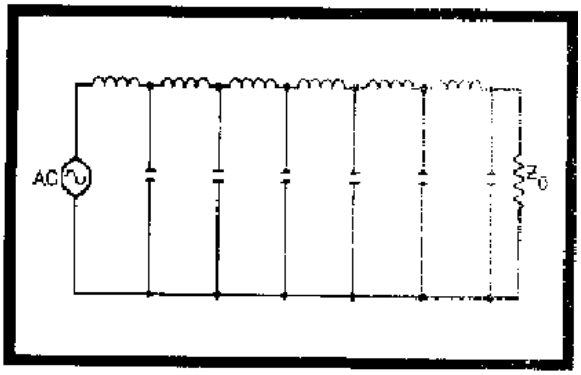


Figure 3-B.—Equivalent transmission line.

IN ANSWERING QUESTION 3-31, REFER TO FIGURE 3-B.

3-31. **Compared to a dc input, what relative amount of time is required for an ac input voltage to travel the length of the line shown in the circuit?**

1. Less
2. Same
3. More

3-32. **The instantaneous voltage on an infinite transmission line can be plotted against time by using which of the following instruments?**

1. A wavemeter
2. A multimeter
3. An oscilloscope
4. A spectrum analyzer

3-33. **On an infinite transmission line with an ac voltage applied, which of the following is an accurate description of the effective voltage distribution along the line?**

1. Voltage is 0 at all points
2. Voltage is constant at all points
3. Voltage varies at a sine-wave rate
4. Voltage varies at double the sine-wave rate

3-34. **The velocity of propagation on a transmission line is controlled by which of the following line characteristics?**

1. Conductance
2. Inductance only
3. Capacitance only
4. Capacitance and inductance

3-35. **The total charge on a transmission line is equal to the current multiplied by which of the following factors?**

1. Time
2. Power
3. Voltage
4. Resistance

3-36. **With only capacitance and inductance of the line given, the time (T) required for a voltage change to travel down a transmission line can be found by what formula? The characteristic impedance for**

an infinite transmission line can be figured using which of the following ratios?

1. T = sqrt(L/C)
3. T = sqrt(LC)
2. T = L + C
4. T = L - C

3-37. The characteristic impedance for an infinite transmission line can be figured using which of the following ratios?

1. Input current to velocity
2. Input voltage to input current
3. Input voltage to line resistance
4. Input current to line resistance

3-38. The characteristic impedance of a transmission line can be figured by using which of the following formulas?

1. Zo = 1/LC
2. Zo = sqrt(LC)
3. Zo = C/L
4. Zo = sqrt(L/C)

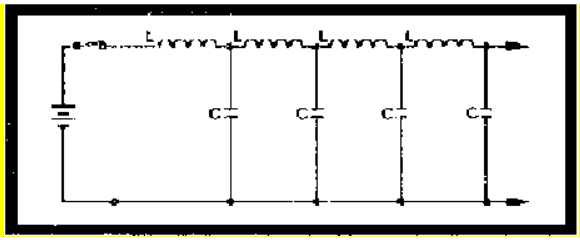


Figure 3-C.—Equivalent transmission line.

IN ANSWERING QUESTIONS 3-39 AND 3-40, REFER TO FIGURE 3-C. ASSUME THAT THE LINE IS 1,200 FEET LONG. A 150-FOOT SECTION IS MEASURED TO DETERMINE L AND C. THE 150-FOOT SECTION HAS AN INDUCTANCE OF 0.36 MILLIHENRIES AND A CAPACITANCE OF 1,000 PICOFARADS

3-39. What is the characteristic impedance of the line?

1. 400 ohms
2. 600 ohms
3. 800 ohms
4. 900 ohms

3-40. What is the velocity of the wave on the 150-foot section?

1. 210,000,000 fps
2. 225,000,000 fps
3. 250,000,000 fps
4. 275,000,000 fps

3-41. If a transmission line is open-ended, which of the following conditions describes its terminating impedance?

1. Finite
2. Infinitely large
3. Equal to load impedance
4. Equal to source impedance

3-42. When a transmission line is not terminated in its characteristic impedance (Zo), what happens to the incident energy that is NOT transferred to the load?

1. It is returned along the transmission line
2. It is radiated into space
3. It is absorbed by the line
4. It is converted to heat energy

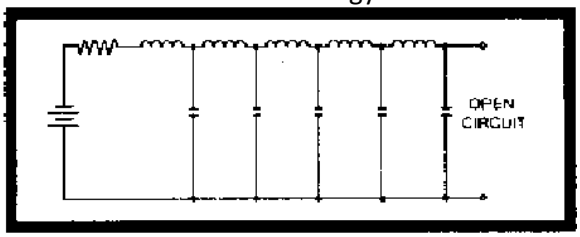


Figure 3-D.—Open-ended transmission line.

IN ANSWERING QUESTIONS 3-43 AND 3-44, REFER TO FIGURE 3-D.

3-43. **When the dc voltage reaches the open end of the transmission line in the figure and is reflected, it has which, if any, of the following changes?**

1. Increased amplitude
2. Decreased amplitude
3. The opposite polarity
4. None of the above

3-44. **When the dc current reaches the open end of the transmission line and is reflected, it has which, if any, of the following changes?**

1. Increased amplitude
2. Decreased amplitude
3. The opposite polarity
4. None of the above

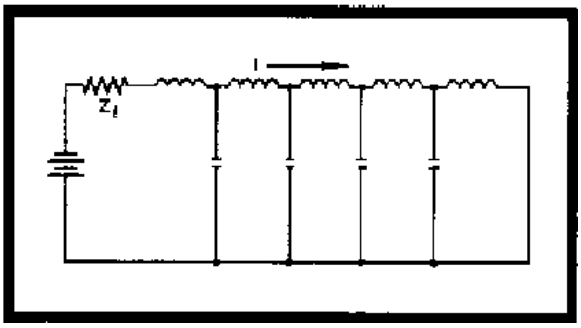


Figure 3-E.—Short-circuited transmission line.

IN ANSWERING QUESTIONS 3-45 AND 3-46, REFER TO FIGURE 3-E.

3-45. **When the dc voltage reaches the shorted end of the transmission line, it is reflected. It has which, if any, of the following changes?**

1. Increased amplitude
2. Decreased amplitude
3. The opposite polarity
4. None

3-46. **When the dc current reaches the shorted end of the transmission line, it is reflected. It has which, if any, of the following changes?**

1. Decrease amplitude
2. Increase amplitude
3. Increased polarity
4. None of the above

3-47. **In an open-ended transmission line with an ac signal applied, what is the phase relationship between the incident and reflected voltage waves?**

1. In phase
2. 45 degrees out of phase
3. 90 degrees out of phase
4. 180 degrees out of phase

3-48. **The resultant of the incident and reflected voltage waves is called the standing wave. Its value is figured by using which of the following procedures?**

1. Adding the effective values of the two waveforms
2. Algebraically adding the instantaneous values of the two waveforms
3. Algebraically subtracting the instantaneous values of the two waveforms
4. Taking the square root of the product of the incident and reflected voltages

3-49. **On an open-ended transmission line that is carrying an ac signal, what is the total number of moving voltage waves?**

1. One
2. Two
3. Three
4. Four

3-50. **At the end of an open-ended transmission line, which, if any, of the following voltage waves is at its maximum value?**

1. Incident
2. Reflected
3. Resultant
4. None

3-51. **On a transmission line that is carrying an ac signal, what is the relative value of the resultant voltage wave 1/4 wavelength from the open end?**

1. Maximum positive
2. Maximum negative
3. Zero

3-52. **In an open-ended transmission line, the resultant ac current waveform is always zero at what point(s)?**

1. At the open end only
2. 1/2 wavelength from the open-end only
3. At the open end and 1/2 wavelength from the open-end

3-53. **The resultant waveform obtained by adding the incident wave to the reflected wave is referred to as a/an**

1. standing wave
2. negative wave
3. algebraic wave
4. concentrated wave

3-54. **On an open-ended transmission line, what is the phase relationship between the standing waves of voltage and current?**

1. In phase
2. 45 degrees out of phase
3. 90 degrees out of phase
4. 180 degrees out of phase

3-55. **Which of the following conditions exist at the end of a shorted transmission line?**

1. Maximum voltage and minimum current
2. Maximum voltage and maximum current
3. Minimum voltage and maximum current
4. Minimum voltage and minimum current

3-56. **Transmission line is considered to be nonresonant (flat) when it is terminated in which of the following ways?**

1. In an impedance equal to Zo
2. In an impedance that is infinite
3. In an inductive reactance greater than Z0
4. In a capacitive reactance greater than Z0

3-57. **Of the following terms, which one is used for the nonresonant transmission line?**

1. A tuned line
2. A shorted line
3. An untuned line
4. A terminated line

3-58. **A transmission line that is resonant is sometimes referred to as which of the following types of lines?**

1. Tuned
2. Matched
3. Untuned
4. Unmatched

3-59. **A short-circuited section of transmission line that is an odd number of quarter wavelengths long shows the same characteristics as which of the following devices?**

1. A series-resonant circuit
2. A parallel-resonant circuit

3. An inductive reactance equal to Z0
4. A capacitive reactance equal to Z0

3-60. **Which of the following circuits appears as a very high resistance at resonance?**

1. Nonresonant
2. Series-resonant
3. Parallel-resonant
4. Each of the above

3-61. **When a series-resonant circuit is resonant at a frequency above the generator frequency, it acts as what type of circuit?**

1. Open
2. Resistive
3. Inductive
4. Capacitive

3-62. **Which of the following sections of transmission line can be used as a parallel resonant circuit?**

1. A shorted 1/4-wavelength section
2. An open 1/4-wavelength section
3. A shorted 1/2-wavelength section
4. An open 3/4-wavelength section

3-63. **A generator connected to an open-ended line greater than 1/4 wave-length but less than 1/2 wave-length senses which of the following circuit component characteristics?**

1. Zero reactance
2. Low resistance
3. Inductive reactance
4. Capacitive reactance

3-64. **Which of the following conditions of current (I) and impedance (Z) exist at even quarter-wave points on a shorted transmission line?**

1. Low I, low Z
2. Low I, high Z
3. High I, high Z
4. High I, low Z

3-65. **What is the maximum distance, in wavelengths, between adjacent zero current points on an open-circuited line?**

1. 1 wavelength
2. 1/2 wavelength
3. 1/4 wavelength
4. 1/8 wavelength

3-66. **When a line is terminated in a capacitance, the capacitor performs which, if any, of the following circuit actions?**

1. It absorbs all the energy
2. It reflects all the energy
3. It reacts as if it were a short
4. None

3-67. **When a transmission line is terminated in an inductive reactance, which, if any, of the following phase shifts takes place with respect to the current and voltage?**

1. Only voltage is phase-shifted
2. Only current is phase-shifted
3. Both voltage and current are phase shifted
4. None

3-68. **When a transmission line is terminated in a resistance greater than Z0, which of the following conditions exist?**

1. The end of the line appears as an open circuit
2. Standing waves appear on the line
3. Voltage is maximum and current is minimum at the end of the line
4. Each of the above

3-69. **On a transmission line, reflections begin at which of the following locations?**

1. At the load
2. At the source
3. At the middle
4. At the half-wavelength point

3-70. **The ratio of maximum voltage to minimum voltage on a transmission line is referred to as the**

1. rswr
2. pswr
3. vswr
4. iswr

3-71. **Which of the following ratios samples the magnetic field along a line?**

1. Vswr
2. Pswr
3. Iswr
4. Rswr

ASSIGNMENT 4

Antennas

4-1. Radio energy is transmitted through which of the following mediums?

1. Rock
2. Soil
3. Water
4. Space

4-2. Energy is transmitted from a transmitter into space using which of the following devices?

1. A receiver
2. A delay line
3. A receiving antenna
4. A transmitting antenna

4-3. Transmitted rf energy takes what form as it is sent into space?

1. A magnetic field only
2. An electric field only
3. An electromagnetic field
4. A static dielectric field

4-4. The dimensions of a transmitting antenna are determined by which of the following factors?

1. Transmitted power
2. Transmitted frequency
3. Distance to the receiver
4. Antenna height above the ground

4-5. A device used to radiate or receive electromagnetic wave energy is referred to as a/an

1. feeder
2. antenna
3. transmitter
4. coupling device

4-6. An antenna that can be mounted to radiate rf energy either vertically or horizontally is classified as which of the following types?

1. Hertz
2. Marconi
3. Quarter-wave
4. Both 2 and 3 above

4-7. A complete antenna system consists of which of the following components?

1. A feeder, a coupling device, and a transmitter
2. A feeder line, a coupling device, and an antenna
3. An antenna, a transmission line, and a receiver
4. An impedance-matching device, a feeder, and a transmission line

4-8. What component in an antenna system transfers energy from the transmitter to the antenna?

1. A feeder
2. A delay line
3. A choke joint
4. A rotating joint

4-9. The type, size, and shape of an antenna are determined by which of the following factors?

1. Power output of the transmitter
2. Transmitter frequency
3. Direction to the receiver
4. Each of the above

4-10. Moving electric and magnetic fields in space have what (a) phase and (b) angular relationships?

1. (a) In phase
   (b) Perpendicular

2. (a) In phase
   (b) Displaced 45º
3. (a) Out of phase
   (b) Displaced 45º
4. (a) Out of phase
(b) Perpendicular

4-11. What is the length of each half of the wire for a dipole antenna?

1. Wavelength
2. 3/4 wavelength
3. 1/2 wavelength
4. 1/4 wavelength

4-12. On a dipole antenna, the sinusoidal variation in charge magnitude lags the sinusoidal variation in current by what amount?

1. 1 cycle
2. 1/2 cycle
3. 1/4 cycle
4. 1/8 cycle

4-13. On a standing wave, the points of high current and voltage are identified by which of the following terms?

1. Peaks
2. Nodes
3. Poles
4. Loops

4-14. The presence of standing waves indicates which of the following conditions of an antenna?

1. Resonance
2. Saturation
3. Nonresonance
4. Minimum efficiency

4-15. The antenna property that allows the same antenna to both transmit and receive energy is

1. gain
2. resonance
3. reciprocity
4. directivity

4-16. There is a ratio between the amount of energy propagated in certain directions by a directional antenna compared to the energy that would be propagated in these directions if the antenna were not directional. This ratio is known as which of the following antenna characteristics?

1. Gain
2. Directivity
3. Reciprocity
4. Polarization

4-17. The polarization plane of the radiation field is determined by which of the following fields?

1. Electric field only
2. Magnetic field only
3. Electromagnetic field

4-18. For best reception of a signal from a horizontally polarized antenna, the receiving antenna should be mounted so that it has what relationship with the transmitting antenna?

1. 0 degrees
2. 45 degrees
3. 90 degrees
4. 135 degrees

4-19. An electric field that rotates as it Travels through space exhibits what type of polarization?

1. Vertical
2. Spherical
3. Elliptical
4. Horizontal

4-20. For ground-wave transmissions, what

type of polarization is required?

1. Vertical
2. Spherical
3. Elliptical
4. Horizontal

4-21. For high-frequency operation, which of the following antenna polarization patterns is preferred?

1. Vertically polarized
2. Spherically polarized
3. Elliptically polarized
4. Horizontally polarized

4-22. Omnidirectional transmission is obtained from which of the following antennas?

1. Elliptically polarized
2. Horizontal half-wave
3. Vertical half-wave
4. Each of the above

4-23. With an antenna height of 40 feet and a transmitter frequency of 90 megahertz, which of the following antenna radiation patterns is best for transmitting over bodies of water?

1. Vertically polarized
2. Spherically polarized
3. Elliptically polarized
4. Horizontally polarized

4-24. To select a desired signal and discriminate against interfering signals from strong vhf and uhf broadcast transmissions, which of the following actions should you take?

1. Increase receiver gain
2. Make the transmitting antenna bidirectional
3. Use a vertically polarized receiving antenna
4. Use narrowly directional arrays as receiving antennas

4-25. A vertically mounted transmission line is LEAST affected by which of the following antenna radiation patterns?

1. Vertically polarized
2. Spherically polarized
3. Horizontally polarized
4. Elliptically polarized

4-26. An antenna with which of the following radiation resistance values will exhibit reduced efficiency?

1. 39 ohms
2. 82 ohms
3. 107 ohms
4. 150 ohms

4-27. An isotropic radiator radiates energy in which of the following patterns?

1. Vertical
2. Bi-directional
3. Unidirectional
4. Omnidirectional

4-28. An ordinary flashlight is an example of what type of radiator?

1. Isotropic
2. Polarized
3. Anisotropic
4. Stroboscopic

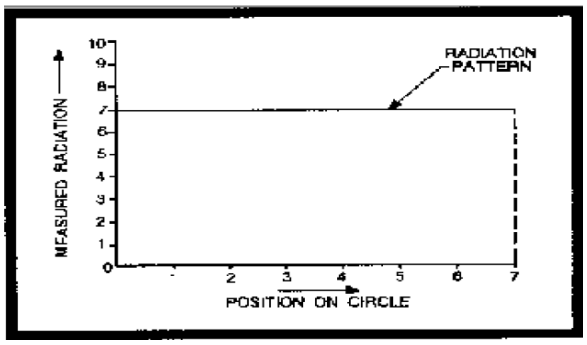


Figure 4-A.—Rectangular-coordinate graph.

IN ANSWERING QUESTION 4-29, REFER TO FIGURE 4-A.

4-29. How many points on the graph can represent the value of 7 radiation units at position 2 of the circle?

1. One
2. Two
3. Three
4. Four

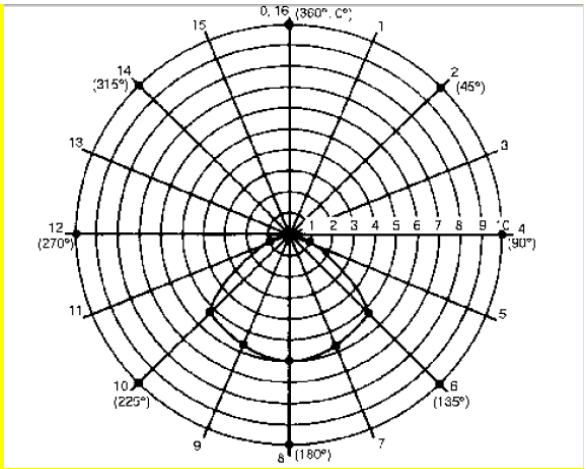


Figure 4-B.—Polar-coordinate graph.

IN ANSWERING QUESTIONS 4-30 AND 4-31, REFER TO FIGURE 4-B.

4-30. Compared with the rectangular coordinate graph, the polar-coordinate graph has the advantage of showing which of the following antenna characteristics?

1. Polarization
2. Radiation pattern
3. Phase relationship
4. Gain versus directivity

4-31. The area enclosed by the radiation pattern is the

1. lobe
2. null
3. axis
4. coordinate

4-32. Inserting an inductor or capacitor in series with an antenna is one method of electrically changing the electrical length of an antenna. What is this method called?

1. Loading
2. Inserting
3. Unloading
4. Decoupling

4-33. Many complex antennas are constructed from what basic antenna?

1. The Marconi antenna
2. The full-wave antenna
3. The half-wave antenna
4. The quarter-wave antenna

4-34. On an energized half-wave antenna, which of the following electrical conditions exist?

1. Voltage is maximum at the ends
2. Voltage is minimum at the ends
3. Current is maximum at the ends
4. Impedance is minimum at the center

4-35. Which of the following radiation patterns is/are exhibited by a simple vertical doublet antenna?

1. Nondirectional in the horizontal plane
2. Directional in the vertical plane

3. Both 1 and 2 above
4. Spherical in all planes

4-36. A method of feeding energy to a halfwave antenna is to connect one end through a capacitor to the output stage. What is this method of feeding called?

1. End feed
2. Voltage feed
3. Both 1 and 2 above
4. Current feed

4-37. An antenna supplied by the center-feed method is fed at what point?

1. Low voltage and low current
2. Low voltage and high current
3. High voltage and low current
4. High voltage and high current

4-38. The basic Marconi antenna has which of the following characteristics?

1. One-quarter wavelength and ungrounded
2. One-half wavelength and grounded at one end
3. One-half wavelength and insulated from ground
4. One-quarter wavelength and grounded at one end

4-39. The Marconi antenna behaves as a dipole for which of the following reasons?

1. It is fed at one end
2. An image antenna is formed by reflections from the ground
3. A quarter-wavelength of conductor is buried in the ground and forms the rest of the dipole
4. The applied signal is rectified so that only half the signal will appear on the quarter-wave antenna

4-40. A series of conductors arranged in a radial pattern and buried in the ground beneath the antenna is referred to as a

1. ground spur
2. counterpoise
3. ground screen
4. ground reflector

4-41. A folded dipole can be used instead of a simple, center-fed dipole for which of the following purposes?
1. Matching voltage
2. Matching impedance
3. Increasing directivity
4. Decreasing directivity

4-42. An antenna arrangement that has elements aligned in a straight line is referred to as what type array?

1. Isotropic
2. Collinear
3. Line-of-sight
4. Unidirectional

4-43. To have current in two adjoining collinear half-wave elements in proper phase, they must be connected by which of the following stubs?

1. A shorted half-wave stub
2. An open quarter-wave stub
3. A shorted eighth-wave stub
4. A shorted quarter-wave stub

4-44. To select a desired signal and discriminate against interfering signals, the receiving antenna should have which of the following characteristics?

1. Be omnidirectional
2. Be highly directional
3. Be vertically polarized
4. Be horizontally polarized

4-45. Adding more elements to a collinear antenna array produces which of the following effects?

1. Increased gain
2. Decreased gain
3. Decreased directivity
4. Mismatched impedances

4-46. What is the maximum number of elements ordinarily used in a collinear array?

1. One
2. Two
3. Three
4. Four

4-47. Constructing a collinear array with elements longer than 1/2 wavelength has which of the following effects on antenna characteristics?

1. Increased gain
2. Decreased gain
3. Increased frequency range
4. Decreased frequency range

4-48. In a two-element collinear array, maximum gain is obtained when the center-to-center spacing between the ends of the elements is approximately what electrical distance?

1. Wavelength
2. 0.15 wavelength
3. 0.5 wavelength
4. 0.75 wavelength

4-49. Compared with collinear arrays, broadside arrays have which of the following advantages?

1. Sharper tuning
2. Broader bandwidth
3. Broader frequency response
4. Less coupling between dipole

4-50. Optimum gain is obtained from a broadside array when the spacing of its elements is which of the following distances?

1. One-half wavelength
2. One-quarter wavelength
3. Greater than one-half wavelength
4. Slightly less than one-quarter

4-51. An end-fire array physically resembles the collinear array except that it is more compact. What disadvantage does the endfire array possess?

1. It has lower gain
2. It has low radiation resistance
3. It has loose coupling
4. Each of the above

4-52. What is the range of electrical spacing between the elements of an end-fire array?

1. 3/4 to 1 wavelength
2. 1/2 to 3/4 wavelength
3. 1/4 to 1/2 wavelength
4. 1/8 to 1/4 wavelength

4-53. The end-fire array produces what type of lobes, if any, along the axis of the array?

1. Minor lobes
2. Major lobes
3. None

4-54. Assuming that the elements are correctly spaced, the directivity of an end-fire array may be increased by which of the following actions?

1. Increasing the frequency
2. Decreasing the frequency
3. Decreasing the number of elements
4. Increasing the number of elements

4-55. A unidirectional pattern can be obtained from an end-fire array by using what phase relationship between the energy fed to adjacent elements?

1. 0º
2. 45º
3. 90º
4. 180º

4-56. Energy is fed to a parasitic element using what method?

1. Direct coupling
2. Inductive coupling
3. Capacitive coupling
4. Transmission-line coupling

4-57. The directivity pattern resulting from the action of parasitic elements depends on which of the following element characteristics?

1. Length of the element
2. Diameter of the element
3. Spacing between parasitic and driven elements
4. Each of the above

4-58. The advantages of unidirectivity and increased gain can best be obtained by using which of the following elements in a parasitic array?

1. Driven elements only
2. Reflector and director elements only
3. Reflector, director, and driven elements
4. Driven and director elements only

4-59. The ratio of energy radiated by an array in the principal direction of radiation to the energy radiated in the opposite direction describes which of the following relationships?

1. Side-to-side ratio
2. Front-to-back ratio
3. Driven-to-parasitic ratio
4. Reflector-to-director ratio

4-60. The Yagi antenna is an example of what type of antenna array?

1. Driven
2. End-fire
3. Multielement parasitic
4. Single-element parasitic

4-61. The addition of parasitic elements to the Yagi antenna has which of the following effects on antenna characteristics?

1. Increased gain
2. Narrower beam width
3. Narrower frequency response
4. Each of the above

4-62. An antenna which is designed especially for vertically-polarized ground waves at low frequencies is the

1. Yagi antenna
2. Marconi antenna
3. Beverage antenna
4. V antenna

4-63. What is the phase relationship of the signals that feed the V antenna?

1. 0º
2. 45º
3. 90º
4. 180º

4-64. A rhombic antenna is essentially a combination of which of the following antennas?

1. Two stacked long-wire radiators
2. Two V antennas placed side by side
3. Two collinear arrays in parallel
4. Four parallel half-wave radiators

4-65. A rhombic antenna has which of the following advantages?

1. Simple construction
2. Wide frequency range
3. Noncritical adjustment
4. Each of the above

4-66. The principal disadvantage of the rhombic antenna is its

1. poor directivity
2. large antenna site
3. low antenna voltage
4. high-frequency inefficiency

4-67. The unidirectional radiation pattern of the rhombic antenna is caused by which of the following antenna characteristics?

1. Size
2. Shape
3. Termination resistance
4. Frequency of the input energy

4-68. Horizontal half-wave antennas mounted at right angles to each other in the same horizontal plane make up which of the following antennas?

1. Rhombic
2. Flat-top
3. Turnstile
4. Ground-plane

4-69. The most common means of obtaining a low-radiation angle from a vertical quarter-wave antenna is by what procedure?

1. Decreasing power
2. Increasing frequency
3. Adding a ground plane
4. Rotating the antenna to a horizontal plane

4-70. A corner reflector antenna is used for which of the following purposes?

1. To decrease frequency range
2. To increase frequency range
3. To produce a unidirectional pattern
4. To produce an omnidirectional pattern

4-71. If a corner-reflector antenna is horizontally polarized, its radiation pattern will take on what shape?

1. A narrow beam in the horizontal plane
2. A narrow beam in the vertical plane
3. A beam similar to a half-wave dipole in the horizontal plane
4. A beam similar to a half-wave dipole with a reflector in the vertical plane

4-72. When radio or radar antennas are energized by transmitters, you must not go aloft until which of the following requirements are met?

1. A safety harness has been issued to you
2. All transmitters are secured and tagged
3. A working aloft "chit" has been filled out and signed by proper authority
4. Each of the above

MODULE 11

MICROWAVE PRINCIPLES

PREPARED BY:

Leoed Salvador and John Ryan Demata

Module 11

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Waveguide Theory and Applications,"

1-1. The portion of the electromagnetic spectrum which falls between 1,000 and 100,000 megahertz is referred to as which of the following regions?
1. X-ray
2. Infrared
3. Microwave
4. Ultra-violet

1-2. Microwave theory is based on the action of which of the following fields?
1. Electric field only
2. Magnetic field only
3. Electromagnetic field

1-2. Coaxial lines are more efficient than two-wire lines at microwave frequencies for which of the following reasons?
1. Because electromagnetic fields are completely confined in coaxial lines
2. Because electromagnetic fields are not completely confined in coaxial lines
3. Because coaxial lines have less resistance to current flow than two-wire transmission lines
4. Each of the above

1-4. The most efficient transfer of electromagnetic energy can be provided by which of the following mediums?
1. Waveguides
2. Twin-lead flat lines
3. Single-conductor lines
4. Coaxial transmission lines

1-5. Copper (I2R) losses are reduced by what physical property of waveguides?
1. Small surface area
2. Large surface area
3. Shape of the waveguide
4. Waveguide material used

1-6. In a coaxial line, the current-carrying area of the inner conductor is restricted to a small surface layer because of which of the following properties?
1. Skin effect
2. Copper loss
3. Conductor density
4. Temperature effect

1-7. Which of the following dielectrics is used in waveguides?
1. Air
2. Mica
3. Insulating oil
4. Insulating foam

1-8. Which of the following characteristics of a waveguide causes the lower-frequency limitation?
1. I2R loss
2. Physical size
3. Wall thickness
4. Dielectric loss

1-9. At very high frequencies, ordinary insulators in a two-wire transmission line display the characteristics of what electrical component?
1. An inductor
2. A resistor
3. A capacitor
4. A transformer

1-10. At very high frequencies, which of the following devices works best as an insulator?
1. Open half-wave section
2. Open quarter-wave section
3. Shorted half-wave section
4. Shorted quarter-wave section

1-11. The range of operating frequencies is determined by which of the following wave-guide dimensions?

1. The widest
2. The longest
3. The shortest
4. The narrowest

1-12. If frequency is decreased, what change, if any, will be required in the dimensions of the wave-guide bus bar?
1. Decrease in dimensions
2. Increase in dimensions
3. None

1-13. The cutoff frequency for a wave-guide is controlled by the physical dimensions of the wave-guide and is defined as the frequency at which two quarter wavelengths are
1. shorter than the "a" dimension
2. shorter than the "b" dimension
3. longer than the "b" dimension
4. longer than the "a" dimension

1-14. In practical applications, which of the following dimensions describes the wide dimension of the wave-guide at the operating frequency?
1. 0.1 wavelength
2. 0.2 wavelength
3. 0.5 wavelength
4. 0.7 wavelength

1-15. Which of the following fields is/are present in wave guides?
1. E field only
2. H field only
3. E and H fields *
4. Stationary field

1-16. A difference in potential across a dielectric causes which of the following fields to develop?
1. Electric field only
2. Magnetic field only
3. Electromagnetic field

Figure 1A.—Electric field.
IN ANSWERING QUESTION 1-17, REFER TO FIGURE 1A.

1-17. What information is indicated by the number of arrows between the plates of the capacitor?
1. The amount of capacitance
2. The amount of current flow
3. The strength of the electric field
4. The strength of the magnetic field

1-18. H lines have which of the following distinctive characteristics?
1. They are continuous straight lines
2. They are generated by voltage
3. They form closed loops*
4. They form only in the wave-guide

1-19. What minimum number of boundary conditions must be satisfied for energy to travel down a waveguide?
1. One
2. Two
3. Three
4. Four

1-20. For an electric field to exist at the surface of a conductor, the field must have what angular relationship to the conductor?
1. 0 degrees
2. 30 degrees
3. 45 degrees
4. 90 degrees /perpendicular

1-21. What, if anything, happens to the amplitude of the wavefronts within a waveguide that DO NOT meet boundary conditions?
1. They Increase rapidly to maximum
2. They decrease slowly to the halfpower point
3. They decrease rapidly to zero
4. Nothing

1-22. If the wall of a wave-guide is perfectly flat, the angle of reflection is equal to which of the following angles?
1. Angle of cutoff
2. Angle of incidence

3. Angle of refraction
4. Angle of penetration

1-23. THIS QUESTION HAS BEEN DELETED.

1-24. How does the group velocity of an electromagnetic field in a waveguide compare to the velocity of a wavefront through free space?
1. Group velocity is faster
2. Group velocity is slower
3. Their velocities are the same

1-25. The group velocity of a wavefront in a waveguide may be increased by which of the following actions?
1. Decreasing the frequency of the input energy
2. Increasing the frequency of the input energy
3. Increasing the power of the input energy
4. Decreasing the power of the input energy

1-26. The various field configurations that can exist in a waveguide are referred to as
1. wavefronts
2. modes of operation
3. fields of operation
4. fields of distribution

1-27. The most efficient transfer of energy occurs in a waveguide in the what mode?
1. Sine
2. Dominant
3. Transverse
4. Time-phase

1-28. How is the cutoff wavelength for a circular waveguide figured?
1. 1.17 times the radius of the waveguide
2. 1.17 times the diameter of the waveguide
3. 1.71 times the diameter of the waveguide
4. 1.71 times the radius of the Waveguide

1-29. The field configuration in waveguides is divided into what two categories?
1. Half-sine and dominant
2. Transverse electric and transverse magnetic
3. Transverse electric and dominant
4. Transverse magnetic and half-sine

1-30. With a mode description of TE1, 0, what maximum number of half-wave patterns exist across the "a" dimension of a waveguide?
1. One
2. Two
3. Three
4. Four

1-31. With the mode description, TE1, 1, what maximum number of half-wave patterns exist across the diameter of a circular waveguide?
1. One
2. Two
3. Three
4. Four

1-32. To inject or remove energy from a waveguide, which of the following devices could you use?
1. Slot
2. Loop
3. Probe
4. Each of the above

1-33. Loose coupling is a method used to reduce the amount of energy being transferred from a waveguide. How is loose coupling achieved when using a probe?
1. By doubling the size of the probe
2. By increasing the length of the probe
3. By decreasing the length of the probe

4. By placing the probe directly in the center of energy field

1-34. Loop coupling is most efficient when the loop is placed at what point in which of the following fields?
1. At the point of maximum electric field
2. At the point of minimum electric field
3. At the point of minimum magnetic field
4. At the point of maximum magnetic field

1-35. Increasing the size of the loop wire increases which of the following loop capabilities?
1. Efficiency
2. Bandwidth coverage
3. Power-handling capability
4. Each of the above

1-36. A waveguide which is not perfectly impedance matched to its load is not efficient. Which of the following conditions in a waveguide causes this inefficiency?
1. Sine waves
2. Dominant waves
3. Standing waves
4. Transverse waves

IN ANSWERING QUESTION 1-37, REFER TO FIGURE 1B.

1-37. The iris shown in the figure has what type of equivalent circuit?
1. Parallel-LC
2. Shunt-resistive
3. Shunt-inductive
4. Shunt-capacitive

1-38. A waveguide iris that covers part of both the electric and magnetic planes acts as what type of equivalent circuit at the resonant frequency?
1. As a shunt inductive reactance
2. As a shunt resistance
3. As a shunt capacitive reactance
4. Each of the above

1-39. A horn can be used as a waveguide termination device because it provides which of the following electrical functions?
1. A reflective load
2. An absorptive load
3. An abrupt change in impedance
4. A gradual change in impedance

1-40. For a waveguide to be terminated with a resistive load, that load must be matched to which of the following properties of the waveguide?
1. The bandwidth
2. The frequency
3. The inductance
4. The characteristic impedance

1-41. A resistive device with the sole purpose of absorbing all the energy in a waveguide without causing reflections is a/an
1. iris
2. horn
3. antenna
4. dummy load

1-42. A resistive load most often dissipates energy in which of the following forms?
1. Heat
2. Light
3. Magnetic
4. Electrical

1-43. Reflections will be caused by an abrupt change in which of the following waveguide physical characteristics?
1. Size
2. Shape
3. Dielectric material
4. Each of the above

1-44. A waveguide bend which is in the E or H plane must be greater than two wavelengths to prevent

1. cracking
2. reflections
3. energy gaps
4. electrolysis

1-45. A flexible waveguide is used in short sections because of the power-loss disadvantages. What is the cause of this power loss?
1. Walls are not smooth
2. E and H fields are not perpendicular
3. Cannot be terminated in its characteristics impedance
4. Wall size cannot be kept consistent

1-46. The choke joint is used for what purpose in a waveguide?
1. To reduce standing waves
2. To restrict the volume of electron flow
3. To prevent the field from rotating
4. To provide a temporary joint in a waveguide during maintenance or repair

1-47. A circular waveguide is normally used in a rotating joint because rotating a rectangular waveguide would cause which of the following unwanted conditions?
1. Oscillation
2. Large power loss
3. Decrease in bandwidth
4. Field-pattern distortion

1-48. In your waveguide inspections, you should be alert for which of the following problems?
1. Corrosion
2. Damaged surface
3. Improperly sealed joints
4. Each of the above

1-49. What type of corrosion occurs when dissimilar metals are in contact?
1. Contact corrosion
2. Metallic corrosion
3. Electrical corrosion
4. Electrolytic corrosion

1-50. Internal arcing in a waveguide is usually a symptom of which of the following conditions?
1. Change in mode
2. Electrolysis at a joint
3. Moisture in the waveguide
4. Gradual change in frequency

1-51. What is the primary purpose of a directional coupler?
1. To sample the energy in a waveguide
2. To change the phase of the energy in the waveguide
3. To change the direction of energy travel in the waveguide
4. To allow energy in the waveguide to travel in one direction only

1-52. What is the electrical distance between the two holes in a simple directional coupler?
1. 1/8 wavelength
2. 1/4 wavelength
3. 1/2 wavelength
4. 3/4 wavelength

1-53. When the two portions of a reflected wave reach the pickup probe of an incident-wave directional coupler, what is their phase relationship?
1. 45º out of phase
2. 90º out of phase
3. 120º out of phase
4. 180º out of phase

1-54. The highest frequency at which a conventional circuit can oscillate is reached when which of the following values can be reduced no further?
1. Total resistance
2. Total inductance only
3. Total capacitance only
4. The total capacitance and inductance

1-55. For a device to be considered a resonant cavity, it must fulfill which of the following requirements?
1. Be enclosed by conducting walls
2. Possess resonant properties
3. Contain oscillating electromagnetic fields
4. All of the above

1-56. What property gives a resonant cavity a narrow bandpass and allows very accurate tuning?
1. Low Q
2. High Q
3. Inductive reactance
4. Capacitive reactance

1-57. What factor(s) determines the primary frequency of a resonant cavity?
1. Size only
2. Shape only
3. Size and shape
4. Q of the cavity

1-58. Tuning is the process of changing what property of a resonant cavity?
1. The Q
2. The power output
3. The cutoff frequency
4. The resonant frequency

1-59. An adjustable slug or screw placed in the area of maximum E lines in a resonant cavity provides what type of tuning?
1. Volume
2. Inductive
3. Resistive
4. Capacitive

1-60. What are the two basic types of waveguide T junctions?
1. H-type and T-type
2. H-type and E-type
3. H-type and magic T
4. E-type and magic T

1-61. A waveguide junction in which the arm area extends from the main waveguide in the same direction as the electric field is an example of what type junction?
1. E-type magic T
2. H-type magic T
3. H-type T junction
4. E-type T junction

Figure 1C.—H-type T junction.

IN ANSWERING QUESTION 1-62, REFER TO FIGURE 1C.

1-62. When an input is fed into the "b" arm in the figure, which of the following output signal arrangements is/are available?
1. Out-of-phase signals from arms "a" and "c"
2. In-phase signals from arms "a" and "c"
3. An output from the "a" arm only
4. An output from the "c" arm only

1-63. E-type and H-type junctions are combined in which of the following devices?
1. Magic T
2. Rat race
3. Feed horn
4. Hybrid ring

1-64. Low power-handling capabilities and internal power losses are the primary disadvantages of which of the following devices?
1. Magic T
2. Rat race
3. Duplexer
4. Hybrid ring

1-65. The hybrid ring is usually used as what type of device in radar systems?
1. Mixer
2. Detector
3. Duplexer

4. Impedance matcher

1-66. Ferrite devices are useful in electronic and microwave applications because they possess magnetic properties and offer which of the following other properties?
1. Negative resistance to current flow
2. Low resistance to current flow
3. High resistance to current flow
4. High conductance for current flow

1-67. Electrons exhibit which of the following types of motion?
1. Spin
2. Orbital
3. Both 1 and 2 above
4. Linear

1-68. Electrons in a ferrite can be caused to wobble on their axes by which of the following actions?
1. Decreasing the internal resistance
2. Increasing the internal resistance
3. Applying a magnetic field
4. Applying an electric field

1-69. The energy in a ferrite attenuator that is attenuated is dissipated as which of the following energy forms?
1. Heat
2. Light
3. Magnetic
4. Electrical

1-70. The amount of rotation in a Faraday rotation type ferrite phase shifter is dependent upon which of the following ferrite properties?
1. Length of the material
2. Diameter of the material
3. Strength of the material
4. Internal resistance of the material

Textbook assignment: Chapter 2, "Microwave Principles," pages 2-1 through 2-66. Chapter 3, "Microwave Antennas," pages 3-1 through 3-20.

2-1. As the frequency in a conventional vacuum tube is increased, what is the effect on the capacitive reactance of the tube?
1. It increases
2. It decreases
3. It remains the same

2-2. Undesirable degenerative feedback in conventional vacuum tubes can be caused by which of the following tube factors?
1. Grid bias
2. Transit time
3. Plate voltage
4. Lead inductance

2-3. A decrease in efficiency in a conventional vacuum tube caused by a phase shift between plate current and grid voltage can be the result of excessive
1. transit time
2. lead inductance
3. capacitive reactance
4. interelectrode capacitance

2-4. Moving tube electrodes further apart to decrease interelectrode capacitance causes which of the following tube characteristics to increase?
1. Transit time
2. Lead inductance
3. Inductive reactance
4. Capacitive reactance

2-5. Which of the following properties of an electron is directly proportional to its velocity?
1. Mass
2. Kinetic energy
3. Potential energy
4. All of the above

2-6. An electron that enters an electrostatic field and travels in the same direction as the lines of force will react in what way?
1. It will accelerate
2. It will decelerate
3. It will spin faster
4. It will spin slower

2-7. The alternate speeding up and slowing down of electrons in a beam that produces electron bunches is known as which of the following modulation terms?
1. Carrier modulation
2. Velocity modulation
3. Amplitude modulation
4. Frequency modulation

2-8. How is an electron affected, if at all, if it enters the buncher-grid gap when the potential across the grids is positive?
1. It is deflected
2. It is accelerated
3. It is decelerated

2-9. The point in a stream of electron bunches at which the catcher cavity will most efficiently remove power is determined by which of the following factors?
1. Electron spin velocity
2. The size of the cavity
3. The size of the bunches
4. Frequency of the buncher-grid signal

2-10. Which of the following electronic interactions is used in klystron operation?
1. Velocity-modulation
2. Voltage and current
3. Variable-capacitance
4. Crossed electromagnetic-field

2-11. In a klystron, an ac potential is superimposed on the dc voltage that is

applied to the buncher grids by what component?
1. The cathode
2. The accelerator grid
3. The buncher-grid cavity resonator
4. The catcher-grid cavity resonator

2-12. A two-cavity klystron that has a feedback path from the catcher cavity to the buncher cavity will operate as what type of circuit?
1. Modulator
2. Amplifier
3. Oscillator
4. Discriminator

2-13. The input signal to a two-cavity klystron amplifier is applied to which of the following components?
1. The cathode
2. The catcher grids
3. The buncher grids
4. The accelerator grid

2-14. In a klystron, the placement of additional cavities between the buncher cavity and catcher cavity increases the power output by causing which of the following electronic actions?
1. Increased velocity modulation
2. Decreased velocity modulation
3. Increased electron-beam speed
4. Decreased electron-beam speed

2-15. What is the purpose of applying a large negative pulse to the cathode of a threecavity klystron?
1. To focus the electron beam
2. To accelerate the electron beam
3. To decelerate the electron beam
4. To modulate the electron beam

2-16. In a three-cavity klystron, what cavity, if any, contributes most to the velocity modulation of the electron beam?
1. The middle cavity
2. The catcher cavity
3. The buncher cavity
4. None

2-17. The bandwidth of a multicavity klystron can be increased by using which of the following tuning methods?
1. Varactor tuning
2. Staggered tuning
3. Electronic tuning
4. Synchronous tuning

2-18. The repeller of a reflex klystron replaces what component in other types of klystrons?
1. The input cavity
2. The output cavity
3. The buncher cavity
4. The intermediate cavity

2-19. In a reflex klystron, what type(s) of electrical charge, if any, does the repeller have?
1. Positive only
2. Negative only
3. Alternately positive and negative
4. None

2-20. In a reflex klystron, the length of time a constant speed electron remains in the space separating the grid and repeller is determined by which of the following factor(s)?
1. Repeller voltage
2. Electron velocity
3. Both 1 and 2 above
4. The distance between grid and Repeller

2-21. A reflex klystron in which the constantspeed
electrons remain in the repeller field for 3/4 cycle is operating in what mode?
1. Mode 1
2. Mode 2
3. Mode 3
4. Mode 4

2-22. In a reflex klystron, the choice of operating mode is determined by which of the following circuit factors?
1. The voltage required
2. The power available
3. The frequency range available
4. Both 2 and 3 above

2-23. In the higher modes, power and amplitude limitations in a reflex klystron are caused by which of the following actions?
1. Electron debunching
2. Frequency fluctuation
3. Decreasing transit time
4. Increasing electron density

2-24. The term "bel" is a unit of measurement that expresses which of the following relationships?
1. Ratio of voltage and resistance
2. Logarithmic ratio between input and output
3. Geometric progression from input to output
4. Ratio of voltage to current

2-25. The term "dBm" is based on what standard reference level?
1. 1 watt
2. 1 volt
3. 1 milliwatt
4. 1 millivolt

2-26. Which of the following twt characteristics makes it ideal for use as an rf amplifier?
1. High-noise and narrow-bandwidth
2. Low-noise and wide-bandwidth
3. High-noise and wide-bandwidth
4. Low-noise and narrow-bandwidth

2-27. In a twt, what is the primary purpose of the helix?
1. To increase the forward velocity of the input
2. To decrease the forward velocity of the input
3. To decrease the reflected velocity of the output
4. To increase the reflected velocity of the output

2-28. Velocity modulation of the electron beam in a twt is achieved by what action?
1. By the action of resonant cavities
2. By interaction of the electron beam with the permanent magnet field
3. By interaction of the electron beam with the electric field in the helix
4. All of the above

2-29. In a twt, what is the purpose of the attenuators along the helix?
1. To focus the beam
2. To limit the input
3. To limit the output
4. To prevent reflections

2-30. A microwave tube that extracts energy from a wave that travels from the collector toward the cathode is referred to as the
1. klystron
2. traveling-wave tube
3. crossed-field amplifier
4. backward-wave oscillator

2-31. In a magnetron, the magnetic field between the plate and cathode serves what purpose?
1. Acts as a grid
2. Provides a plate load
3. Acts as a space-charge suppressor

4. Provides filament power

2-32. What property in a magnetron is controlled by the cavities in the plate?
1. Input power
2. Output power
3. Input voltage
4. Output frequency

2-33. In a magnetron, what causes the path of an electron to curve when it is moving from the cathode to the plate?
1. The cathode pulse
2. The electric field
3. The resonant cavities
4. The permanent magnetic field

2-34. The critical value of magnetic field strength in a magnetron causes which of the following electronic actions?
1. Plate cavities stop oscillating
2. Output power decreases to zero
3. Electrons strike the plate and return to the cathode
4. Electrons miss the plate and return to the cathode

2-35. Magnetron oscillators are divided into what total number of classes?
1. One
2. Two
3. Three
4. Four

2-36. THIS QUESTION HAS BEEN DELETED.

2-37. In a negative-resistance magnetron, which, if any, of the following values of magnetic field strengths is required to start oscillations?
1. Critical value
2. Slightly lower than critical value
3. Slightly higher than critical value
4. None of the above

2-38. In magnetrons, the effect of filament bombardment can be reduced by which of the following actions?
1. Increasing plate voltage
2. Reducing filament voltage
3. Reducing signal frequency
4. Increasing signal frequency

2-39. In electron-resonance magnetrons, which of the following anode blocks is/are used?
1. Vane anode
2. Rising-sun anode
3. Hole-and-slot anode
4. Each of the above

2-40. In the electron-resonance magnetron, the total electric field is produced by which of the following field combinations?
1. The dc field only
2. The ac and dc fields
3. The ac and magnetic fields
4. The dc and magnetic fields

2-41. Energy from working electrons is received by which of the following magnetron fields?
1. The ac field only
2. The dc field only
3. Both the ac and dc fields
4. The magnetic field

2-42. In a magnetron, the total action of many electrons returning to the cathode while others are moving toward the anode forms which of the following patterns?
1. Vertical wavefront
2. Space-charge wheel
3. Spherical wavefront
4. Horizontal space charge

2-43. The greatest power output is produced in what magnetron mode of operation?
1. Mode 1
2. Mode 2
3. The pi mode
4. The radian mode

2-44. Magnetic lines of force passing between cavities are intercepted in which, if any, of the following magnetron coupling methods?
1. Slot coupling method
2. Strap-fed loop method
3. Segment-fed loop method
4. None of the above

2-45. Inductive tuning in a magnetron is accomplished by which of the following actions?
1. Changing the cavity resistance
2. Altering the cavity surface-to-volume ratio
3. Decreasing the size of the slot gap
4. Decreasing the space charge

2-46. A magnetron should be "baked in" under which of the following conditions?
1. Before each use
2. After periods of idleness
3. After initial installation
4. Both 2 and 3 above

2-47. The crossed-field amplifier produces which of the following desirable circuit characteristics?
1. Wide bandwidth
2. High efficiency
3. Large power-handling capability
4. All of the above

2-48. The tunneling action of the tunnel diode produces which of the following useful properties?
1. Long transit time
2. Positive resistance
3. Negative resistance
4. Variable inductance

2-49. The tuned circuit in a tunnel-diode oscillator determines which of the following circuit values?
1. Frequency
2. Resistance
3. Power range
4. Capacitance

2-50. Tuning a tunnel-diode oscillator by changing the capacitance of the tuned circuit can be accomplished by which of the following tuning methods?
1. Bias tuning
2. Slot tuning
3. Current tuning
4. Varactor tuning

2-51. In the reflection-type, circulator-coupled tunnel-diode amplifier, what component prevents feedback to the tuned input circuit?
1. The circulator
2. The output loop
3. The tuned cavity
4. The tunnel diode

2-52. Stability is a problem in which, if any, of the following tunnel-diode frequency converters?
1. High-gain converter
2. Unity-gain converter
3. Conversion-loss converter
4. None of the above

2-53. The varactor is a type of pn junction that acts as which of the following types of electronic devices?
1. Fixed resistor
2. Fixed capacitor
3. Variable resistor
4. Variable capacitor

2-54. What is the most important feature of the parametric amplifier?
1. Low noise

2. High gain
3. Power output
4. Frequency range

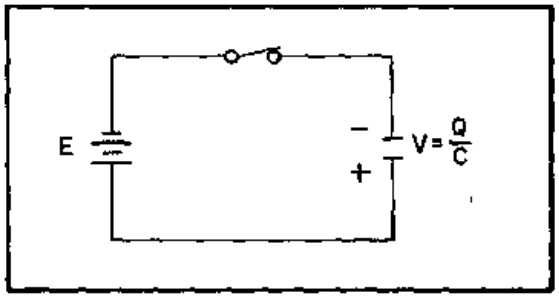


Figure 2A.—Voltage amplification circuit.

IN ANSWERING QUESTION 2-55, REFER TO FIGURE 2A.

2-55. How is amplification accomplished in the circuit?
1. By opening the switch
2. By varying the frequency
3. By varying the resistance
4. By varying the capacitance

2-56. In a nondegenerative parametric amplifier, how does the pump frequency compare to the input signal frequency?
1. The pump frequency is half the input signal frequency
2. The pump frequency is double the input signal frequency
3. The pump frequency is more than double the input signal
4. The pump frequency is equal to the input signal frequency

2-57. In a nondegenerative parametric amplifier with a pump frequency of 12 gigahertz and an idler frequency of 9 gigahertz, what is the input signal frequency?
1. 3 gigahertz
2. 18 gigahertz
3. 21 gigahertz
4. 108 gigahertz

2-58. Bulk-effect semiconductors have what primary advantage over normal pnjunction semiconductors?
1. Smaller size
2. Lower frequency
3. Simpler construction
4. Greater power output

2-59. Gallium-arsenide semiconductors begin to exhibit which of the following electrical characteristics at the threshold point?
1. Variable inductance
2. Positive resistance
3. Negative resistance
4. Variable capacitance

2-60. In an avalanche transit-time diode, what causes the dc bias energy previously absorbed by avalanche electrons to be given up to the microwave field?
1. The electron velocity
2. The negative-resistance property
3. The electron transit time
4. The amount of dc bias energy Available

2-61. In a point-contact diode, passing a large current from the catwhisker to the silicon crystal produces what region?
1. A domain region
2. A small p region
3. A small n region
4. An avalanche region

2-62. A Schottky barrier diode has which of the following advantages over a pointcontact diode?
1. Lower frequency range
2. Higher frequency range

3. Lower noise generation
4. Higher noise generation

2-63. The PIN diode begins acting as a variable resistance at what minimum frequency?
1. 100 megahertz
2. 200 megahertz
3. 300 megahertz
4. 400 megahertz

2-64. Power ratio is a term used to express what property of an antenna?
1. Efficiency
2. Reciprocity
3. Sensitivity
4. Power output

2-65. A standing-wave ratio (swr) describes which of the following quantities?
1. Transmission-to-reception efficiency value
2. The amount of output power
3. The amount of mismatch between a transmission line and its load
4. The amount of characteristic Impedance

2-66. Directivity refers to which of the following properties of a radiated beam?
1. Power gain
2. Standing-wave ratio
3. Narrowness of the beam
4. Polarization of the beam

2-67. Surface angular measurements for antenna directivity in radar and communications systems are made in relationship to which of the following references?
1. Vertical plane only
2. Horizontal plane only
3. Horizontal plane and true north
4. Vertical plane and true north

2-68. Radar range is determined as a function of which of the following measures?
1. Pulse travel time
2. Elevation angle of the antenna
3. Distance to the horizon
4. Angular velocity of the energy

2-69. The parabolic reflector is often used because it produces a radiation pattern with which of the following antenna characteristics?
1. Omnidirectional
2. Highly directive
3. Many equal lobes
4. Spherical wavefronts

2-70. In a lens antenna, what is the purpose of the collimating lens?
1. It produces spherical wavefronts
2. It produces an omnidirectional pattern
3. It forces parallel segments of the wavefront into spherical paths
4. It forces radial segments of the wavefront into parallel paths

2-71. A lens antenna which accelerates some portion of the wavefronts so that all wavefronts exit the lens at the same time is referred to as the
1. metallic delay lens
2. waveguide-type lens
3. loaded microwave lens
4. dielectric delay lens

2-72. In a delay-type lens, the amount of delay in the phase of the wave passing through the lens is determined by which of the following characteristics?
1. The dielectric constant of the lens
2. The characteristic impedance of the lens

3. The physical size of the lens
4. All of the above

2-73. What is/are the basic type(s) of antenna array(s) in common use?
1. Driven only
2. Parasitic only
3. Parasitic and driven

2-74. In a frequency-sensitive antenna, the physical length of the serpentine section and its relationship to the wavelength of the applied energy determines which of the following characteristics?
1. Output power
2. Beam narrowness
3. Antenna efficiency
4. Direction of the beam

2-75. In a horizontal-slot antenna, the polarization of the energy is radiated in what direction?
1. Vertical
2. Spherical
3. Horizontal
4. Omnidirectional

MODULE 12

RADIO FREQUENCY COMMUNICATIONS PRINCIPLES

PREPARED BY:

Cindy Villaflores and Don Ryan Villamayor

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Amplitude Modulation," pages 1-1 through 1-75.

1-1. The action of impressing intelligence upon a transmission medium is referred to as
1. modulating
2. demodulating
3. heterodyning
4. wave generating

1-2. You can communicate with others using which of the following transmissions mediums?
1. Light
2. Wire lines
3. Radio waves
4. Each of the above

1-3. When you use a vector to indicate force in a diagram, what do (a) length and (b) arrowhead position indicate?
1. (a) Magnitude (b) direction
2. (a) Magnitude (b) frequency
3. (a) Phase (b) frequency
4. (a) Phase (b) direction

1-4. Vectors are used to show which of the following characteristics of a sine wave?
1. Fidelity
2. Amplitude
3. Resonance
4. Distortion

1-5. A rotating coil in the uniform magnetic field between two magnets produces a sine wave. It is called a sine wave because the voltage depends on which of the following factors?
1. The number of turns in the coil
2. The speed at which the coil is rotating
3. The angular position of the coil in the magnetic field
4. Each of the above

1-6. The trigonometric relationship for the sine of an angle in a right triangle is figured using which of the following ratios?
1. Opposite side ÷ hypotenuse
2. Adjacent side ÷ hypotenuse
3. Hypotenuse ÷ opposite side
4. Hypotenuse ÷ adjacent side

1-7. The part of a sine wave that is above the voltage reference line is referred to as the
1. peak amplitude
2. positive alternation
3. negative alternation
4. instantaneous amplitude

1-8. The degree to which a cycle has been completed at any given instant is referred to as the
1. phase
2. period
3. frequency
4. amplitude

1-9. The frequency of the sine wave is determined by which of the following sine-wave factors?
1. The maximum voltage
2. The rate at which the vector rotates
3. The number of degrees of vector rotation
4. Each of the above

1-10. Which of the following mathematical relationships do you use to figure the period of a sine wave?
1.
3.
2.
4.

1-11. Which of the following Greek letters is the symbol for wavelength?
1. _
2. _
3. _
4. _

1-12. Which of the following waveform characteristics determines the wavelength of a sine wave?
1. Phase
2. Period
3. Amplitude
4. Phase Angle

1-13. An electromagnetic wavefront moves through free space at approximately what speed in meters per second?
1. 3,000,000
2. 30,000,000
3. 300,000,000
4. 3,000,000,000

1-14. What is the wavelength of a 1.5 MHz frequency?
1. 100 meters
2. 200 meters
3. 300 meters
4. 400 meters

1-15. As the frequency of a signal is increased, what change can be noted about its wavelength?
1. It decreases
2. It increases
3. It remains the same

1-16. The ability of a circuit to faithfully reproduce the input signal in the output is known by what term?
1. Fidelity
2. Fluctuation
3. Directivity
4. Discrimination

1-17. In rf communications, modulation impresses information on which of the following types of waves?
1. Carrier wave
2. Complex wave
3. Modulated wave
4. Modulating wave

1-18. Which of the following types of modulation is a form of amplitude modulation?
1. Angle
2. Phase
3. Frequency
4. Continuous-wave

1-19. With a sine-wave input, how will the output compare to the input in (a) a linear circuit and (b) a nonlinear circuit?
1. (a) Proportional
(b) proportional
2. (a) Proportional
(b) not proportional
3. (a) Not proportional
(b) not proportional
4. (a) Not proportional
(b) proportional

1-20. What effect, if any, does a nonlinear device have on a sine wave?
1. It amplifies without distortion
2. It attenuates without distortion
3. It generates harmonic frequencies
4. None

1-21. For the heterodyning action to occur in a circuit, (a) what number of frequencies must be present and (b) to what type of circuit must they be applied?
1. (a) Two (b) linear
2. (a) Two (b) nonlinear
3. (a) Three (b) nonlinear
4. (a) Three (b) linear

1-22. Spectrum analysis is used to view which of the following characteristics of an rf signal?
1. Phase
2. Bandwidth
3. Modulating wave
4. Modulation envelope

1-23. The method of rf communication that uses either the presence or absence of a carrier in a prearranged code is what type of modulation?
1. Pulse modulation
2. Amplitude modulation

3. Continuous-wave modulation
4. Pulse-time modulation

1-24. What is the purpose of the key in a cw transmitter?
1. It generates the rf oscillations
2. It heterodynes the rf oscillations
3. It controls the rf output
4. It amplifies the rf signal

1-25. To ensure frequency stability in a cw transmitter, you should NOT key what circuit?
1. The mixer
2. The detector
3. The oscillator
4. The rf amplifier

1-26. When keying a high-power transmitter, what component should you use to reduce the shock hazard?
1. A coil
2. A relay
3. A resistor
4. A capacitor

1-27. Interference detected by a receiver is often caused by the application and removal of power in nearby transmitters. This interference can be prevented by using what type of circuit in such transmitters?
1. Power filter
2. On-off filter
3. Key-click filter
4. Rf detector filter

1-28. Transmitter machine keying was developed for which of the following purposes?
1. To increase the speed of communications
2. To make communications more intelligible
3. To reduce interference
4. Each of the above

1-29. Which of the following advantages is a benefit of cw communications?
1. Wide bandwidth
2. Fast transmission
3. Long-range operation
4. Each of the above

1-30. To prevent a transmitter from being loaded unnecessarily, where should you connect the antenna?
1. At the oscillator input
2. At the oscillator output
3. At the power-amplifier input
4. At the power-amplifier output

1-31. Amplifier tubes are added to the output of a transmitter for which of the following reasons?
1. To increase power
2. To increase frequency
3. To increase stability
4. To increase selectivity

1-32. Which of the following combinations of frequency multiplier stages will produce a total multiplication factor of 72?
1. 36, 36
2. 4, 3, 3, 2
3. 4, 4, 3, 2
4. 18, 18, 18, 18

1-33. To change sound energy into electrical energy, which of the following devices should you use?
1. A speaker
2. A microphone
3. An amplifier
4. An oscillator

1-34. Which of the following is the schematic symbol for a microphone?
1.
3.
2.
4.

1-35. What component in a carbon microphone converts a dc voltage into a varying current?

1. Button
2. Diaphragm
3. Transformer
4. Carbon granules

1-36. The action of the double-button carbon microphone is similar to which of the following electronic circuits?
1. A limiter
2. An oscillator
3. A voltage doulber
4. A push-pull amlifier

1-37. A carbon microphone has which of the following advantages over other types of microphones?
1. Ruggedness
2. Sensitivity
3. Low output voltage
4. Frequency response

1-38. The voltage produced by mechanical stress placed on certain crystals is a result of which of the following effects?
1. Hall
2. Acoustic
3. Electrostatic
4. Piezoelectric

1-39. If you require a microphone that is lightweight, has high sensitivity, is rugged, requires no external voltage, can withstand temperature, vibration, and moisture extremes, and has a uniform frequency response of 40 to 15,000 hertz, which of the following types of microphones should you select?
1. Carbon
2. Crystal
3. Dynamic
4. Electrostatic

1-40. What component in a magnetic microphone causes the lines of flux to alternate?
1. The coil
2. The magnet
3. The diaphragm
4. The armature

1-41. What are the two major sections of an AM transmitter?
1. Audio frequency unit and radio frequency unit
2. Audio frequency unit and master oscillator
3. Audio frequency unit and final power amplifier
4. Audio frequency unit and intermediate power amplifier

1-42. The intermediate power amplifier serves what function in a transmitter?
1. It generates the carrier
2. It modulates the carrier
3. It increases the frequency of the signal
4. It increases the power level of the signal

1-43. The final audio stage in an AM transmitter is the
1. mixer
2. modulator
3. multipler
4. multiplexer

1-44. The vertical axis on a frequencyspectrum graph represents which of the following waveform characteristics?
1. Phase
2. Duration
3. Frequency
4. Amplitude

1-45. When a 500-hertz signal modulates a 1-megahertz carrier, the 1-megahertz carrier and what two other frequencies are transmitted?
1. 500 and 999,500 hertz
2. 500 and 1,000,500 hertz
3. 999,500 and 1,500,000 hertz
4. 999,500 and 1,000,500 hertz

1-46. If 750 hertz modulates a 100-kilohertz carrier, what would the upper-sideband

frequency be?
1. 99,250 hertz
2. 100,000 hertz
3. 100,500 hertz
4. 100,750 hertz

1-47. In an AM wave, where is the audio intelligence located?
1. In the carrier frequency
2. In the spacing between the sideband frequencies
3. In the spacing between the carrier and sideband frequencies
4. In the sideband frequencies

1-48. What determines the bandwidth of an AM wave?
1. The carrier frequency
2. The number of sideband frequencies
3. The lowest modulating frequency
4. The highest modulating frequency

1-49. If an 860-kilohertz AM signal is modulated by frequencies of 5 and 10 kilohertz, what is the bandwidth?
1. 5 kilohertz
2. 10 kilohertz
3. 15 kilohertz
4. 20 kilohertz

1-50. If a 1-megahertz signal is modulated by frequencies of 50 and 75 kilohertz, what is the resulting maximum frequency range?
1. 925,000 to 1,000,000 hertz
2. 925,000 to 1,075,000 hertz
3. 975,000 to 1,025,000 hertz
4. 1,000,000 to 1,075,000 hertz

1-51. If an rf carrier is 100 percent AMmodulated,
what will be the rf output
when the modulating signal is (a) at its negative peak and (b) at its positive peak?
1. (a) 0
(b) 2 times the amplitude of the unmodulated carrier
2. (a) 0
(b) 1/2 the amplitude of the unmodulated carrier
(a) 1/2 the amplitude of the unmodulated carrier
3.
(b) 1/2 the amplitude of the unmodulated carrier
(a) 1/2 the amplitude of the unmodulated carrier
4.
(b) 2 times the amplitude of the unmodulated carrier

1-52. In an AM signal that is 100 percent modulated, what maximum voltage value is present in each sideband?
1. 1/4 the carrier voltage
2. 1/2 the carrier voltage
3. 3/4 the carrier voltage
4. Same as the carrier voltage

1-53. Overmodulation of an AM signal will have which, if any, of the following effects on the bandwidth?
1. It will increase
2. It will decrease
3. It will remain the same

1-54. In a carrier wave with a peak amplitude of 400 volts and a peak modulating voltage of 100 volts, what is the modulation factor?
1. 0.15
2. 0.25
3. 0.45
4. 0.55

1-55. The percent of modulation for a modulated carrier wave is figured using which of the following formulas?
1.
3.
2.
4.

1-56. Modulation produced in the plate circuit of the last radio stage of a system is

known by what term?
1. Low-level modulation
2. High-level modulation
3. Final-amplifier modulation
4. Radio frequency modulation

1-57. Which, if any, of the following advantages is a primary benefit of plate modulation?
1. It operates at low efficiency
2. It operates at low power levels
3. It operates with high efficiency
4. None of the above

1-58. A final rf power amplifier biased for plate modulation operates in what class of operation?
1. A
2. B
3. AB
4. C

1-59. Heterodyning action in a plate modulator takes place in what circuit?
1. Grid
2. Plate
3. Screen
4. Cathode

1-60. A plate modulator produces a modulated rf output by controlling which of the following voltages?
1. Plate voltage
2. Cathode voltage
3. Grid-bias voltage
4. Grid-input voltage

1-61. To achieve 100-percent modulation in a plate modulator, what maximum voltage must the modulator tube be capable of providing to the final power amplifier (fpa)?
1. Twice the fpa plate voltage
2. The same as the fpa plate voltage
3. Three times the fpa plate voltage
4. Half the fpa plate voltage

1-62. In a plate modulator, with no modulation, how will the plate current of the final rf amplifier appear on a scope?
1. A series of pulses at the carrier frequency
2. A series of pulses at twice the carrier frequency
3. A series of pulses at 1/4 the carrier frequency
4. A series of pulses at 1/2 the carrier frequency

1-63. In the collector-injection modulator, af and rf are heterodyned by injecting the rf into (a) what circuit and the af into (b) what circuit?
1. (a) Base (b) collector
2. (a) Base (b) emitter
3. (a) Emitter (b) collector
4. (a) Emitter (b) base

1-64. Plate- and collector-injection modulators are the most commonly used modulators for which of the following reasons?
1. The rf amplifier stages can be operated class C for linearity
2. The rf amplifier stages can be operated class C for maximum efficiency
3. They require small amounts of audio power
4. They require large amounts of audio power

1-65. A control-grid modulator would be used in which of the following situations?
1. In extremely high-power, wideband equipment where high-level modulation is difficult to achieve
2. In cases where the use of a minimum of audio power is desired
3. In portable and mobile equipment to reduce size and power requirements
4. Each of the above

1-66. Which of the following inputs is/are applied to the grid of a control-grid modulator?
1. Rf

2. Af
3. Dc bias
4. Each of the above

1-67. Excessive modulating signal levels have which, if any, of the following effects on a control-grid modulator?
1. They increase output. amplitude
2. They decrease output amplitude
3. They create distortion
4. None

1-68. Compared to a plate modulator, the control-grid modulator has which of the following advantages?
1. It is more efficient
2. It has less distortion
3. It requires less power from the modulator
4. It requires less power from the amplifier

1-69. The control-grid modulator is similar to which of the following modulator circuits?
1. Plate
2. Cathode
3. Base-injection
4. Emitter-injection

Figure 1A.—Modulator circuit.
IN ANSWERING QUESTIONS 1-70 THROUGH 1-72, REFER TO FIGURE 1A.
1-70. What components in the circuit establish the bias for Q1?
1. R1 and R2
2. R2 and R3
3. R1 and R3

1-71. The rf voltage in the circuit is applied at (a) what points and the af voltage is applied at (b) what points?
1. (a) A and B (b) C and D
2. (a) C and D (b) A and B
3. (a) C and D (b) E and F
4. (a) E and F (b) C and D

1-72. What components develop the rf modulation envelope?
1. C1 and R1
2. C2 and R1
3. C3 and R3
4. C4 and L1

1-73. A cathode modulator is used in which of the following situations?
1. When rf power is unlimited and distortion can be tolerated
2. When rf power is limited and distortion cannot be tolerated
3. When af power is unlimited and distortion can be tolerated
4. When af power is limited and distortion cannot be tolerated

1-74. In a cathode modulator, the modulating voltage is in series with which of the following voltages?
1. The grid voltage only
2. The plate voltage only
3. Both the grid and plate voltages
4. The cathode voltage only

Figure 1B.—Emitter-injection modulator.
IN ANSWERING QUESTION 1-75, REFER TO FIGURE 1B.

1-75. In the circuit, what components develop the modulation envelope?
1. Q1
2. C2 and R1
3. C3 and R3
4. C4 and L1

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Angle and Pulse Modulation," pages 2-1 through 2-64.

2-1. Frequency-shift keying resembles what type of AM modulation?

1. CW modulation
2. Analog AM modulation
3. Plate modulation
4. Collector-injection modulation

2-2. Frequency-shift keying is generated using which of the following methods?

1. By shifting the frequency of an oscillator at an af rate
2. By shifting the frequency of an oscillator at an rf rate
3. By keying an af oscillator at an rf rate
4. By keying an af oscillator at an af rate

2-3. In a frequency-shift keyed signal, where is the intelligence contained?

1. In the duration of the rf energy
2. In the frequency of the rf energy
3. In the amplitude of the rf energy
4. In the spacing between bursts of rf energy

2-4. If an fsk transmitter has a MARK frequency of 49.575 kilohertz and a SPACE frequency of 50.425 kilohertz, what is the assigned channel frequency?

1. 49 kilohertz
2. 49.575 kilohertz
3. 50 kilohertz
4. 50.425 kilohertz

2-5. Fsk is NOT affected by noise interference for which of the following reasons?

1. Noise is outside the bandwidth of an fsk signal
2. Fsk does not rely on the amplitude of the transmitted signal to carry intelligence
3. The wide bandwidth of an fsk signal prevents noise interference
4. Each of the above

2-6. In an fsk transmitter, what stage is keyed?

1. The oscillator
2. The power supply
3. The power amplifier
4. The buffer amplifier

2-7. When the amount of oscillator frequency shift in an fsk transmitter is determined, which of the following factors must be considered?

1. The number of buffer amplifiers
2. The transmitter power output
3. The frequency multiplication factor for the transmitter amplifiers
4. The oscillator rest frequency

2-8. In an fsk transmitter with a doubler and a tripler stage, the desired frequency shift is 1,200 hertz. To what maximum amount is the oscillator frequency shift limited?

1. 60 hertz
2. 100 hertz
3. 120 hertz
4. 200 hertz

2-9. Fsk has which of the following advantages over cw?

1. Fsk has a more stable oscillator
2. Fsk is easier to generate
3. Fsk rejects unwanted weak signals
4. Fsk does not have noise in its output

2-10. The "ratio of transmitted powers" provides what information?

1. Transmitter power out in a cw system
2. Transmitter power out in an fsk system
3. Improvement shown using cw instead of fsk transmission
4. Improvement shown using fsk instead of cw transmission methods

2-11. In an fm signal, (a) the RATE of shift is proportional to what characteristic of the modulating signal, and (b) the AMOUNT of shift is proportional to what

characteristic?
1. (a) Amplitude (b) amplitude
2. (a) Amplitude (b) frequency
3. (a) Frequency (b) frequency
4. (a) Frequency (b) amplitude

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 2A.—Oscillator circuit.

IN ANSWERING QUESTIONS 2-12 THROUGH 2-14, REFER TO FIGURE 2A.

2-12. When a sound wave strikes the condenser microphone (M), it has which, if any, of the following effects on the oscillator circuit?
1. It changes output phase
2. It changes output voltage
3. It changes output frequency
4. It has no effect

2-13. What is the purpose of capacitor C in the circuit?
1. It helps set the carrier frequency of the oscillator
2. It prevents amplitude variations in the oscillator output
3. It sets the maximum frequency deviation of the oscillator
4. It varies the output frequency in accordance with the modulating voltage

2-14. A 1,000-hertz tone of a certain loudness causes the frequency-modulated carrier for the circuit to vary ±1,000 hertz at a rate of 1,000 times per second. If the AMPLITUDE of the modulating tone is doubled, what will be the maximum carrier variation?
1. ±1,000 hertz at 1,000 times per second
2. ±1,000 hertz at 2,000 times per second
3. ±2,000 hertz at 1,000 times per second
4. ±2,000 hertz at 2,000 times per second

2-15. The maximum deviation for a 1.5 MHz carrier is set at ±50 kHz. If the carrier varies between 1.5125 MHz and 1.4875 MHz (±12.5 kHz), what is the percentage of modulation?
1. 25 %
2. 50 %
3. 75 %
4. 100 %

2-16. An fm transmitter has a 50-watt carrier with no modulation. What maximum amount of output power will it have when it is 50-percent modulated?
1. 25 watts
2. 50 watts
3. 75 watts
4. 100 watts

2-17. Frequencies that are located between adjacent channels to prevent interference are referred to as
1. sidebands
2. bandwidths
3. guard bands
4. blank channels

2-18. Modulation index may be figured by using which of the following formulas?
1. 2f/fm
2. fm/2f
3. fm/Df
4. Df/fm

2-19. A 50-megahertz fm carrier varies between 49.925 megahertz and 50.075 megahertz 10,000 times per second. What is its modulation index?
1. 5
2. 10
3. 15
4. 20

Figure 2B.—Modulation index table.

IN ANSWERING QUESTIONS 2-20 AND 2-21, REFER TO FIGURE 2B.

2-20. An fm-modulated carrier varies between 925 kilohertz and 1,075 kilohertz 15,000 times per second. What is the bandwidth, in kilohertz, of the transmitted signal?

(HINT: You will need to figure MI to be able to find the sidebands.)
1. 340
2. 420
3. 480
4. 560

2-21. The spectrum of a 500 kilohertz fm modulated carrier has a 60-kilohertz bandwidth and contains 12 significant sidebands. How much, in kilohertz, is the carrier deviated?
1. ±5
2. ±7.5
3. ±10
4. ±15

2-22. In a reactance-tube modulator, the reactance tube shunts what part of the oscillator circuitry?
1. The amplifier
2. The tank circuit
3. The biasing network
4. The feedback network

2-23. With no modulating signal applied, a reactance tube has which, if any, of the following effects on the output of an oscillator?
1. It will decrease amplitude
2. It will increase amplitude
3. It will change resonant frequency
4. It will have no effect

2-24. The reactance-tube frequency modulates the oscillator by which of the following actions?
1. By shunting the tank circuit with a variable resistance
2. By shunting the tank circuit with a variable reactance
3. By shunting the tank circuit with a variable capacitance
4. By causing a resultant current flow in the tank circuit which either leads or lags resonant current

Figure 2C.—Semiconductor reactance modulator.
IN ANSWERING QUESTIONS 2-25 AND 2-26, REFER TO FIGURE 2C.

2-25. The semiconductor reactance modulator in
the circuit is in parallel with a portion of the oscillator tank circuit coil. Modulation results because of interaction with which of the following transistor characteristics?
1. Collector-to-emitter resistance
2. Collector-to-emitter capacitance
3. Base-to-emitter resistance
4. Base-to-emitter capacitance

2-26. With a positive-going modulating signal applied to the base of Q2, (a) what will circuit capacitance do and (b) what will the output frequency do?
1. (a) Decrease (b) decrease
2. (a) Decrease (b) increase
3. (a) Increase (b) increase
4. (a) Increase (a) decrease

2-27. What type of circuit is used to remove the AM component in the output of a semiconductor reactance modulator?
1. A mixer
2. A filter
3. A limiter
4. A buffer amplifier

Figure 2D.—Multivibrator modulator.
IN ANSWERING QUESTIONS 2-28 AND 2-29, REFER TO FIGURE 2D.

2-28. The multivibrator modulator produces fm modulation by which of the following actions?
1. By modulating the collector voltages
2. By modulating the base-return voltages
3. By modulating the value of the base value of the base capacitors
4. By modulating the value of the base resistors

2-29. What is the purpose of the filter on the output of the multivibrator modulator?
1. To establish the fundamental operating frequency
2. To eliminate unwanted frequency variations
3. To eliminate unwanted odd harmonics
4. To eliminate unwanted even harmonics

2-30. A multivibrator frequency modulator is limited to frequencies below what maximum frequency?
1. 1 megahertz
2. 2 megahertz
3. 5 megahertz
4. 10 megahertz

2-31. To ensure the frequency stability of an fm transmitter, which, if any, of the following actions could be taken?
1. Modulate a crystal-controlled oscillator at the desired frequency
2. Modulate a low-frequency oscillator, and use frequency multipliers to achieve the operating frequency
3. Modulate a low-frequency oscillator, and heterodyne it with a higherfrequency oscillator to achieve the desired frequency
4. None of the above

2-32. A varactor is a variable device that acts as which of the following components?
1. Resistor
2. Inductor
3. Capacitor
4. Transistor

2-33. As the positive potential is increased on the cathode of a varactor, (a) what happens to reverse bias and (b) how is dielectric width affected?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

Figure 2E.—Phase relationships.

IN ANSWERING QUESTION 2-34, REFER TO FIGURE 2E.

2-34. In the figure, (a) waveform X has what phase relationship to waveform Y, and (b) waveform Y has what relationship to waveform Z?
1. (a) Lags (b) leads
2. (a) Lags (b) lags
3. (a) Leads (b) lags
4. (a) Leads (b) leads

2-35. A 10 kilohertz, 10-volt square wave is applied as the phase-modulating signal to a transmitter with a carrier frequency of 60 megahertz. What is the output frequency during the constant-amplitude portions of the modulating signal?
1. 10 kilohertz
2. 59,990 kilohertz
3. 60,000 kilohertz
4. 60,010 kilohertz

2-36. In a phase modulator, the frequency during the constant-amplitude portion of the modulating wave is the
1. peak frequency
2. rest frequency
3. deviation frequency
4. modulating frequency

2-37. In phase modulation, (a) the AMPLITUDE of the modulating signal determines what characteristic of the phase shift, and (b) the FREQUENCY of the modulating signal determines what characteristic of the phase shift?
1. (a) Rate (b) rate
2. (a) Rate (b) amount
3. (a) Amount (b) amount
4. (a) Amount (b) rate

2-38. The frequency spectrums of a phasemodulated signal resemble the spectrum of which, if any, of the following types of modulation?
1. Amplitude modulated

2. Frequency modulated
3. Continuous-wave modulated
4. None of the above

2-39. Compared to fm, increasing the modulating frequency in phase modulation has what effect, if any, on the bandwidth of the phase-modulated signal?
1. It increases
2. It decreases
3. None

2-40. A simple phase modulator consists of a capacitor in series with a variable resistance. What total amount of carrier shift will occur when X C is 10 times the resistance?
1. 0 degrees
2. 45 degrees
3. 60 degrees
4. 90 degrees

2-41. The primary advantage of phase modulation over frequency modulation is that phase modulation has better carrier
1. power stability
2. amplitude stability
3. frequency stability
4. directional stability

2-42. Phase-shift keying is most useful under which of the following code element conditions?
1. When mark elements are longer than space elements
2. When mark elements are shorter than space elements
3. When mark and space elements are the same length
4. When mark and space elements are longer than synchronizing elements

2-43. When a carrier is phase-shift keying modulated, (a) a data bit ONE will normally cause the carrier to shift its phase what total number of degrees, and (b) a data bit ZERO will cause the carrier to shift its phase what total number of degrees?
1. (a) 60 (b) 0
2. (a) 0 (b) 180
3. (a) 180 (b) 180
4. (a) 180 (b) 0

2-44. Which of the following circuits is used to generate a phase-shift keyed signal?
1. Logic circuit
2. Phasor circuit
3. Phasitron circuit
4. Longitudinal circuit

2-45. When a carrier is modulated by a square wave, what maximum number of sideband pairs will be generated?
1. 1
2. 9
3. 3
4. An infinite number

2-46. As the square wave modulating voltage is increased to the same amplitude as that of the carrier, what will be the effect on (a) the carrier amplitude and (b) amplitude of the sidebands?
1. (a) Remains constant
(b) Increases
2. (a) Decreases
(b) Increases
3. (a) Increases
(b) Remains constant
4. (a) Increases
(b) Decreases

2-47. In a square-wave modulated signal, total sideband power is what percentage of the total power?
1. 0 percent
2. 25 percent
3. 33 percent
4. 50 percent

2-52. Which of the following ratios is used to determine pulse-repetition frequency (prf)?
1. 3.
2. 4.

2-53. Average power in a pulse-modulation system is defined as the
1. power during rest time
2. power during each pulse
3. power during each pulse averaged over rest time
4. power during each pulse averaged over one operating cycle

2-54. In pulse modulation, what term is used to indicate the ratio of time the system is actually producing rf?
1. Rest cycle
2. Duty cycle
3. Average cycle
4. Transmit cycle

2-55. In a pulse-modulation system, which of the following formulas is used to figure the percentage of transmitting time?
1. 3.
2. 4.

2-56. When pulse modulation is used for range finding in a radar application, which of the following types of pulse information is used?
1. Reflected pulse return interval
2. Reflected pulse duration
3. Reflected pulse amplitude
4. Reflected pulse frequency

2-57. In a spark-gap modulator, what is the function of the pulse-forming network?
1. To store energy
2. To increase the level of stored energy
3. To act as a power bleeder
4. To rapidly discharge stored energy

2-58. The damping diode in a thyratron modulator serves which of the following purposes?
1. It discharges the pulse-forming network
2. It limits the input signal
3. It prevents the breakdown of the thyratron by reverse-voltage transients
4. It rectifies the input signal

2-59. Compared to a spark-gap modulator, the thyratron modulator exhibits which of the following advantages?
1. Improved timing
2. Higher output pulses
3. Higher trigger voltage
4. Operates over a narrower range of anode voltages and pulse-repetition rates

2-60. To transmit intelligence using pulse modulation, which of the following pulse characteristics may be varied?
1. Pulse duration
2. Pulse amplitude
3. Pulse-repetition time
4. Each of the above

2-61. To accurately reproduce a modulating signal in a pulse-modulated system, what minimum number of samples must be taken per cycle?
1. One
2. Two
3. Three
4. Four

2-62. What is the simplest form of pulse modulation?
1. Pulse-code modulation
2. Pulse-duration modulation
3. Pulse-frequency modulation
4. Pulse-amplitude modulation

2-63. The same pulse characteristic is varied in which of the following types of pulse modulations?
1. Pam and pdm
2. Pdm and pwm
3. Pwm and ppm
4. Ppm and pam

2-65. Which, if any, of the following is the primary disadvantage of pulse-position modulation?
1. It depends on transmitter-receiver

synchronization
2. It is susceptible to noise interference
3. Transmitter power varies
4. None of the above

2-66. A pfm transmitter transmits 10,000 pulses per second without a modulating signal applied. How, if at all, will a modulating signal affect the transmitted pulse rate?
1. It will decrease the transmitted pulse rate
2. It will increase the transmitted pulse rate
3. Both 1 and 2 above
4. It will not affect the transmitted pulse Rate

2-67. The process of arbitrarily dividing a wave into a series of standard values is referred to as
1. arbitration
2. quantization
3. interposition
4. approximation

2-68. A pcm system is capable of transmitting 32 standard levels that ate sampled 2.5 times per cycle of a 3-kilohertz modulating signal. What maximum number of bits per second are transmitted?
1. 18,750
2. 37,500
3. 75,000
4. 240,000

2-69. Which of the following is a characteristic of a pcm system that makes it advantageous for use in multiple-relay link systems?
1. Average power is constant
2. Average power decreases with each relay
3. Noise is not cumulative at relay stations
4. Quantization noise decreases with each relay

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Demodulation," pages 3-1 through 3-35.

3-1. The process of recreating the original modulating frequencies (intelligence) from an rf carrier is known by which of the following terms?
1. Detection
2. Demodulation
3. Both 1 and 2 above
4. Distribution

3-2. When a demodulator fails to accurately recover intelligence from a modulated carrier, which of the following types of distortion result?
1. Phase
2. Frequency
3. Amplitude
4. Each of the above

3-3. In a demodulator circuit, which of the following components is required for demodulation to occur?
1. A linear device
2. A nonlinear device
3. A variable resistor

3-4. In cw demodulation, the first requirement of the circuit is the ability to detect
1. the presence or absence of the carrier
2. amplitude variations in the carrier
3. frequency variations in the carrier
4. phase variations in the carrier

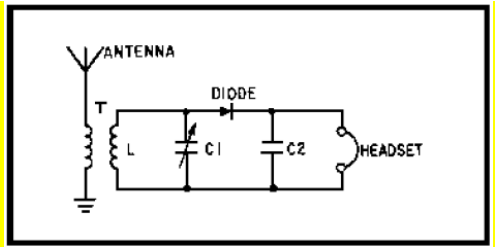


Figure 3A.—Cw demodulation.

IN ANSWERING QUESTION 3-5, REFER TO FIGURE 3A.

3-5. In the figure, L and C1 form a frequencyselective network that serves what purpose?
1. It removes the carrier
2. It rectifies the oscillations
3. It tunes the circuit to the desired rf carrier
4. It provides filtering to maintain a constant dc output

3-6. To aid in distinguishing between two or more cw signals that are close to the same frequency, which of the following detectors is used?
1. Diode
2. Crystal
3. Heterodyne
4. Transistor

3-7. Assume that two signals are received, one at 500 kHz and the other at 501 kHz. What frequency, in kHz, should be mixed with them to distinguish the 501 kHz signal by producing a 1 kHz output?
1. 499
2. 500
3. 501
4. 502

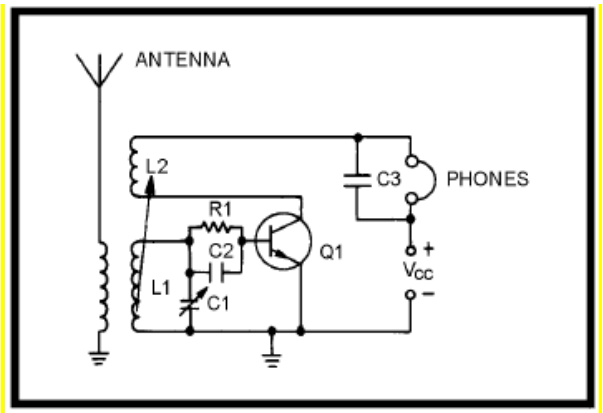


Figure 3B.—Detector.

IN ANSWERING QUESTIONS 3-8 THROUGH 3-11, REFER TO FIGURE 3B.

3-8. The detector circuit in the figure uses the heterodyning principle to detect the incoming signal. What type of detector is it?
1. Hartley
2. Colpitts
3. Armstrong
4. Regenerative

3-9. What component controls the operating frequency of the detector?
1. C1
2. C2
3. L2
4. R1

3-10. What component provides the feedback necessary for oscillations to occur?
1. R1
2. C2
3. C3
4. L2

3-11. Which of the following circuit functions does Q1 perform?
1. Mixer
2. Detector
3. Oscillator
4. Each of the above

3-12. A circuit that is nonlinear, provides filtering, and is sensitive to the type of modulation applied to it fulfills the requirements of which, if any, of the following circuits?
1. Mixer
2. Modulator
3. Demodulator
4. None of the above

3-13. A detector uses which of the following signals to approximate the original waveform?
1. The sum frequency
2. The carrier frequency
3. The modulation envelope

THIS SPACE LEFT BLANK INTENTIONALLY.

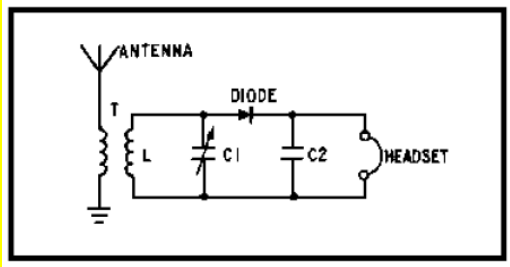


Figure 3C.—Detector.

IN ANSWERING QUESTIONS 3-14 THROUGH 3-16, REFER TO FIGURE 3C.

3-14. What type of detector is shown in the figure?
1. Series-diode
2. Parallel-diode
3. Inductive-diode
4. Capacitive-diode

3-15. What is the purpose of C1 and L?
1. To smooth the incoming rf
2. To select the desired af signal
3. To select the desired rf signal
4. To smooth the detected af signal

3-16. What is the purpose of C2?
1. To smooth the incoming rf signal
2. To select the desired af signal
3. To select the desired rf signal
4. To smooth the detected af signal

3-17. A shunt diode circuit is used as a detector in which of the following instances?
1. When a large input signal is supplied
2. When a large output current is required
3. When the input signal variations overdrive the audio amplifier stages
4. When the input signal variations are too small to produce a full output from audio amplifier stages

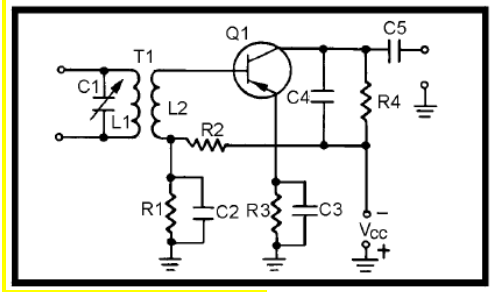


Figure 3D.—Detector.

IN ANSWERING QUESTIONS 3-18 THROUGH 3-21, REFER TO FIGURE 3D.

3-18. What type of detector is shown in the figure?
1. Ratio
2. Common-base
3. Regenerative
4. Common-emitter

3-19. What circuit component acts as the load for the detected audio?
1. R1
2. R2
3. R3
4. R4

3-20. What is the purpose of C4?
1. Tp bypass af
2. To bypass rf
3. To remove power supply voltage variations
4. To determine the operating frequency of the circuit

3-21. This detector circuit is used under which of the following circuit conditions?
1. When higher frequencies are used
2. When the best possible frequency selection is required
3. When weak signals need to be detected
4. When strong signals need to be detected

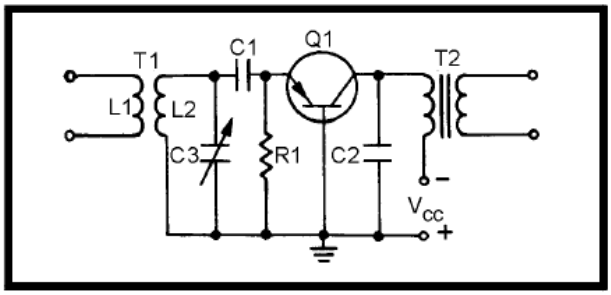


Figure 3E.—Circuit.

IN ANSWERING QUESTIONS 3-22 THROUGH 3-24, REFER TO FIGURE 3E.

3-22. What type of Circuits is/are shown in the figure?
1. A detector
2. An amplifier
3. Both 1 and 2 above
4. An oscillator

3-23. What is the purpose of T2?
1. To filter rf
2. To filter af
3. To couple the af output
4. To couple the rf output

3-24. What is the function of C1 and R1?
1. To act as an integrator
2. To act as a frequency-selective network
3. To act as a filter network
4. To act as a differentiator

THIS SPACE LEFT BLANK INTENTIONALLY.

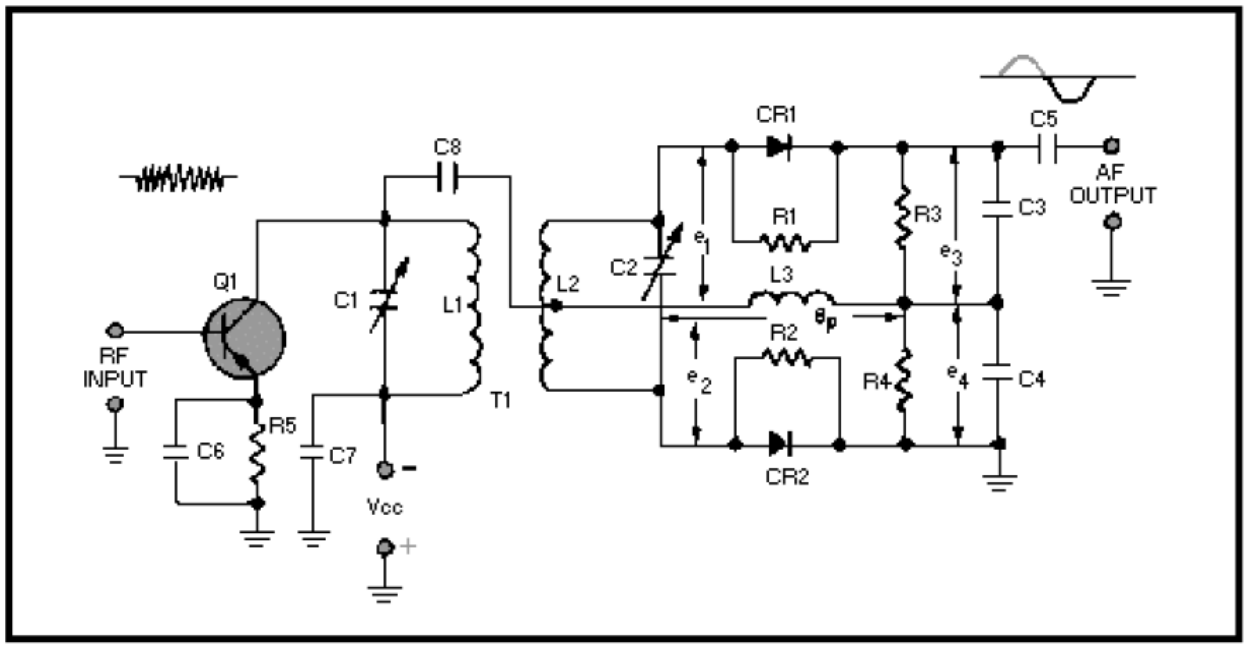


Figure 3F.—Foster-Seeley discriminator.

IN ANSWERING QUESTIONS 3-25 THROUGH 3-30, REFER TO FIGURE 3F.

3-25. In the figure, what is the purpose of Q1?
1. To act as a limiter only
2. To act as an amplifier only
3. To act as a limiter and an amplifier
4. To act as an oscillator

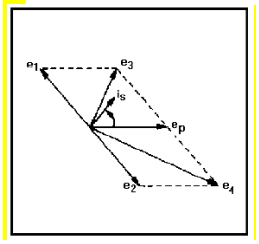
3-26. To what frequency are C1/L1 and C2/L2 tuned?
1. The af input
2. The center frequency of fm signal
3. The lowest fm deviation frequency
4. The highest fm deviation frequency

3-27. What is the function of L3?
1. To couple af to the output
2. To couple rf from the tank circuits to CR1 and CR2
3. To prevent af from being coupled to the power supply
4. To provide the dc return path for CR1 and CR2

3-28. At resonance, what is the amplitude of e3 compared to e4?
1. e3 is less than e4
2. e3 is equal to e4
3. e3 is greater than e4

3-29. When the circuit is operating ABOVE resonance, (a) does inductive reactance increase or decrease, and (b) does capacitive reactance increase or decrease?
1. (a) Increases (b) increases
2. (a) Increases (b) decreases
3. (a) Decreases (b) decreases
4. (a) Decreases (b) increases

3-30. Circuit operation BELOW resonance is represented by which of the following vector diagrams?
1.
2.



3.

THIS SPACE LEFT BLANK INTENTIONALLY.

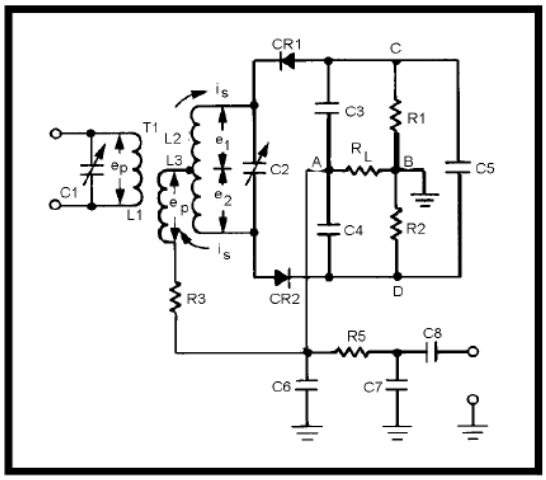


Figure 3G.—Ratio detector.

IN ANSWERING QUESTIONS 3-31 THROUGH 3-40, REFER TO FIGURE 3G.

3-31. To what frequency(ies) are (a) L1 and C1 and (b) L2 and C2 tuned?
1. (a) Center frequency
(b) lower frequency limit
2. (a) Center frequency
(b) center frequency
3. (a) Lower frequency limit
(b) center frequency
4. (a) Lower frequency limit
(b) lower frequency limit

3-32. What circuit filtering function do R5, C6, and C7 provide?
1. Low-pass
2. High-pass
3. Band-pass
4. Band-reject

3-33. At resonance, what type of circuit does the tank circuit appear to be?
1. Reactive
2. Resistive
3. Inductive
4. Capacitive

3-34. At resonance, what is the phase relationship between tank current and primary voltage?
1. Tank current leads primary voltage by 90 degrees
2. Tank current lags primary voltage by 90 degrees
3. Tank current and primary voltage are in phase
4. Tank current and primary voltage are out of phase

3-35. At resonance, what relative amount of conduction takes place through CR1 compared to that for CR2?
1. CR1 conducts more than CR2
2. CR1 conducts less than CR2
3. CR1 and CR2 conduct the same amount

3-36. At resonance, (a) will the charges on C3 and C4 be equal or unequal, and (b) will their polarities be the same or opposite?
1. (a) Equal (b) same
2. (a) Equal (b) opposite
3. (a) Unequal (b) opposite
4. (a) Unequal (b) same

3-37. ABOVE resonance, both voltages e1 and e 2 have specific phase shift relationships to voltage e in that they either shift nearer to or farther from the phase of ep. What are the phase relationships between (a) e1 and ep and (b) e2 and ep?
1. (a) e1 is nearer to ep
(b) e2 is nearer to ep
2. (a) e1 is nearer to ep
(b) e2 is farther from ep
3. (a) e1 is farther from ep
(b) e2 is nearer to ep
4. (a) e1 is farther from ep
(b) e2 is farther from ep

3-38. If C3 is charged to 6 volts and C4 is charged to 4 volts, what is the output voltage?
1. 1 volt

2. 2 volts
3. 3 volts
4. 4 volts

3-39. When operating BELOW resonance, what is the relationship of the vector sum of e 1 and ep to the vector sum of e2 and ep?
1. The sum of e1 and ep is larger than the sum of e2 and ep
2. The sum of e1 and ep is smaller than the sum of e2 and ep
3. The slam of e1 and ep is equal to the sum of e2 an ep

3-40. What components help to reduce the effects of amplitude variations at the input of the circuit?
1. R1, R2, and C5
2. R5, C6, and C7
3. R1, R2, C3, and C4
4. L1, L2, L3, and C2

3-41. What is the minimum input voltage, in millivolts, required for a ratio detector?
1. 100
2. 200
3. 300
4. 400

3-42. Which of the following circuit functions is performed by the gated-beam detector?
1. Limiter
2. Detector
3. Amplifier
4. Each of the above

THIS SPACE LEFT BLANK INTENTIONALLY.

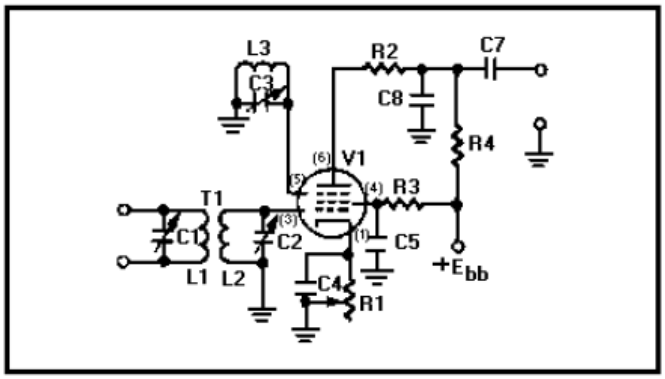


Figure 3H.—Gated-beam detector.

IN ANSWERING QUESTIONS 3-43 THROUGH 3-47, REFER TO FIGURE 3H.

3-43. What components in the circuit are used to set the reference frequency for a gatedbeam detector?
1. C1 and L1
2. C2 and L2
3. C3 and L3
4. C4 and R1

3-44. What tube pins connect to elements that perform in a manner similar to an AND gate in a digital device?
1. Pins 1 and 3
2. Pins 3 and 4
3. Pins 3 and 5
4. Pins 4 and 5

3-45. What type of tank circuit is the quadrature tank (L3 and C3)?
1. Low-Q
2. High-Q
3. Nonresonant
4. Series-resonant

3-46. For plate current to flow, what must be the polarities of (a) the quadrature grid and (b) the limiter grid?
1. (a) Negative (b) negative
2. (a) Negative (b) positive
3. (a) Positive (b) positive
4. (a) Positive (b) negative

3-47. ABOVE the center frequency of the

received fm signal, (a) will the tank appear capacitive or inductive, and (b) will the average plate current increase or decrease?
1. (a) Inductive (b) increase
2. (a) Inductive (b) decrease
3. (a) Capacitive (b) decrease
4. (a) Capacitive (b) increase

3-48. To demodulate a phase-modulated signal, which, if any, of the following types of demodulators may be used?
1. Peak
2. Quadrature
3. Series-diode
4. None of the above

3-49. Which of the following circuits can be used as a communications pulse demodulator?
1. Conversion
2. Peak detector
3. Low-pass filter
4. Each of the above

THIS SPACE LEFT BLANK INTENTIONALLY.

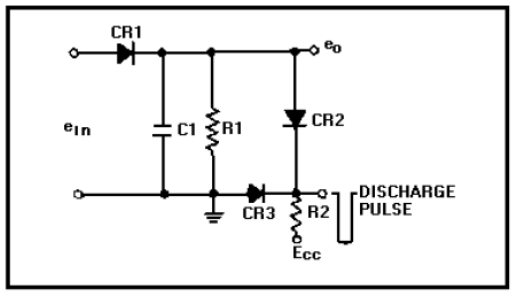


Figure 3I.—Detector.

IN ANSWERING QUESTIONS 3-50 THROUGH 3-52, REFER TO FIGURE 3I.

3-50. To detect pulse-amplitude modulation, what value must the RC time constant of R1 and C1 in the circuit be?
1. Five times the pulse width
2. Ten times the pulse width
3. Five times the interpulse period
4. Ten times the interpulse period

3-51. Which, if any, of the following functions is the purpose of CR2?
1. To quickly discharge C1 between received pulses
2. To rectify input pulses
3. To clamp the output to a positive level
4. None of the above

3-52. What change must be made to the circuit to detect pulse-duration modulation?
1. Remove R1
2. Increase the value of R1
3. Decrease the value of R1
4. Add a resistor in series with CR1

3-53. When a pulse-duration modulated signal is determined by using a low-pass filter, what characteristic of the signal is used?
1. Width
2. Amplitude
3. Frequency
4. Pulse position

3-54. To detect pulse-duration modulation, the low-pass filter components must be selected so that they pass only the
1. carrier frequency
2. intermediate frequency
3. pulse-repetition frequency
4. desired modulating frequency

3-55. What type(s) of modulation is/are normally detected by first converting it/them to another type of modulation?
1. Ppm only
2. Pfm only
3. Pcm only
4. Ppm, pfm, and pcm

3-56. What type of circuit can be used to convert from ppm to pdm for demodulation?
1. An amplifier
2. A flip-flop
3. An oscillator
4. A transformer

THIS SPACE LEFT BLANK

INTENTIONALLY.

Figure 3J.—Pcm conversion.

IN ANSWERING QUESTIONS 3-57 THROUGH 3-59, REFER TO FIGURE 3J.

3-57. To convert from pcm to pam, what type of circuit is used to apply the pcm to the input of the circuit shown?
1. A constant-current source
2. A constant-voltage source
3. A limiter-amplifier source
4. An oscillator-amplifier source

3-58. If C1 is allowed to charge 16 volts during the period of one pulse, each additional pulse increases the charge by 16 volts. With the binary-coded equivalent of an analog 12 applied to the input, what will be the output of the circuit at sampling time?
1. 10 volts
2. 12 volts
3. 14 volts
4. 16 volts

MODULE 13

INTRODUCTION TO NUMBER SYSTEMS AND LOGIC

PREPARED BY:

Jerson John Mata

ASSIGNMENT 1

Textbook Assignment: "Number Systems," chapter 1, pages 1-1 through 1-69.

1-1. Modern number systems are built around which of the following components?
1. Unit, number, and radix
2. Number, base, and radix
3. Position, power, and unit
4. Digit, power, and position

1-2. What term describes a single object in a modern number system?
1. Unit
2. Base
3. Digit
4. Number

1-3. What is a number?
1. A quantity of objects
2. A counting system based on symbols
3. The decimal system
4. A symbol representing a unit or a quantity

1-4. Which of the following symbols is NOT an Arabic figure?
1. C
2. 2
3. 7
4. 9

1-5. What term describes the number of symbols used in a number system?
1. Power
2. Radix
3. Exponent
4. Subscript

1-6. What is the base of a number system using all the letters of the alphabet□ A=0, B=1, C=2, and so forth?
1. 29
2. 25
3. 28
4. 26

1-7. A number system uses the symbols 0 through 4. What is its base?
1. 6
2. 5
3. 3
4. 4

1-8. Using positional notation, what two factors determine the value of a number?
1. Symbol and position
2. Position and base
3. Radix and symbol
4. Unit and symbol

1-9. How many decimal units are represented by the 5 in the number 157210?
1. 100
2. 50
3. 500
4. 5000

1-10. The 1 in 157210 is equal to what power of ten?
1. 101
2. 102
3. 103
4. 104

1-11. The power of a number is indicated by the
1. subscript
2. exponent
3. radical
4. radix

1-12. What is the value of 5 times 100?
1. 1
2. 0.5
3. 5
4. 50

1-13. Which of the following numbers is a mixed number?
1. 14.03
2. 156
3. 1,257
4. .0004

Prepared by: Harlem A. Agnote

1-14. What term describes the symbol that separates the whole and fractional numbers in any number system?
1. Exponent
2. Radix point
3. Decimal point
4. Position point

1-15. What is the MSD of (a) 0.4201, (b) 13, and (c) 32.06?
1. (a) 4 (b) 1 (c) 3
2. (a) 1 (b) 3 (c) 2
3. (a) 2 (b) 1 (c) 2
4. (a) 4 (b) 3 (c) 3

1-16. What term is defined as a number to be added to a preceding number?
1. Addend
2. Augend
3. Carry
4. Sum

1-17. Identify A through D in the following example.
1 – A
25 – B
+ 17 – C
42 – D
1. Addend, sum, carry, augend
2. Carry, augend, addend, sum
3. Augend, carry, sum, addend
4. Carry, augend, sum, addend

IN ANSWERING QUESTION 1-18,
PERFORM THE INDICATED OPERATION.

1-18. Add:
1. 418
2. 508
3. 528
4. 518

1-19. In subtraction, the (a) is subtracted from the (b).
1. (a) Minuend (b) subtrahend
2. (a) Remainder (b) subtrahend
3. (a) Subtrahend (b) difference
4. (a) Subtrahend (b) minuend

1-20. A borrow is required in which of the following examples?
1. 64-59
2. 32-12
3. 59-17
4. 29-11

1-21. The result of subtraction is known as the
1. addend
2. quotient
3. difference
4. subtrahend

1-22. What are the (a) radix and (b) the symbols used in the binary number system?
1. (a) 1 (b) 0, 1
2. (a) 2 (b) 1, 0
3. (a) 3 (b) 0, 1, 2
4. (a) 0 (b) 1, 2

1-23. Positional notation for the binary system is based on powers of
1. 1
2. 2
3. 3
4. 0

1-24. What is the decimal equivalent of 23?
1. 6
2. 2
3. 8
4. 10

1-25. The decimal number 1 is equal to what power of two?
1. 21
2. 22
3. 23
4. 20

1-26. Which of the following powers of two indicates a fraction?
1. 21
2. 20
3. 2 2
4. 22

Prepared by: Harlem A. Agnote

1-27. Which digit is the MSD in the binary number 1011001?
1. The 0 farthest to the left
2. The 1 farthest to the left
3. The 0 farthest to the right
4. The 1 farthest to the right

1-28. Which of the following combinations of binary addition is INCORRECT?
1. 1 + 1 = 1 with a carry
2. 1 + 0 = 1
3. 0 + 0 = 0
4. 0 + 1 = 1

IN ANSWERING QUESTIONS 1-29 THROUGH 1-33, PERFORM THE INDICATED OPERATION.

1-29. Add:
100102
+ 10102

1. 100002
2. 111002
3. 101012
4. 110102

1-30. Add:
111012
+ 010012

1. 111112
2. 1001102
3. 1110102
4. 1000002

1-31. Add:
1112
+ 0012

1. 1002
2. 10102
3. 10012
4. 10002

1-32. Add:
1002
0102
+ 0012

1. 10002
2. 10012
3. 1012
4. 1112

1-33. Add:
110102
1002
+ 1112

1. 0111102
2. 1010102
3. 100101
4. 1110012

1-34. Which of the following rules of binary subtraction is correct?
1. 0 – 0 = 0 with a borrow
2. 1 – 0 = 0
3. 2 – 1 = 1
4. 1 – 0 = 1

1-35. In the following example, which number is the minuend?
101102
– 11002
1. 101102
2. 11002
3. 10102
4. 101012

1-36. Which of the following rules of binary subtraction requires the use of a borrow?
1. 0 – 0
2. 1 – 0
3. 1 – 1
4. 0 – 1

1-37. In binary subtraction, what is the value of a borrow when it is moved to the next lower order column?
1. 12
2. 22
3. 102
4. 1010

Prepared by: Harlem A. Agnote

IN ANSWERING QUESTIONS 1-38 THROUGH 1-40, PERFORM THE INDICATED OPERATION.

1-38. Subtract:
111112
– 101012

1. 101002
2. 110102
3. 001012
4. 010102

1-39. Subtract:
101012
– 11112

1. 001102
2. 010012
3. 011002
4. 000102

1-40. Subtract:
100012
– 01102
1. 10102
2. 10112
3. 11102
4. 10012

1-41. Subtraction is accomplished by which of the following methods in a computer that can only add?
1. Binary subtraction
2. Decimal complement
3. Complementary subtraction
4. Minuend complement

1-42. What is the R's-1 complement of 63310?
1. 47710
2. 46610
3. 36610
4. 37710

1-43. What is the R's-1 complement of 10111012?
1. 01000102
2. 10111102
3. 898889810
4. 898889910

1-44. What is the R's complement of 39510?
1. 60410
2. 60510
3. 71510
4. 71410

1-45. Which of the following parts of a subtraction problem must be complemented to perform complementary subtraction?
1. Subtrahend
2. Difference
3. Remainder
4. Minuend

1-46. Which of the following examples is the correct step when using the R's complement to subtract 12310 from 26410?
1. 735
+ 123
2. 264
+ 876
3. 264
+ 321
4. 264
+ 877

1-47. Which of the following solutions is correct when using the R's complement method of subtracting 51610 from 84510?
1. 845
+ 483
328
2. 845
+ 484
329
3. 845
+ 615
460
4. 155
+ 516
671

1-48. Which of the following numbers is the

R's-1 complement of the binary number 10101?
1. 101002
2. 010112
3. 011002
4. 010102

1-49. Perform the R's-1 complement of the following binary numbers.
(a) 1000, (b) 1101, (c) 0100
1. (a) 01112 (b) 00102 (c) 10112
2. (a) 01102 (b) 00112 (c) 10102
3. (a) 01112 (b) 00112 (c) 10112
4. (a) 01102 (b) 00102 (c) 10102

1-50. Which of the following statements regarding the forming of the R's complement of a binary number is correct?
1. Retain the MSD and complement all other digits
2. Complement all digits and subtract 1
3. Complement all digits
4. Retain the least significant 1 and complement all other digits to the left

1-51. Which of the following numbers is the R's complement of 1001012?
1. 1010102
2. 0110112
3. 1101102
4. 1010012

IN ANSWERING QUESTIONS 1-52 AND 1-53, USE THE R'S COMPLEMENT METHOD TO SOLVE THE PROBLEMS.

1-52. Subtract:
10012
- 1012
1. 1102
2. 0102
3. 1002
4. 11002

1-53. Subtract:
11012
- 10102
1. 00012
2. 01002
3. 01102
4. 00112

1-54. In the previous problems, what is indicated by the carry that expands the difference by one place?
1. The answer is incorrect
2. The answer is a positive number
3. The answer is correct
4. The answer is a negative number

IN ANSWERING QUESTIONS 1-55 THROUGH 1-57, SOLVE THE SUBTRACTION PROBLEMS AND INDICATE THE SIGN OF THE DIFFERENCE.

1-55. Subtract:
100102
- 100012
1. 000012 positive
2. 011112 negative
3. 011002 positive
4. 000012 negative

1-56. Subtract:
00012
- 11112
1. 00102 negative
2. 01112 positive
3. 11102 negative
4. 11112 positive

1-57. Subtract:
011112
- 100002
1. 111112 negative
2. 000012 negative
3. 011112 positive
4. 100002 positive

1-58. What is the radix of the octal number system?
1. 1010
2. 0 to 7
3. 8

Prepared by: Harlem A. Agnote

4. 78

1-59. Which of the following is NOT a valid octal number?
1. 6048
2. 5918
3. 7438
4. 4778

1-60. Which of the following equations is correct?
1. 80 = 8
2. 81 = 1
3. 84 = 8 8 8
4. 82 = 8 8

1-61. One octal digit is represented by how many binary digits?
1. One
2. Two
3. Three
4. Four

1-62. What is the decimal value of 83?
1. 6410
2. 12810
3. 25610
4. 51210

1-63. Which of the following symbols is the least significant digit of the octal number 1622.374?
1. 1
2. 2
3. 6
4. 4

1-64. What is the sum of 48 and 48?
1. 1010
2. 108
3. 78
4. 168

1-65. What is the sum of 778 and 38?
1. 1278
2. 808
3. 1008
4. 1028

IN ANSWERING QUESTION 1-66, PERFORM THE INDICATED OPERATION.

1-66. Add:
3748
+ 1658
1. 4658
2. 5618
3. 4378
4. 5318

1-67. Find the sum of 77418 and 678.
1. 100008
2. 100308
3. 70308
4. 107308

1-68. What is the sum of 78, 68, 58, and 48?
1. 228
2. 178
3. 268
4. 248

IN ANSWERING QUESTIONS 1-69 AND 1-70, PERFORM THE INDICATED OPERATION.

1-69. Add:
26018
+ 50358
1. 76368
2. 76408
3. 106368
4. 107008

1-70. Add:
23458
+ 76548
1. 101108
2. 107418
3. 105718
4. 122218

1-71. Which, if any, of the following is a difference between subtracting octal numbers and subtracting decimal numbers?

1. The amount of the borrow
2. The octal minuend is converted to decimal
3. The octal subtrahend is converted to decimal
4. None; there is no difference

IN ANSWERING QUESTIONS 1-72 THROUGH 1-74, PERFORM THE INDICATED OPERATION.

1-72. Subtract:
6468
– 4218
1. 1258
2. 2658
3. 2258
4. 22510

1-73. Subtract:
4218
– 2678
1. 1448
2. 2328
3. 1328
4. 1428

1-74. Subtract:
30008
- 7778
1. 20018
2. 20118
3. 21118
4. 20008

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Number Systems," pages 2-1 through 2-36.

2-1. Which of the following numbers does NOT represent a hexadecimal value?
1. 2DF4
2. A32B
3. 47CE
4. 9FGF

2-2. What is the decimal value of the highest symbol in the hex system?
1. 1510
2. 1610
3. F16
4. 1016

2-3. The decimal number 256 is equal to what power of 16?
1. 163
2. 162
3. 164
4. 161

2-4. List the MSD and LSD of the hex number F24.ECB.
1. MSD = 4, LSD = E
2. MSD = 4, LSD = B
3. MSD = F, LSD = 4
4. MSD = F, LSD = B

IN ANSWERING QUESTIONS 2-5 THROUGH 2-7, PERFORM THE INDICATED OPERATION.

2-5. Find the sum.
A16
+ 416
1. C16
2. D16
3. E16
4. F16

2-6. Add:
1E16
+ 1916
1. 3316
2. 3116
3. 3716
4. 4716

2-7. Add:
47816
+79216
1. C1116
2. C0A16
3. B0016
4. BFA16

2-8. When a borrow is taken from a hex number, that number is reduced by how much?
1. 1
2. 1016
3. 1610
4. 1010

IN ANSWERING QUESTION 2-9, FIND THE DIFFERENCE.

2-9. Subtract:
1016
– 816
1. A16
2. 716
3. 816
4. 916

2-10. To begin conversion of a decimal number to a different base, divide the (a) by (b).
1. (a) new base
(b) 10
2. (a) decimal number
(b) 2
3. (a) decimal number
(b) the new base
4. (a) new base
(b) the decimal equivalent

2-11. Which of the following terms describes the first remainder when converting

decimal numbers to other bases?
1. MSD
2. LSD
3. Radix of the new base
4. Exponent of the new base

IN ANSWERING QUESTIONS 2-12 THROUGH 2-14, USE THE DIVISION METHOD TO CONVERT DECIMAL NUMBERS TO BINARY.

2-12. 4310
1. 1010112
2. 1101012
3. 1000112
4. 1011012

2-13. 6310
1. 1010112
2. 1100112
3. 1011012
4. 1111112

2-14. 13010
1. 11110002
2. 11110102
3. 100000102
4. 100010102

2-15. To convert fractional decimal numbers to binary, multiply the number by (a) and extract the portion of the product to the (b) of the radix point.
1. (a) 2 (b) left
2. (a) 2 (b) right
3. (a) 10 (b) left
4. (a) 10 (b) right

IN ANSWERING QUESTIONS 2-16 THROUGH 2-19, PERFORM THE INDICATED OPERATION.

2-16. Convert 0.7510 to binary.
1. 0.102
2. 0.012
3. 0.112
4. 1.002

2-17. Convert 0.62510 to binary.
1. 0.0112
2. 0.1012
3. 0.1102
4. 0.1002

2-18. Convert 12.510 to base 2.
1. 1100.102
2. 1010.012
3. 1001.102
4. 1101.012

2-19. Convert 33.3410 to base 2 (four places).
1. 11110.10102
2. 100001.10102
3. 100001.01012
4. 100010.10112

IN ANSWERING QUESTIONS 2-20 THROUGH 2-22, USE THE DIVISION METHOD TO CONVERT DECIMAL NUMBERS TO OCTAL.

2-20. 19310
1. 628
2. 1428
3. 3018
4. 4038

2-21. 74610
1. 13528
2. 25318
3. 14768
4. 23128

2-22. 300710
1. 50008
2. 56778
3. 47718
4. 41158

IN ANSWERING QUESTIONS 2-23 THROUGH 2-25, PERFORM THE INDICATED OPERATION.

2-23. Convert 0.30510 to octal (four places).
1. 0.57658

2. 0.14718
3. 0.30508
4. 0.23418

2-24. Convert 78.910 to octal (three places).
1. 100.4178
2. 103.7148
3. 116.7148
4. 116.1478

2-25. Convert 506.6610 to octal (four places).
1. 677.50638
2. 521.44018
3. 653.37748
4. 772.52178

2-26. What is the hex equivalent of 4510?
1. 1F16
2. 2416
3. 2A16
4. 2D16

2-27. What is the hex equivalent of 25510?
1. AE16
2. BC16
3. CG16
4. FF16

IN ANSWERING QUESTIONS 2-28 THROUGH 2-30, PERFORM THE INDICATED OPERATION.

2-28. Convert 160910 to hex.
1. 5A516
2. 64916
3. C4116
4. A9516

2-29. Convert 0.84 to hex (three places).
1. 0.D7016
2. 0.1F316
3. 0.AAC16
4. 0.C3E16

2-30. Convert 0.10910 to hex (four places).
1. 0.111416
2. 0.101F16
3. 0.1BE716
4. 0.09D416

2-31. What is the hex equivalent of 174.9510? Carry out two places.
1. 9F.C416
2. AE.F316
3. AE.9C16
4. BA.EC16

2-32. What is the hex equivalent of 7023.86910? Carry out to four places.
1. 1C5E.A9F616
2. 1B6F.DE7616
3. 1D7C.EC8716
4. 1AA9.DB1A16

IN ANSWERING QUESTIONS 2-33 THROUGH 2-38, CONVERT THE BINARY NUMBERS TO THEIR OCTAL EQUIVALENT.

2-33. 00110102
1. 1508
2. 0328
3. 0428
4. 0628

2-34. 0010100111002
1. 5168
2. 1478
3. 6678
4. 12348

2-35. 01010110111111012
1. 533758
2. 1557768
3. 2557718
4. 1267718

2-36. 0.11101010002
1. 0.15608
2. 0.16508
3. 0.7508
4. 0.7248

2-37. 1001000.000111102
1. 110.0748

2. 440.0368
3. 410.0708
4. 220.0748

2-38. 1111111011.111100112
1. 1773.7468
2. 7751.3638
3. 1773.6338
4. 7751.4738

IN ANSWERING QUESTIONS 2-39 THROUGH 2-42, CONVERT THE BINARY NUMBERS TO THEIR HEXADECIMAL EQUIVALENTS.

2-39. 1011012
1. B116
2. 5516
3. 1B16
4. 2D16

2-40. 1110101100102
1. EB216
2. EC416
3. 7B216
4. 726216

2-41. 0.01001111002
1. 0.4 F16
2. 0.9 E16
3. 0.13C16
4. 0.23616

2-42. 11011100.1100101010112
1. 670.625316
2. 9A.BAC16
3. DC.CAB16
4. AB.CDE16

IN ANSWERING QUESTIONS 2-43 THROUGH 2-45, CONVERT THE OCTAL NUMBERS TO THEIR BINARY EQUIVALENTS.

2-43. 5718
1. 1011110012
2. 10111112
3. 1010111012
4. 1101110102

2-44. 13128
1. 01011010102
2. 10110010102
3. 001110001012
4. 010101010102

2-45. 136.528
1. 1110110.1011002
2. 11011111.1010102
3. 01011011.0101012
4. 01011110.1010102

IN ANSWERING QUESTIONS 2-46 AND 2-47, PERFORM THE INDICATED OPERATIONS.

2-46. Convert 24.738 to hex.
1. 11.7616
2. 14.EC16
3. 24.7D16
4. 20.A616

2-47. Convert 657.138 to hex.
1. 328.06516
2. D37.2616
3. 1AF.2C16
4. 20A.B116

IN ANSWERING QUESTIONS 2-48 THROUGH 2-50, CONVERT THE HEX NUMBERS TO BINARY.

2-48. 2A16
1. 010010102
2. 001010102
3. 010011002
4. 000111002

2-49. E4716
1. 1110010001112
2. 1111010001112
3. 1100100011102
4. 1010101001112

2-50. 8C.1F16
1. 100111.001111102

Prepared by: Harlem A. Agnote

2. 10001100.000111112
3. 1001100.000111102
4. 10011101.000111112

IN ANSWERING QUESTIONS 2-51 AND 2-52, CONVERT THE HEX NUMBERS TO OCTAL.

2-51. 74E16
1. 74168
2. 72178
3. 35168
4. 46368

2-52. F1.C816
1. 741.6208
2. 661.3048
3. 331.648
4. 361.628

2-53. What is the decimal equivalent of 10112
1. 1310
2. 1110
3. 910
4. 1010

IN ANSWERING QUESTIONS 2-54 AND 2-55, PERFORM THE INDICATED OPERATION.

2-54. Convert 1011012 to decimal.
1. 5510
2. 2910
3. 3610
4. 4510

2-55. Convert 11101110112 to decimal.
1. 77310
2. 86710
3. 95510
4. 167310

IN ANSWERING QUESTIONS 2-56 THROUGH 2-60, CONVERT THE OCTAL NUMBERS TO THEIR DECIMAL EQUIVALENTS.

2-56. 1338
1. 10010
2. 10710
3. 6310
4. 9110

2-57. 27378
1. 189910
2. 150310
3. 210510
4. 151110

2-58. 777.78
1. 511.87510
2. 614.75010
3. 614.87510
4. 511.75010

2-59. 1603.758 (three places)
1. 1219.84010
2. 907.65010
3. 899.95310
4. 1143.15010

2-60. 2000.18
1. 1250.2510
2. 1024.12510
3. 969.510
4. 1000.0510

IN ANSWERING QUESTIONS 2-61 THROUGH 2-64, CONVERT THE HEX NUMBERS TO THEIR DECIMAL EQUIVALENTS.

2-61. 1B316
1. 43510
2. 118510
3. 239010
4. 427510

2-62. 10AF16
1. 427110
2. 298510
3. 341710
4. 400310

2-63. C3.616
1. 46.510

Prepared by: Harlem A. Agnote

2. 84.410
3. 150.50510
4. 195.37510

2-64. 4DD.E16
1. 1245.750510
2. 1245.875010
3. 733.750510
4. 733.937510

2-65. What term describes the use of four binary digits to represent one decimal digit?
1. Decimal-coded binary
2. Octal-coded binary
3. Binary-coded decimal
4. Hexadecimal notation

2-66. How many binary digits are required to represent the decimal number 243 in BCD?
1. 12
2. 8
3. 3
4. 4

IN ANSWERING QUESTIONS 2-67 AND 2-68, PERFORM THE INDICATED OPERATION.

2-67. Convert 38910 to BCD.
1. 0000 1110 0101BCD
2. 0011 0001 1101BCD
3. 0011 1000 1001BCD
4. 0011 0100 0101BCD

2-68. Convert 010001010111BCD to decimal.
1. 89710
2. 85710
3. 49710
4. 45710

2-69. Which of the following numbers has the highest decimal value?
1. 100110012
2. 111000012
3. 1001 1001BCD
4. 1000 0110BCD

2-70. Which of the following numbers is NOT a valid BCD number?
1. 0110
2. 1001
3. 1000
4. 1010

IN ANSWERING QUESTIONS 2-71 THROUGH 2-75, PERFORM THE INDICATED OPERATION.

2-71. Add:
0101BCD
0010BCD
1. 0111BCD
2. 1001BCD
3. 1010BCD
4. 1000BCD

2-72. Add:
1001BCD
0111BCD
1. 0001 0000BCD
2. 0001 0110BCD
3. 0111 0110BCD
4. 0001 1111BCD

2-73. Add:
1001BCD
+100BCD
1. 1101BCD
2. 0011BCD
3. 0001 0011BCD
4. 0001 0110BCD

2-74. Add:
0010 0011BCD
+ 0001 1000BCD
1. 0011 1011BCD
2. 0011 0001BCD
3. 0100 1011BCD
4. 0100 0001BCD

2-75. Add:
0110 0100BCD
+ 1001 0010BCD
1. 0000 1111 0110BCD

Prepared by: Harlem A. Agnote

2. 0001 0101 1100BCD
3. 0001 0101 0110BCD
4. 0001 0111 0100BCD

ASSIGNMENT 3

Textbook assignment: Chapter 2, “Fundamental Logic Circuits,” pages 2-1 through 2-36; and "Special Logic Circuits," Chapter 3, pages 3-1 through 3-3.

NOTE: UNLESS OTHERWISE INDICATED, ALL QUESTIONS AND ANSWERS REFER TO POSITIVE LOGIC.

3-1. Logic is the development of a reasonable conclusion based on known information.
1. T
2. F

3-2. Which of the following methods is used to represent the FALSE condition of the logic symbol, F?
1. (F)
2. [F]
3. F
4. F

3-3. Which of the following statements describes logic polarity?
1. Negative logic is indicated by a vinculum
2. Positive logic is always represented by a positive voltage
3. A logic 1 is a positive voltage; a logic 0 is a negative voltage
4. The change in voltage polarity to represent a logic 1

3-4. Which of the following examples represents positive logic?
1. −5v equals 0, −10v equals 1
2. +5v equals 0, +10v equals 1
3. +5v equals 1, +10v equals 0
4. −5v equals 1, +5v equals 0

3-5. Of the following examples, choose the one that represents negative logic.
1. −15v equals 0, −10v equals 1
2. −10v equals 1, −15v equals 0
3. 0v equals 0, −10v equals 1
4. − −5v equals 0, 0v equals 1

3-6. If the letter X represents an input to a logic device, what logic state of X must exist to activate the device or contribute to the activation of the device?
1. 0
2. 1
3. Positive logic
4. Negative logic

3-7. A chart that lists all possible input combinations and resultant output is called a
1. Truth Table
2. Decision Table
3. logic symbol listing
4. polarity magnitude listing

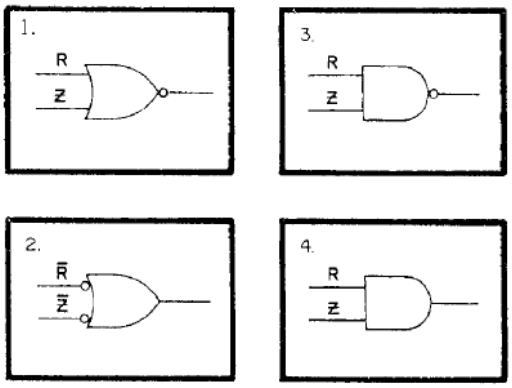
3-8. What is a logic gate?
1. A block diagram
2. An astable multivibrator
3. A bistable multivibrator
4. A decision-making circuit

3-9. Which of the following logic gates requires all inputs to be TRUE at the same time to produce a TRUE output?
1. OR
2. NOT
3. AND
4. NAND

3-10. Which of the following output Boolean expressions is/are correct for an AND gate?
1. f = AB
2. f = A·B
3. Both 1 and 2 above
4. A=B

3-11. Which of the following symbols represents the output Boolean expression RZ?

Prepared by: Harlem A. Agnote



ANSWER: 4

Figure 3A. AND gate timing diagram.

IN ANSWERING QUESTIONS 3-12 THROUGH 3-14, REFER TO FIGURE 3A.

3-12. At which of the following times will the output of a two input AND gate go HIGH?

1. T2, T5, and T8
2. T4 only
3. T2, T6, and T10
4. T4 and T9

3-13. At which of the following times will the output of the AND gate be LOW?

1. T1 to T4 and T5 to T8
2. T1 to T4 and T6 to T9
3. T4 to T6 and T8 to T10
4. T1 to T3 and T6 to T10

3-14. If input B were used instead of input B, how would the output be affected, if at all?

1. It would be HIGH from T2 to T 4
2. It would be LOW from T4 to T 6
3. It would be HIGH from T2 to T 3and T8 to T9
4. It would not be affected

3-15. What is the output Boolean expression for an AND gate having F, G, K, and L as inputs?

1. f = F GKL

2. f = F + GKL
3. f = F G K L
4. f = F G L

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 3B. Logic symbol diagram.

IN ANSWERING QUESTIONS 3-16 THROUGH 3-18, REFER TO FIGURE 3B.

3-16. Which of the following gates is represented by the symbol in the figure?

1. AND

2. OR

3. NOR
4. X-OR

3-17. What is the output Boolean expression for the gate?

1. X, Y+Z
2. X+Y
3. X+Y+Z
4. X Y Z

THIS SPACE LEFT BLANK INTENTIONALLY.

3-18. Which of the following Truth Tables correspond to the gate in the figure?

1.

X Y Z f
0 0 0 0
0 0 1 1
0 1 0 1
0 1 1 1
1 0 0 1
1 0 1 1
1 1 0 1
1 1 1 1

2.

X Y Z f
0 0 0 0
0 0 1 0
0 1 0 0
0 1 1 1
1 0 0 0
1 0 1 1
1 1 0 1
1 1 1 1

3.

Prepared by: Harlem A. Agnote

X Y Z f
0 0 0 0
0 0 1 1
0 1 0 1
0 1 1 0
1 0 0 1
1 0 1 0
1 1 0 0
1 1 1 1
4.
X Y Z f
0 0 0 0
0 0 1 1
0 1 0 1
0 1 1 1
1 0 0 0
1 0 1 1
1 1 0 1
1 1 1 1

Figure 3C. OR gate timing diagram.

IN ANSWERING QUESTIONS 3-19 THROUGH 3-21, REFER TO FIGURE 3C.

3-19. The gate will have a HIGH output at which of the following times?
1. T0 to T3, T4 to T7, and T8 to T9
2. T1 to T2 and T4 to T9
3. T3 to T4 and T7 to T8
4. T1 to T2 only

3-20. What are the input logic states between T5
and T6?
1. X = 1, Y = 0, Z = 0
2. X = 1, Y = 0, Z = 1
3. X = 0, Y = 1, Z = 0
4. X = 0, Y = 1, Z = 1

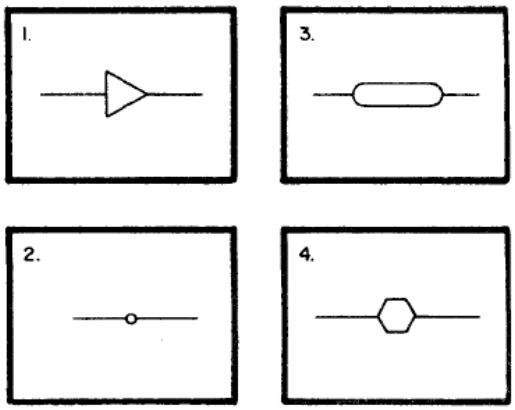
3-21. Between T0 and T6, at what times will the output of the gate be LOW?
1. T3 to T4
2. T2 to T5
3. T3 to T6
4. T0 to T1

3-22. What is the Boolean expression for an OR gate having the following inputs?

T (LOW)
R (LOW)
P (HIGH)
1. T R P
2. T R P
3. T + R + P
4. T + R + P

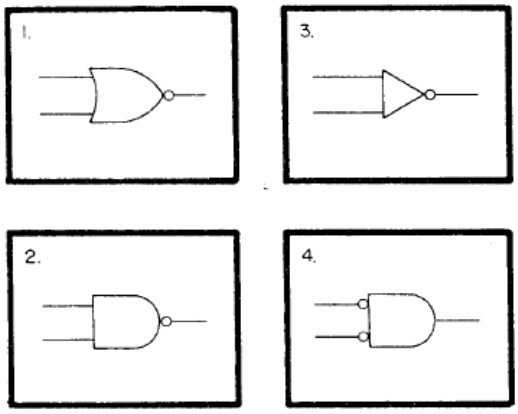
3-23. What is the purpose of an inverter?
1. To change logic polarity
2. To change voltage levels
3. To amplify the input
4. To complement the input

3-24. Which of the following symbols represents an inverter?



ANSWER: 2

3-25. Which of the following is the standard logic symbol for a NAND gate?



ANSWER: 2

3-26. What is the output expression for an inverter with the following input?
(RQ) + (S T)
1. (RQ) + (ST)
2. RQ S T
3. RQST
4. (RQ) (ST)

3-27. Which of the following gates produces a HIGH output when any or all of the inputs are LOW?
1. AND
2. OR
3. NAND
4. NOR

Figure 3D. Incomplete NAND gate Truth Table.
IN ANSWERING QUESTION 3-28, REFER TO FIGURE 3D.

3-28. Which of the following NAND gate input combinations and output function is missing?
1. X = 0, Y = 1, f = 0
2. X = 0, Y = 1, f = 1
3. X = 0, Y = 0, f = 0
4. X = 1, Y = 1, f = 1

3-29. What is the output Boolean expression for a NAND gate with inputs G, K, and P ?
1. GKP
2. GKP
3. GKP
4. G K P

3-30. The output of a NOR gate will be HIGH under which of the following conditions?
1. When all inputs are HIGH
2. When all inputs are LOW
3. When one input is HIGH
4. When one input is LOW

3-31. What is the output Boolean expression for a NOR gate with P , Q, and R as inputs?
1. P Q R
2. P Q R
3. P Q R
4. P Q R

Figure 3E. Input signal timing diagram.
IN ANSWERING QUESTIONS 3-32 THROUGH 3-34, REFER TO FIGURE 3E.

3-32. Figure 3E represents the input signals to a NOR gate. What is the output expression?
1. M + N
2. M N
3. M N
4. M N

3-33. At which of the following times will the output be HIGH?
1. T3 to T4
2. T8 to T9
3. T4 to T6 and T7 to T8
4. T3 to T4 and T8 to T9

3-34. What should the output be between times T3 and T4?
1. LOW
2. HIGH

Figure 3F. Logic gates.
IN ANSWERING QUESTIONS 3-35 THROUGH 3-37, REFER TO FIGURE 3F.

3-35. What is the output expression for gate D?
1. X Z
2. XZ
3. X Z
4. X Z

3-36. The Truth Tables are identical for which two gates?
1. C and D
2. A and D
3. B and C
4. A and B

3-37. Which gate represents the output expression XZ?
1. A
2. B
3. C
4. D

Prepared by: Harlem A. Agnote

Figure 3G. Logic circuit.
IN ANSWERING QUESTION 3-38, REFER TO FIGURE 3G.

3-38. Which of the following output expressions represents the output of gate 3?
1. (RS) (TV)
2. RS + TV
3. (RS) + (TV)
4. (RS) +(TV)

Figure 3H. Logic circuit.
IN ANSWERING QUESTIONS 3-39 AND 3-40, REFER TO FIGURE 3H.

3-39. The output expression JK represents the output of which, if any, of the following gates?
1. 1
2. 2
3. 3
4. None of the above

3-40. What is the output expression for gate 3?
1. JK(L M)
2. (J K)(LM)
3. (J K) (LM)
4. K(J 1)(LM)

Figure 3I. Logic circuit.
IN ANSWERING QUESTIONS 3-41 THROUGH 3-45, REFER TO FIGURE 3I.

3-41. What is the output expression for gate 105?
1. (RS) (T V)
2. RSTV
3. (RS)(T V)
4. (RS) (T V)

3-42. Which of the following gates provides a common output to two other gates?
1. 101
2. 102
3. 104
4. 106

3-43. Which of the following expressions represents the output of gate 106?
1. WXTV
2. W X T V
3. (TV) (WX)
4. (T V) (WX)

3-44. Which of the following conditions will cause gate 107 output to be HIGH?
1. Gate 106 is LOW; Y and Z are HIGH
2. Gate 106 is LOW; Y is HIGH, Z is LOW
3. Gate 106 is HIGH; Y and Z are LOW
4. Gate 106 is HIGH; Y is LOW, Z is HIGH

3-45. What is the output expression for gate 107?
1. (TV WX)(Y Z)
2. (T V W X)(YZ)
3. ((T+V)+(W+X))(YZ)
4. (T V)(WX)(Y Z)

3-46. Boolean algebra is used primarily by which of the following groups?
1. Fabricators
2. Technicians
3. Design engineers
4. Repair personnel

3-47. Which of the following Boolean laws states, "a term that is TRUE in one part of an expression will be TRUE in all parts of the expression"?
1. Identity
2. Commutative
3. Complementary
4. Double negative

3-48. The examples AB = BA and A+B = B+A represent which of the following Boolean laws?
1. Associative
2. Commutative
3. Intersection

Prepared by: Harlem A. Agnote

4. Union

3-49. What type of logic gate is modified to produce an exclusive OR gate?
1. AND
2. NAND
3. OR
4. NOR

3-50. Which of the following symbols represents the operation function of an exclusive OR gate?
1.
**2. **
3.
4.

Figure 3J. Logic gate.
IN ANSWERING QUESTIONS 3-51 AND 3-52, REFER TO FIGURE 3J.

3-51. What will be the output of the gate when (a) X is HIGH and Z is LOW, and (b) X and Z are both HIGH?
1. (a) LOW (b) LOW
2. (a) LOW (b) HIGH
3. (a) HIGH (b) LOW
4. (a) HIGH (b) HIGH

3-52. What will be the output of the gate when (a) X and Z are both LOW and (b) X is LOW and Z is HIGH?
1. (a) LOW (b) LOW
2. (a) LOW (b) HIGH
3. (a) HIGH (b) LOW
4. (a) HIGH (b) HIGH

3-53. Which of the following symbols represents an exclusive NOR gate?

3-54. What is the output of an exclusive NOR gate when (a) all inputs are LOW and (b) all inputs are HIGH?
1. HIGH (b) HIGH
2. LOW (b) HIGH
3. HIGH (b) LOW
4. LOW (b) LOW

3-55. What is the output expression for an exclusive NOR gate with R and T as inputs?
1. R T
2. R
3. R
4. R T

ASSIGNMENT 4

Textbook assignment: Chapter 4, "Special Logic Circuits," pages 3-3 through 3-67.

4-1. Which of the following circuits will add two binary digits but not produce a carry?
1. AND gate
2. Half adder
3. Quarter adder
4. Summation amplifier

Figure 4A.—Logic circuit.

IN ANSWERING QUESTIONS 4-2 THROUGH 4-5, REFER TO FIGURE 4A.

4-2. What type of circuit is depicted in the figure?
1. Inverter amplifier
2. Half subtracter
3. Half adder
4. Quarter adder

4-3. Which of the following gates will have HIGH outputs when K is HIGH and L is LOW?
1. 1 only
2. 3 only
3. 1 and 2
4. 1 and 3

4-4. What will be the output of gate 3 when K and L are both HIGH?
1. LOW
2. HIGH

4-5. Assume that K and L are both HIGH. Which of the following statements represents the output of gate 3?
1. 1 plus 1 = 0 (No carry)
2. 1 plus 0 = 1
3. 0 plus 1 = 1
4. 0 plus 0 = 0

4-6. Which of the following gates performs the same function as a quarter adder?
1. Half adder
2. Exclusive OR
3. NOR
4. Exclusive NOR

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 4B.—Logic circuit.

IN ANSWERING QUESTIONS 4-7 THROUGH 4-9, REFER TO FIGURE 4B.

4-7. Which of the following circuits is shown in the figure?
1. Quarter adder
2. Half adder
3. Full adder
4. Subtracter

4-8. Which of the following gate combinations may be replaced with an exclusive OR gate?
1. 1, 2, and 3
2. 1, 2, and 4
3. 1, 3, and 4
4. 2, 3, and 4

4-9. The output of gate 3 is the (a) and the output of gate 4 is the (b).
1. (a) Carry (b) sum
2. (a) Sum (b) difference
3. (a) Sum (b) carry
4. (a) Carry (b) difference

4-10. What is the largest sum that can be obtained from a half adder?
1. 012
2. 102
3. 112
4. 1002

4-11. Which of the following statements describes the difference between a half adder and a full adder?
1. A half adder produces a carry
2. A full adder produces a carry
3. A half adder will add a carry from

Prepared by: Harlem A. Agnote

another circuit
4. A full adder will add a carry from another circuit
THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 4C.—Logic circuit.

IN ANSWERING QUESTIONS 4-12 THROUGH 4-14, REFER TO FIGURE 4C.

4-12. What type of circuit is shown in the figure?
1. Full adder
2. Subtracter adder
3. Double half adder
4. Double exclusive OR

4-13. If A and B are 0 and C is 1, what will be the outputs at D and E?
1. D = 0, E = 0
2. D = 0, E = 1
3. D = 1, E = 0
4. D = 1, E = 1

4-14. Under which of the following conditions will outputs D and E both be HIGH?
1. A, B, and C are HIGH
2. A and B are HIGH, C is LOW
3. A and B are LOW, C is HIGH
4. A, B, and C are LOW

4-15. What is the largest sum that can be obtained from a full adder?
1. 102
2. 112
3. 1002
4. 1112

4-16. How many full adders are required to form a parallel adder capable of adding 100012 and 10002?
1. Five
2. Six
3. Three
4. Four

4-17. Which of the following statements describes the method used in computers to subtract binary numbers?
1. R's complement the minuend and add to the subtrahend
2. Add the minuend and subtrahend and complement the sum
3. R's complement the subtrahend and add to the minuend
4. Subtract the subtrahend from the minuend and complement the difference

Figure 4D.—Adder/subtracter circuit.

IN ANSWERING QUESTIONS 4-18 THROUGH 4-20, REFER TO FIGURE 4D.

4-18. What type of complement is performed by X-OR gates 1 and 2?
1. R's complement
2. Minuend complement
3. R's + 1 complement
4. Difference complement

4-19. Which of the following inputs is used for the least significant digit of the minuend?
1. A1
2. A2
3. B1
4. B2

4-20. What will be the output of (a) X-OR 2 and (b) X-OR 1 in the subtract mode with a subtrahend of 102?
1. (a) 0 (b) 0
2. (a) 0 (b) 1
3. (a) 1 (b) 0
4. (a) 1 (b) 1

4-21. Flip-flops are what type of multivibrators?
1. Astable
2. Monostable
3. Free running
4. Bistable

4-22. Flip-flops may NOT be used for which of the following operations?
1. Temporary storage

2. Subtraction
3. Division
4. Transfer of information

4-23. When, if ever, will the outputs Q and Q of an R-S flip-flop be the same?
1. When R and S are both LOW
2. When R is LOW and S is HIGH
3. When R is HIGH and S is LOW
4. Never

Figure 4E.—R-S flip-flop with timing diagram.
WHEN ANSWERING QUESTIONS 4-24 AND 4-25, REFER TO FIGURE 4E.

4-24. Assume the flip-flop is set at T0. At which of the following times will the flip-flop be reset?
1. T1 to T3, T5 to T6, and T9 to T10
2. T0 to T1, T3 to T5, and T6 to T9
3. T1 to T3, T5 to T7, and T9 to T10
4. T1 to T4, T5 to T7, and T9 to T10

4-25. What happens to the flip-flop at T6?
1. It sets
2. It resets
3. It sets and immediately resets
4. It remains reset

4-26. Which of the following statements describes a toggle flip-flop?
1. A monostable device
2. An astable device that changes state only on a set pulse
3. A two input bistable device
4. A bistable device with a single input

4-27. A T flip-flop is used primarily for which of the following functions?
1. To divide the input frequency by two
2. To double the input frequency
3. To amplify the input frequency
4. To invert the input frequency

4-28. What are the inputs to a D flip-flop?
1. Set and reset
2. Set and clock
3. Data and clock
4. Reset and data

4-29. What is the purpose of a D flip-flop?
1. To eliminate the output of the equipment
2. To divide the data input by the clock frequency
3. To store data until it is needed
4. To toggle the data input

4-30. An inverter on the clock input has which of the following effects on the D flipflop?
1. The output will change on the negative-going transition of the clock pulse
2. The output will change on the positive-going transition of the clock pulse
3. The data input will change at the clock frequency
4. The output will change at the clock frequency

4-31. Which of the following statements is true concerning CLR and PR pulses to the D flip-flop?
1. CLR causes Q to go high, PR causes Q to go low
2. CLR and PR override any existing output condition
3. Other inputs override CLR and PR
4. CLR and PR have no effect on the output

4-32. Which of the following statements is correct concerning D flip-flops?
1. The output is delayed up to one clock pulse
2. Input data is delayed until it coincides with the clock
3. The clock is delayed until it coincides with the input data
4. The output is always a square wave

Figure 4F.—Standard symbol for a J-K flip-flop.
WHEN ANSWERING QUESTIONS 4-33 THROUGH 4-36, REFER TO FIGURE 4F.

4-33. The flip-flop shown in the figure may be used in place of which of following flipflops?
1. R-S
2. T
3. D
4. Each of the above

4-34. With the clock applied and J and K inputs held HIGH, what is the output at Q?
1. Constant HIGH
2. Constant LOW
3. Toggle at one half the clock frequency
4. Toggle at twice the clock frequency

4-35. What will be the Q output if K is HIGH and CLK goes HIGH?
1. HIGH
2. LOW

4-36. A pulse on which of the following inputs will cause the flip-flop to set regardless of the other inputs?
1. CLK
2. CLR
3. J or K
4. PR or PS

4-37. The circuit which generates a timing signal to control operations is called a/an
1. clock
2. counter
3. oscillator
4. bistable multivibrator

4-38. Which of the following statements is true regarding astable multivibrators used as clocks?
1. As multivibrator frequency increases, stability decreases
2. Output 2 will have a higher voltage than output 1
3. The frequency stability may be increased by applying a higher frequency trigger
4. A trigger of lower frequency will stabilize the output frequency

4-39. Which of the following types of circuits will produce a stable clock when triggered by an outside source?
1. R-S flip-flop
2. Bistable multivibrator
3. One-shot multivibrator
4. D flip-flop

4-40. Which of the following types of clocks would probably be used in a complex piece of equipment with a variety of timing requirements?
1. Single triggered-monostable
2. Single free-running
3. Triggered-astable for each section of the equipment
4. Multiphase

4-41. What is the modulus of a 3-stage binary counter?
1. 7
2. 8
3. 3
4. 4

4-42. Counters may be used for which of the following purposes?
1. Counting operations, quantities and time
2. Dividing frequency
3. Addressing information in storage
4. Each of the above
THIS SPACE LEFT BLANK INTENTIONALLY

Figure 4G.—Standard symbol circuit.
WHEN ANSWERING QUESTIONS 4-43 THROUGH 4-46, REFER TO FIGURE 4G. FOR EACH QUESTION, ASSUME THAT ALL FFs ARE INITIALLY RESET.

4-43. What type of circuit is shown?
1. J-K flip-flops
2. Clock

Prepared by: Harlem A. Agnote

3. Shift register
4. Ripple counter

4-44. Assume all lights are out. After 6 input pulses, which two lamps will be lit?
1. A and B
2. A and C
3. B and C
4. B and D

4-45. Assume all lamps are out. After 16 input pulses, which lamps, if any, will be lit?
1. A, B, C, and D
2. B, C, and D
3. A, B, and D
4. None

4-46. What is the main disadvantage of using this circuit with a high frequency input?
1. The circuit will burn up
2. Possible errors in the output
3. The flip-flops will act as T flip-flops
4. Above a certain frequency the circuit will count in the opposite direction

Figure 4H.—Counter circuit.
WHEN ANSWERING QUESTIONS 4-47 THROUGH 4-50, REFER TO FIGURE 4H.

4-47. What is the maximum count that this counter is capable of holding?
1. 58
2. 78
3. 38
4. 48

4-48. What type of counter is shown?
1. Ring
2. Asynchronous
3. Synchronous
4. Decade

4-49. Under which of the following conditions will the output of the AND gate be HIGH?
1. FF 1 and FF 2 are set
2. FF 1 and FF 2 are reset
3. FF 2 and FF 3 are set
4. FF 1 and FF 3 are reset

4-50. With all the FFs initially reset, the AND gate output will be HIGH after how many input pulses?
1. 3 only
2. 4 only
3. 7 only
4. 3 and 7

Figure 4I.—Counter circuit.
WHEN ANSWERING QUESTIONS 4-51 AND 4-52, REFER TO FIGURE 4I.

4-51. What is the maximum binary count that will be shown before all the flip-flops reset?
1. 1112
2. 10102
3. 11112
4. 10002

4-52. To change the maximum count from 1010 to 910, which two flip-flops would be wired as NAND gate inputs?
1. FF 1 and FF 2
2. FF 2 and FF 3
3. FF 1 and FF 4
4. FF 1 and FF 3
THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 4J.—Counter circuit.
WHEN ANSWERING QUESTIONS 4-53 THROUGH 4-55, REFER TO FIGURE 4J.

4-53. Which of the following types of counters is shown in the figure?
1. Ring
2. Asynchronous
3. Synchronous
4. Decade

4-54. At any given time, how many flip-flops may be set?
1. Only one
2. Any two

3. Any three
4. All

4-55. Which of the following conditions must exist to set FF 3?
1. AND gate 1 output HIGH
2. AND gate 2 output HIGH
3. AND gate 3 output LOW
4. Clock input to AND gate 3 LOW and AND gate 4 output HIGH

THIS SPACE LEFT BLANK INTENTIONALLY

Figure 4K.—Down counter.
WHEN ANSWERING QUESTIONS 4-56 AND 4-57, REFER TO FIGURE 4K.

4-56. Assume only FF 1 and FF 3 are set. Which, if any, of the flip-flops will be set after the next clock pulse?
1. FF 2 only
2. FF 3 only
3. FF 2 and FF 3
4. None

4-57. Assume that all FFs are set, which of the following actions will take place at clock pulse 4?
1. FF 1, FF 2 and FF 3 will set
2. FF 1 will set, FF 2 and FF 3 will reset
3. FF 1, FF 2, and FF 3 will reset
4. FF 1 and FF 2 will set, FF 3 will reset

4-58. What term identifies a series of FFs designed to temporarily store information?
1. Data word
2. Counter
3. Register
4. DIP package

4-59. Which of the following statements describes parallel transfer?
1. Data is transferred one bit at a time
2. All data bits are transferred simultaneously
3. Data is received in serial form and transferred in parallel form
4. Data is transferred on a single line

Figure 4L.—Parallel register.
WHEN ANSWERING QUESTIONS 4-60 AND 4-61, REFER TO FIGURE 4L.

4-60. Which of the following methods will clear the register of old information no longer needed?
1. A HIGH applied to the READ IN line
2. A HIGH applied to the RESET line
3. A LOW applied on the RESET and a HIGH on the READ OUT lines
4. HIGHs are applied on the A, B, C, D, and READ IN lines

4-61. Under which of the following conditions will the output of gate 7 be HIGH?
1. When FF 3 and RESET are HIGH
2. When gate 3 and FF 3 are HIGH
3. When FF 3 and READ OUT are HIGH
4. When the output of gate 3 is HIGH

THIS SPACE LEFT BLANK INTENTIONALLY

Figure 4M.—Shift register.
WHEN ANSWERING QUESTIONS 4-62 THROUGH 4-67, REFER TO FIGURE 4M.

4-62. Which of the following operations is the circuit capable of performing?
1. Serial-to-parallel conversion
2. Parallel-to-serial conversion
3. Left shifts
4. Each of the above

4-63. What is the maximum word length the register is capable of handling?
1. 6 bit
2. 5 bit
3. 3 bit
4. 4 bit

4-64. How many clock/shift pulses are required to serially input a word into the register?
1. 1
2. 5
3. 3
4. 4

4-65. To output a word in parallel form, how many output lines are required?
1. 1
2. 2
3. 4
4. 8

4-66. To increase the value of a word by one power of 2, how many shifts are required?
1. 1
2. 2
3. 3
4. 0

4-67. Which of the following operations takes the longest time?
1. Serial in, parallel out
2. Serial in, serial out
3. Parallel in, serial out
4. Parallel in, parallel out

4-68. Shifting a word in a shift register 3 places to the left is equal to multiplying the number by how much?
1. 1010
2. 210
3. 810
4. 410

4-69. Logic families are identified by which of the following means?
1. Logic polarity required
2. The types of elements used
3. Size and cost of manufacture
4. Packaging (DIP, TO, flat packs)

4-70. A TTL logic circuit would use which of the following types of elements?
1. Diode-transistor
2. Resistor-transistor
3. Transistor-transistor
4. Complementary metal oxide Semiconductors

MODULE 14

INTRODUCTION TO MICROELECTRONICS

PREPARED BY:

Marianne Dane Trinidad

1-1. What term is used to describe electronic systems that are made up of extremely small parts or elements?
1. Microelectronics
2. Modular packages
3. Integrated circuits
4. Solid-state technology

1-2. During World War II, which of the following limitations were considered unacceptable for military electronics systems?
1. Large size, heavy weight, and wide bandwidth
2. Excessive power requirements, large size, and complex manning requirements
3. Large size, heavy weight, and excessive power requirements
4. Heavy weight, complex circuits and limited communications range

1-3. The development of which of the following types of components had the greatest impact on the technology of microelectronics?
1. Vacuum tubes and resistors
2. Transformers and capacitors
3. Vacuum tubes and transistors
4. Transistors and solid-state diodes

1-4. For a vacuum tube to operate properly in a variety of different circuit applications, additional components are often required to "adjust" circuit values. This is because of which of the following variations within the vacuum tube?
1. Element size
2. Warm-up times
3. Plug-in mountings
4. Output characteristics

1-5. Point to point wiring in a vacuum tube circuit often caused which of the following unwanted conditions?
1. Heat interactions
2. Inductive interactions
3. Capacitive interactions
4. Both 2 and 3 above

1-6. Functional blocks of a system that can easily be removed for troubleshooting and repair are called
1. sets
2. chassis
3. modules
4. vacuum tubes

1-7. Which of the following characteristics of a printed circuit board (pcb) is NOT an advantage over a point-to-point wired tube circuit?
1. The pcb weighs less
2. The pcb eliminates the need for point-to-point wiring
3. The pcb eliminates the need for a heavy metal chassis
4. The pcb contains a limited number of components

1-8. A module in which the components are supported by end plates is referred to as
1. a pcb
2. cordwood
3. a substrate
4. encapsulated

1-9. A module which is difficult to repair because it is completely imbedded in solid material is one which has been
1. balanced
2. enveloped
3. integrated
4. encapsulated

1-10. All components and interconnections are formed on or within a single substrate in which of the following units?
1. Cordwood
2. Integrated circuit
3. Equivalent circuit
4. Printed circuit board

1-11. Monolithic integrated circuits are

usually referred to as
1. hybrids
2. substrates
3. silicon chips
4. selenium rectifiers

1-12. In integrated circuits, a conductive or nonconductive film is used for which of the following types of components?
1. Capacitors and diodes
2. Transistors and diodes
3. Resistors and capacitors
4. Resistors and transistors

1-13. Which of the following types of electronic circuits is NOT a hybrid integrated circuit?
1. Thick film and transistors
2. Thin film and silicon chips
3. Transistors and vacuum tubes
4. Silicon chips and transistors

1-14. What maximum number of logic gates should be expected in a large-scale integration circuit?
1. 20
2. 200
3. 2,000
4. 20,000

1-15. Integrated circuits containing more than 64,000 bits of memory are referred to as
1. hybrid integration
2. large-scale integration
3. small-scale integration
4. very large-scale integration

1-16. Which of the following pieces of equipment is used to prepare component layout in complex ICs?
1. A mask
2. A camera
3. A computer
4. A microscope

1-17. A device that allows the depositing of material in selected areas of a semiconductor substrate, but not in others, is known as a
1. blind
2. screen
3. filter
4. wafer mask

1-18. Which of the following types of material is preferred for film circuit substrates?
1. Silicon
2. Ceramic
3. Germanium
4. Fiberglass

1-19. A typical silicon wafer has approximately (a) what diameter and (b) what thickness?
1. (a) 2 inches (b) 0.01 to 0.02 inches
2. (a) 2 inches (b) 0.21 to 0.40 inches
3. (a) 3 inches (b) 0.21 to 0.40 inches
4. (a) 3 inches (b) 0.01 to 0.20 inches

1-20. Artificially grown silicon or germanium crystals are used to produce substrates for which of the following types of integrated circuits?
1. Hybrid
2. Thin-film
3. Thick-film
4. Monolithic

1-21. Elements penetrate the semiconductor substrate in (a) what type of IC but (b) do NOT penetrate the substrate in what type of IC?
1. (a) Diffused (b) thin-film
2. (a) Diffused (b) epitaxial
3. (a) Thick-film (b) epitaxial
4. (a) Thick-film (b) thin-film

1-22. Pn junctions are protected from contamination during the fabrication process by which of the following materials?
1. Oxide
2. Silicon
3. Germanium
4. Photoetch

1-23. The prevention of unwanted interaction or leakage between components is accomplished by which of the following techniques?
1. Isolation
2. Insulation
3. Integration
4. Differentiation

1-24. Vacuum evaporation and cathode sputtering are two methods used to produce which of the following types of components?
1. Diodes
2. Thin-film
3. Thick-film
4. Transistors

1-25. To deposit highly reactive materials on a substrate, which of the following methods is used?
1. Photoetching
2. Photolithography
3. Cathode sputtering
4. Vacuum evaporation

1-26. To produce thin film resistors, which of the following materials is/are used?
1. Nichrome
2. Tantalum
3. Titanium
4. Each of the above

1-27. Which of the following is a major advantage of hybrid ICs?
1. Ease of manufacture
2. Ease of replacement
3. Design flexibility
4. Easy availability

1-28. IC packaging is required for which of the following reasons?
1. To dissipate heat
2. For ease of handling
3. To increase shelf life
4. To meet stowage requirements

1-31. Which of the following types of DIPs are most commonly used in the Navy's microelectronics systems?
1. Glass
2. Metal
3. Ceramic
4. Plastic

1-32. In IC production, gold or aluminum bonding wires are used for which of the following purposes?
1. To bond the chip to the package
2. To provide component isolation
3. To connect the package to the circuit board
4. To connect the chip to the package leads

1-33. IC packages that may be easily installed by hand or machine on mounting boards fall into which of the following categories?
1. TO
2. DIP
3. Flatpack
4. Each of the above

1-34. The need for bonding wires has been eliminated by which of the following production techniques?
1. LSI
2. Beam lead
3. Flip chip
4. Both 2 and 3 above

1-38. Letters and numbers stamped on the body of an IC serve to provide which of the following types of information?
1. Use
2. Serial number
3. Date of manufacture
4. Applicable equipment

1-39. Descriptive information about a particular type of IC may be found in which of the following documents?
1. The manufacturer's data sheet
2. The equipment Allowance Part List(APL)
3. The National Stock Number (NSN)
4. The IC identification number list

1-40. Assemblies made up EXCLUSIVELY of discrete electronic parts are classified as
1. vacuum-tube circuits
2. microcircuit modules
3. hybrid microcircuits
4. miniature electronics circuits

1-41. An assembly of microcircuits or a combination of microcircuits and discrete components is referred to as a
1. mother board
2. microprocessor
3. miniature module
4. microcircuit module

1-42. A technician has isolated a problem to a plug-in module on a printed circuit board. What is this level of system packaging?
1. Level O
2. Level I
3. Level II
4. Level III

1-43. A faulty transistor would be identified as what level of packaging?
1. Level O
2. Level I
3. Level II
4. Level III

1-44. A chassis located in a radar antenna pedestal would be identified as what level of system packaging?
1. Level I
2. Level II
3. Level III
4. Level IV

1-45. Which of the following characteristics is NOT an advantage of multilayer printed circuit boards?
1. Allows greater wiring density on boards
2. Provides shielding for a large number of conductors
3. Eliminates complicated wiring harnesses
4. Reduces the number of components per board

1-46. Which of the following circuit connection methods is NOT used in making interconnections on a multilayer printed circuit board interconnection?
1. Terminal lug
2. Clearance hole
3. Layer build-up
4. Plated-through hole

1-47. The most complex to produce and difficult to repair printed circuit boards are those made using which of the following methods?
1. Layer-buildup
2. Clearance-hole
3. Step-down-hole
4. Plated-through-hole

1-48. Environmental performance requirements for ICs are set forth in which of the following publications?
1. 2M repair manual
2. Military Standards
3. System maintenance manuals
4. Manufacturer's data sheet

1-49. Ground planes and shielding are used to prevent which of the following electrical interactions?
1. Cross talk
2. External interference
3. The generation of rf within the system
4. All of the above

1-50. Training requirements for miniature and microminiature (2M) repair personnel was established by which of the following authorities?
1. Chief of Naval Education and Training
2. Chief of Naval Technical Training
3. Chief of Naval Operations
4. Commander, Naval Sea Systems

Prepared by: Harlem A. Agnote

Command

1-51. The standards of workmanship and guidelines for specific repairs to equipment are contained in which of the following Navy publications?
1. Introduction to Microelectronics
2. NAVSHIPS Technical Manual
3. Electronics Installation and Maintenance Books (EIMB)
4. Miniature/Microminiature (2M) Electronic Repair Program

1-52. A technician is authorized to perform 2M repairs upon satisfactory completion of which of the following types of training?
1. A 2M training class
2. On-the-job training
3. NEETS, Module 14
4. Any electronics class "A" school

1-53. Repairs that are limited to discrete components and single- and doublesided boards are classified as what level of repairs?
1. Intermediate
2. Organizational
3. Miniature component
4. Microminiature component

1-54. To ensure that a 2M technician maintains the minimum standards of workmanship, the Navy requires that the technician meet which of the following requirements?
1. Be licensed
2. Be certified
3. Be experienced
4. Be retrained

1-55. If a technician should fail to maintain the required standards of workmanship, the technician's certification is subject to what action?
1. Cancellation
2. Recertification
3. Reduction to next lower level
4. Withholding pending requalification

1-56. The most extensive shop facilities and highly skilled technicians are located at what SM & R level of maintenance?
1. Depot
2. Operational
3. Intermediate
4. Organizational

1-57. SM & R code D maintenance facilities are usually located at which of the following activities?
1. Shipyards
2. Contractor maintenance organizations
3. Shore-based facilities
4. All of the above

1-58. Direct support to user organizations is provided by which of the following SM & R code maintenance levels?
1. Depot
2. Operational
3. Intermediate
4. Organizational

1-59. Inspecting, servicing, and adjusting equipment is the function of which of the following SM & R code maintenance levels?
1. Depot
2. Operational
3. Intermediate
4. Organizational

1-60. The maintenance level at which normal 2M repairs are performed is set forth in the maintenance plan and specified by the
1. NAVSEA 2M Repair Program
2. Source, Maintenance, and Recoverability (SM & R) code
3. Chief of Naval Operations
4. Equipment manufacturers' documentation

1-61. Boards or modules that are SM & R code D may be repaired at the organizational level under which of the

following conditions?
1. On a routine basis
2. When parts are available
3. To meet an urgent operational commitment
4. When code D repair will take six weeks or longer

1-62. Source, Maintenance, and Recovery (SM & R) codes that list where repair parts may be obtained, who is authorized to make the repair, and the maintenance level for the item are found in which of the following documents?
1. Allowance Equipage Lists (AEL)
2. Allowance Parts Lists (APL)
3. Manufacturer's Parts List
4. Navy Stock System

1-63. Test equipment that continuously monitors performance and automatically isolates faults to removable assemblies is what category of equipment?
1. On-line
2. Off-line
3. General purpose
4. Fault isolating

1-64. A dc voltmeter that is permanently attached to a power supply for the purpose of monitoring the output is an example of what type test equipment?
1. General Purpose Electronic Test Equipment (GPETE)
2. Built in Test Equipment (BITE)
3. Off-line test equipment
4. Specialized test equipment

1-65. Which of the following types of test equipment is classified as off-line automatic test equipment?
1. Centralized Automatic Test System (CATS)
2. Versatile Avionic Shop Test System (VAST)
3. General Purpose Electronic Test Equipment (GPETE)
4. Test Evaluation and Monitoring System (TEAMS)

1-66. Fault diagnosis using GPETE should only be attempted by which of the following personnel?
1. Officers
2. Technician strikers
3. Experienced technicians
4. Basic Electricity and Electronics school graduates

1-67. During fault isolation procedures, a device or component should be desoldered and removed from the circuit only at which of the following times?
1. After defect verification
2. For out-of-circuit testing
3. During static resistance checks
4. At any time the technician desires

1-68. 2M repair stations are equipped according to the types of repairs to be accomplished. The use of microscopes and precisions drill presses would be required in which of the following types of repair?
1. Miniature
2. Microminiature
3. Both 1 and 2 above
4. Emergency

1-69. In the selection of a soldering iron tip, which of the following factors should be considered?
1. The complexity of the pcb
2. The composition of the pcb
3. The area and mass being soldered
4. The type of component being soldered

1-70. The handpiece that can be used for the greatest variety of operations is the
1. solder extractor
2. rotary-drive tool
3. resistive tweezers
4. lapflow and thermal scraper handtool

1-71. Regardless of location, 2M repair

stations require adequate work surface area, lighting, power, and what other minimum requirement?
1. Heat source
2. Ventilation
3. Illumination
4. Dust-free space

1-72. Solder used in electronics is an alloy composed of which of the following metals?
1. Tin and zinc
2. Tin and lead
3. Lead and zinc
4. Lead and copper

1-73. A roll of solder is marked 60/40. What do these numbers indicate?
1. 60% tin, 40% lead
2. 60% tin, 40% copper
3. 60% lead, 40% tin
4. 60% lead, 40% copper

1-74. Which of the following alloys will melt directly into a liquid and have no plastic or semiliquid state?
1. Metallic alloy
2. Eutectic alloy
3. Zinc-lead alloy
4. Copper-zinc alloy

1-75. The PREFERRED solder alloy ratio for electronic repair is 63/37. Which of the following alloy ratios is also ACCEPTABLE for this type of repair?
1. 30/70
2. 50/50
3. 60/40
4. 70/30

MODULE 15

PRINCIPLES OF SYNCHROS, SERVOS, AND GYROS

PREPARED BY:

Charlotte Vivien Casaul and Jonathan Dino

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Synchros," pages 1-1 through 1-78.

1-1. Which of the following terms accurately describes a synchro?
1. Position-sensing
2. Electromechanical
3. Rotary
4. Each of the above

1-2. What are the two general classifications of synchro systems?
1. Torque and load
2. Torque and control
3. Load and control
4. Load and lock

1-3. What is the difference in application between the two classifications of synchros?
1. Light versus heavy load
2. Mechanical versus electrical Output
3. Circular versus straight-line motion
4. High-frequency versus low-frequency operation

1-4. Which of the following types of synchro devices provides a mechanical output?
1. A control transformer
2. A torque receiver
3. A torque transmitter
4. A control transmitter

1-5. A 115-volt, 400-Hz torque transmitter with a diameter of 2.36 inches will have what military standard designation code?
1. 115 V-23CT6
2. 115 V-24TT4
3. 23TD4
4. 24TX4

1-6. A 3.5-inch diameter differential receiver will have what Navy prestandard designation code?
1. 35CR
2. 35TDR
3. 5D
4. 5DG

1-7. What does the arrow on a synchro schematic symbol indicate?
1. The direction of current flow
2. The direction of rotor movement
3. The angular position of the stator
4. The angular position of the rotor

1-8. What are the two major components of a synchro?
1. The rotor and the stator
2. The housing and the stator
3. The rotor and the shaft
4. The housing and the shaft

1-9. What type of rotor can be composed of a single winding or three Y-connected windings?
1. Salient-pole
2. Drum or wound
3. Fixed
4. "H"

1-10. How does the stator of a TX receive voltage?
1. By a physical connection with the rotor
2. By a magnetic coupling with another stator
3. By a magnetic coupling with the rotor
4. By a physical connection with a source

1-11. What part of a synchro provides a point for external connections?
1. The terminal board
2. The slip ring
3. The stator
4. The brush

1-12. Which of the following terms is defined

as the amount of load a machine can turn?
1. Radian force
2. Load factor
3. Torque
4. Tension

1-13. Which of the following units should be used in measuring the amount of turning force of a synchro?
1. Ounces
2. Pounds
3. Foot-pounds
4. Ounce-inches

1-14. An overloaded synchro will probably exhibit which of the following conditions?
1. Overspeed
2. Oscillation
3. Excessive temperature
4. Noisy operation

1-15. A synchro receiver has which of the following characteristics that is NOT found in an ordinary transformer?
1. A primary that can rotate in relation to the secondary
2. A primary magnetically coupled to the secondary
3. A step-up turns ratio
4. An air core

1-16. When a synchro transmitter is in the zero-degree position, the rotor is aligned in what manner?
1. With winding S1
2. With winding S2
3. With winding S3
4. Between winding S1 and S2

1-17. Maximum voltage is induced in a stator winding of a synchro transmitter when the rotor and the stator winding have what angle between them?
1. 0 degrees
2. 30 degrees
3. 60 degrees
4. 90 degrees

1-18. Which of the following factors does NOT affect the amplitude of the voltage induced in a stator winding of a synchro transmitter?
1. The angular displacement between the rotor and stator
2. The amplitude of the primary voltage
3. The speed of data transmission
4. The turns ratio of the synchro

1-19. Damping is necessary for which of the following synchro devices?
1. Receiver
2. Transmitter
3. Control transformer
4. Differential transmitter

1-20. The primary purpose of damping is to reduce which of the following conditions in a synchro device?
1. Readings 180º out of phase
2. Overheating
3. Oscillating
4. Each of the above

1-21. What is the minimum number of synchro devices needed for a simple synchro transmission system?
1. One
2. Two
3. Three
4. Four

1-22. In a simple synchro system, what leads are connected to the source voltage?
1. R1 and R2
2. S1 and S2
3. S2 and S3
4. R1 and S1

1-23. When a synchro transmitter, and receiver are in correspondence, what is the relative value of the (a) current through the stators and (b) receiver torque?
1. (a) Maximum (b) maximum
2. (a) Maximum (b) minimum

Prepared by: Harlem A. Agnote

3. (a) Minimum (b) minimum
4. (a) Minimum (b) maximum

1-24. What term applies to the angle through which a synchro transmitter rotor is rotated mechanically?
1. Lag
2. Lead
3. Gain
4. Signal

1-25. If a synchro receiver is required to rotate in a direction opposite to the rotation of the transmitter rotor, what leads should be reversed?
1. R1 and R2
2. S1 and S2
3. S2 and S3
4. S1 and S3

1-26. If a synchro receiver and transmitter are always 180 degrees out of phase with each other, what leads are reversed?
1. R1 and R2
2. S1 and S2
3. S2 and S3
4. S1 and S3

1-27. What type of synchro can accept two signals simultaneously and add or subtract?
1. Transmission
2. Differential
3. Automatic
4. Shiftless

1-28. What are the two types of synchro devices that will accept two inputs?
1. TR and TX
2. TR and TDX
3. TDR and TX
4. TDR and TDX

1-29. What types of synchro devices have (a) one electrical and one mechanical input and an electrical output; and (b) two electrical inputs and a mechanical outputs?
1. (a) TR (b) TX
2. (a) TX (b) TR
3. (a) TDX (b) TDR
4. (a) TDR (b) TDX

1-30. What determines whether a differential synchro device adds or subtracts its inputs?
1. The way it is connected in the system
2. The direction of rotor movement
3. The number of stator windings
4. The supply voltage polarity

1-31. In a TDX system, for the TR rotor to follow the TX rotor exactly, in what position must the TDX rotor be kept?
1. 0 degree position
2. 60 degree position
3. 120 degree position
4. 240 degree position

1-32. What is the angular position of a TR rotor when it is pointing to the S3 winding?
1. 0 degrees
2. 60 degrees
3. 120 degrees
4. 240 degrees

1-33. If a TDX system with standard synchro connections has the TX rotor at the 60-degree position and the TDX rotor at the 270-degree position, what is the position of the TR rotor?
1. 110 degrees
2. 150 degrees
3. 210 degrees
4. 250 degrees

1-34. For a TDX system to add its inputs rather than subtract them, what leads must be reversed between (a) the TX and TDX, and (b) the TR and TDX?
1. (a) S1 and S2 (b) R1 and R3
2. (a) S1 and S3 (b) R1 and R3
3. (a) S2 and S3 (b) R1 and R2
4. (a) S1 and S3 (b) R1 and R2

Prepared by: Harlem A. Agnote

1-35. For a TDR system to add its inputs rather than subtract them, what leads must be reversed at the TDR?
1. S1 and S3
2. S1 and S2
3. R1 and R3
4. R1 and R2

1-36. If a TDR system is connected for addition and the TX rotor connected to the TDR rotor turns counterclockwise, in what direction will the TDR rotor field rotate?
1. In a direction determined by the other TX stator
2. In a direction determined by the other TX rotor
3. Counterclockwise
4. Clockwise

1-37. Which of the following types of synchros is used in a system requiring large amounts of power and high accuracy?
1. Torque
2. Control
3. Differential
4. Each of the above

1-38. What are the three types of control synchros?
1. TX, TR, CT
2. TX, CDX, CR
3. CX, CT, CR
4. CX, CT, CDX

1-39. The CX and CDX differ from the TX and TDX because the CX and CDX have which of the following characteristics?
1. Lower impedance windings
2. Higher impedance windings
3. Larger physical size
4. Smaller physical size

1-40. Which of the following is NOT a characteristic of the rotor of a control transformer (CT) rotor?
1. It is connected to a high-impedance load
2. It must be turned by an external force
3. It is connected to an ac source
4. It has a drum- or wound-type rotor

1-41. When a control transformer is at electrical zero, the rotor is perpendicular to what winding?
1. S1
2. S2
3. S3
4. R2

1-42. If a control transformer is held at electrical zero and the control transmitter is turned 90 degrees counterclockwise, what is (a) the amplitude of the induced voltage in the rotor of the control transformer, and (b) the phase relationship of this voltage and the excitation voltage to the control transmitter?
1. (a) Maximum (b) out-of-phase
2. (a) Maximum (b) in phase
3. (a) Minimum (b) out-of-phase
4. (a) Minimum (b) in phase

1-43. Which of the following terms applies to the output of a control transformer?
1. Mechanical movement
2. Deflection angle
3. Output voltage
4. Error signal

1-44. If the output of a control transformer is zero, what is the relationship of the rotors of the control transformer and the control transmitters?
1. In correlation
2. Out of correlation
3. In correspondence
4. Out of correspondence

1-45. Synchro capacitors are used to provide which of the following characteristics in a synchro system?
1. Improved accuracy
2. Reduced oscillations
3. Wider frequency response

Prepared by: Harlem A. Agnote

4. Higher load-carrying capacity

1-46. Which of the following synchro devices uses a synchro capacitor?
1. TX
2. RX
3. TDR
4. CDX

1-47. What type of current is eliminated by synchro capacitors?
1. Loss
2. Rotor
3. Stator
4. Magnetizing Stator

1-48. In what configuration are synchro capacitors connected in a synchro circuit?
1. Wye, across the rotor windings
2. Delta, across the rotor windings
3. Wye, across the stator windings
4. Delta, across the stator windings

1-49. To maintain system accuracy, where are synchro capacitors physically placed in a synchro circuit?
1. Close to the TX or RX
2. Close to the TDX, CDX, or CT
3. Midway between the TX and CT
4. Far away from the TDR, CDX, or CT

1-50. Synchro systems that transmit data at two different speeds are referred to by which of the following terms?
1. Dual-speed
2. Two-speed
3. Twin-speed
4. Each of the above

1-51. Multispeed synchro systems have which of the following advantages over singlespeed synchro systems?
1. Easier to troubleshoot and align
2. Fewer moving parts
3. Greater accuracy
4. All of the above

1-52. What does the gear ratio between the two transmitters in a dual-speed synchro system determine?
1. The direction of transmitter-rotation
2. The direction of receiver rotation
3. The speeds of transmission
4. The relative direction of rotation

1-53. Which of the following synchro systems, if any, should be used to transmit very large quantities?
1. Single-speed
2. Two-speed
3. Tri-speed
4. None of the above

1-54. Which of the following is a disadvantage of a double receiver as compared to two single receivers?
1. The entire unit must be replaced if one portion fails
2. It takes up much more space
3. It is much more costly
4. It is much heavier

1-55. The voltage used to prevent false synchronizations is known by what term?
1. Error voltage
2. Signal voltage
3. Source voltage
4. Stickoff voltage

1-56. What is the reference point for the alignment of all synchro units?
1. Mechanical zero
2. Electrical zero
3. Mechanical null
4. Electrical null

1-57. What is the most accurate method of aligning a synchro?
1. The dc voltmeter method
2. The ac voltmeter method
3. The synchro-tester method
4. The electric-lock method

1-58. During synchro alignment, what is the

purpose of the coarse setting?
1. To ensure a setting of zero degrees rather than 180 degrees
2. To prevent the voltmeter from being overloaded
3. To keep the synchro device from overheating
4. To correct the fine setting

1-59. If a synchro receiver is properly zeroed, when do the stator windings have electrical zero voltages?
1. When the rotor is moving
2. When the rotor is stopped
3. When the rotor is at 270 degrees
4. When the rotor is at its reference position

1-60. When a 115-volt synchro transmitter is set on its coarse-zero position, approximately what voltage should be read on a voltmeter?
1. 15 volts
2. 26 volts
3. 37 volts
4. 193 volts

1-61. When a 115-volt source is used during the alignment of a differential synchro, what is the maximum time the circuit can be energized without causing damage to the synchro?
1. 1 minute
2. 2 minutes
3. 15 minutes
4. 30 minutes

1-62. After a control transformer has been zeroed and clamped down, what is the final step in the zeroing procedure?
1. Replace the fuses
2. Turn it to 270 degrees
3. Recheck the zero voltage reading
4. Disconnect all wires to the control transformer

1-63. The output voltage of a control transformer on electrical zero is which of the following relative values?
1. Equal to the supply voltage
2. Half the supply voltage
3. Maximum
4. Minimum

1-64. When a tri-speed synchro system is being zeroed, which synchro should be zeroed first?
1. Coarse
2. Medium
3. Largest
4. Fine

1-65. What method of zeroing a synchro is the fastest but NOT the most accurate?
1. The dc voltmeter method
2. The ac voltmeter method
3. The synchro-tester method
4. The electrical-lock method

1-66. The electrical-lock method of zeroing a synchro requires accessible leads and which of the following conditions?
1. A rotor free to turn
2. A stator free to turn
3. A supply voltage to the stators
4. A zero-volt potential between S1 and S2

1-67. A synchro is zeroed by the use of a synchro tester. After it is zeroed, the S1 and S3 leads are shorted together, and the synchro tester dial moves. What does this indicate?
1. The synchro is zeroed correctly
2. The synchro is not zeroed correctly
3. The supply voltage is too low
4. The supply voltage is too high

1-68. If you find that a synchro has bad bearings, which of the following actions should you take?
1. Replace the bearing
2. Lubricate the synchro
3. Replace the synchro
4. Continue to use it

1-69. Which of the following troubles is common in newly installed synchro systems?
1. Dirty brushes
2. Improper wiring
3. Worn slip rings
4. Shorted synchro windings

1-70. What type of indicating device is usually installed in the stator circuit of a torque synchro system?
1. A voltmeter indicator
2. An ohmmeter indicator
3. An overload indicator
4. A blown-fuse indicator

1-71. A synchro system with four receivers is malfunctioning. All of the receivers have incorrect readings. Which of the following is/are the most likely cause(s) of the trouble?
1. Damper failure
2. The transmitter
3. One of the receivers
4. All of the receivers

1-72. An ac voltmeter is connected between windings S1 and S3 of a synchro transmitter. Which of the following rotor positions should give a zero voltage reading?
1. 180º
2. 240º
3. 300º
4. 330º

1-73. When a synchro tester is used in place of a synchro transmitter, which of the following precautions will help to keep the tester from being overloaded?
1. Use a 26-volt supply only
2. Use a 115-volt supply only
3. Use only one syncho receiver
4. Use at least three synchro receivers

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Servos," pages 2-1 through 2-38. Chapter 3, "Gyros," pages 3-1 through 3-27. Chapter 4, "Related Devices," pages 4-1 through 4-12.

2-1. A servo is normally designed to move (a) what type of load to (b) what type of positions?
1. (a) Small (b) Exact
2. (a) Small (b) Approximate
3. (a) Large (b) Exact
4. (a) Large (b) Approximate

2-2. Servo systems can be found in which of the following forms?
1. Pneumatic
2. Hydraulic
3. Electromechanical
4. Each of the above

2-3. Which of the following systems are control systems?
1. Open-loop
2. Closed-loop
3. Both 1 and 2 above
4. Inductive-loop

2-4. A servo system is defined as which of the following types of control systems?
1. Open-loop
2. Closed-loop
3. Both 1 and 2 above
4. Inductive-loop

2-5. Which of the following is a basic difference between an open-loop control system and a closed-loop control system?
1. Number of loops
2. Size of the load
3. Speed of movement
4. System of feedback

IN ANSWERING QUESTIONS 2-6 THROUGH 2-8, MATCH THE FUNCTION LISTED IN COLUMN B TO THE SERVO COMPONENT LISTED IN COLUMN A THAT ACCOMPLISHES THE FUNCTION.
A. SERVO COMPONENTS

2-6. Synchro control System - 1

2-7. Servo amplifier -1

2-8. Servo motor -1

B. FUNCTIONS
1. Moves the load
2. Provides power
3. Controls movement
4. Converts dc to ac

2-9. In a dc position servo system, what characteristic of the error signal determines the direction in which the load is driven?
1. Amplitude
2. Frequency
3. Polarity
4. Phase

2-10. The sum point in a position servo system combines what two signals to produce an error signal?
1. Response and output
2. Feedback and Output
3. Feedback and input
4. Output and input

2-11. A position servo system exhibits a series of overtravels. This condition is known by which of the following terms?
1. Hunting
2. Overdamping
3. Undershooting
4. All of the above

2-12. A velocity servo has which of the following characteristics?

Prepared by: Harlem A. Agnote

1. Senses position of the load; no error signal at correspondence
2. Senses position of the load; error signal present at correspondence
3. Senses speed of the load; no error signal at correspondence
4. Senses speed of the load; error signal present at correspondence

2-13. What device is usually used to provide feedback in a velocity servo loop?
1. Potentiometer
2. Tachometer
3. CT
4. CX

2-14. For a servo system to operate smoothly and efficiently, it must have balance between which of the following factors?
1. Acceleration and speed
2. Inertia and oscillation
3. Amplification and damping
4. Overshooting and feedback signal

2-15. When friction-clutch damping is used in a servo system, the first overshoot of the load may be characterized as
1. small
2. large
3. reversed
4. eliminated

2-16. Error-rate damping is considered to be better than friction or friction-clutch damping because of which of the following characteristics of the error-rate damping system?
1. A large error signal of short duration will not be damped
2. A small error signal of short duration will not be damped
3. A large change in the error signal causes maximum damping
4. A small change in the error signal causes maximum damping

2-17. Under what condition would a servo system that is properly designed and operating correctly have an oscillating load?
1. The input signal is large in amplitude
2. The input signal oscillates
3. Error-rate damping is used
4. Friction damping is used

2-18. A servo system is found to be "noisy." If the bandwidth of the servo amplifier were adjusted to reject the unwanted noise signals, which of the following characteristics of the servo system would be affected?
1. Amplifier gain
2. Power requirements
3. Correspondence position
4. Error-detection capability

2-19. Which of the following devices can be used as a position sensor in a servo system?
1. A summing network
2. An E-transformer
3. A potentiometer
4. A CT

2-20. Which of the following devices are magnetic error detectors?
1. CXs
2. E-transformers
3. Summing networks
4. All of the above

2-21. A dc rate generator is used in which of the following loops of a velocity servo system?
1. Prime mover
2. Feedback
3. Control
4. Error

2-22. What is the function of a modulator in a servo system?
1. To change the frequency of an ac error signal
2. To impress an ac error signal on an ac carrier
3. To convert a dc error signal to an ac

error signal
4. To convert an ac error signal to a dc error signal

2-23. In a servo system that uses a modulator, what characteristic of the modulator output determines the direction of load movement?
1. Amplitude
2. Frequency
3. Polarity
4. Phase

2-24. What phase relationships between the input and reference signals are sensed by a servo demodulator?
1. 0º and 180º
2. 45º and 225º
3. 90º and 270º
4. 135º and 315º

2-25. In a properly operating servo system, what is the phase relationship between the reference voltages to the error detector and the demodulator?
1. In phase only
2. 180º out of phase only
3. Out of phase; somewhere between 0º and 180º
4. In phase or 180º out of phase, depending on the demodulator input

2-26. Which of the following should be a characteristic of a servo amplifier?
1. Narrow frequency band
2. High output impedance
3. 180º phase shift
4. Low noise level

2-27. An ac servo motor would probably be used instead of a dc servo motor in which of the following situations?
1. To move heavy loads at a constant speed
2. To move heavy loads at variable speeds
3. To move light loads at a constant speed
4. To move light loads at variable speeds

2-28. Which of the following circuits that is required in a multispeed servo system is NOT required in a single-speed servo system?
1. Position sensor
2. Error detector
3. Feedback loop
4. Synchronizer

2-29. In a two-speed servo system such as that described in the text, which of the following components controls the movement of the load at 2º but does NOT control the movement of the load at 10º?
1. Fine CT
2. Coarse CT
3. Synchronizer
4. Servoamplifier

2-30. In which of the following situations should a magnetic amplifier be used instead of a conventional amplifier?
1. When a small load is to be driven at high speeds
2. If great accuracy is required in positioning the load
3. If a dual-speed servo system is required
4. When a heavy load is to be moved

2-31. Most servo systems used in the Navy are of which of the following types?
1. Open-loop
2. Multi-loop
3. Single-loop
4. Summing-loop
ANSWER not in the choices, CLOSED-LOOP system

2-32. Which of the following objects has gyroscopic properties?
1. A spinning top
2. A wheel on a moving bicycle

3. The moving blade assembly of an electric fan
4. Each of the above

Figure 2A.—Gyro model, universally mounted.
IN ANSWERING QUESTION 2-33, REFER TO FIGURE 2A.

2-33. Which of the following axes, if any, is the gyro spin axis?
1. X-X
2. Y-Y
3. Z-Z
4. None of the above

2-34. The ability of a gyro to maintain a fixed position in space is referred to by what term?
1. Precession
2. Rigidity
3. Apparent rotation
4. Gimbal-stability

2-35. A gyro will resist all forces that attempt to change its
1. location
2. spin axis direction
3. speed of rotation
4. center of gravity

2-36. What action takes place when an outside force attempts to tilt the spin axis of a gyro?
1. The gyro precesses in the direction of the applied force
2. The gyro precesses in a direction opposite to the applied force
3. The gyro precesses in a direction at a right angle to the applied force
4. The gyro remains fixed in its original position

2-37. For a gyro to be universally mounted, it MUST have a total of how many gimbals, if any?
1. One
2. Two
3. Three
4. None

2-38. Of the following factors, which one does NOT affect rigidity?
1. Rotor speed
2. Rotor shape
3. Rotor weight
4. Rotor position

2-39. The forces that act through the center of gravity of a gyro and do NOT cause precession are referred to by what term?
1. Forces of translation
2. Forces of induction
3. Forces of isolation
4. Forces of erection

2-40. Which of the following factors determine(s) the amount of precession that will result from a given applied force?
1. Rotor speed
2. Rotor weight
3. Rotor shape
4. All of the above

2-41. Which of the following factors determine(s) the direction a gyro will precess in response to a particular force?
1. Speed of the rotor's spin
2. Shape of the rotor
3. Direction of the rotor's spin
4. All of the above

Figure 2B.—Rotors of equal weights but different shapes.
IN ANSWERING QUESTION 2-42, REFER TO FIGURE 2B.

2-42. If all of the rotors are rotated at the same speed, which one will have the greatest rigidity?
1. A
2. B
3. C
4. D

2-43. According to the right-hand rule for gyro precession, what does the thumb indicate?
1. Spin vector and axis
2. Torque vector and axis
3. Precession vector and axis
4. Axis of rotor rotation only

2-44. Which of the following is a universally mounted gyro?
1. A one-degree-of-freedom gyro
2. A two-degrees-of-freedom gyro
3. A restrained gyro
4. A rate gyro

2-45. A free gyro at the Equator appears to tilt. What is the approximate total number of degrees it will tilt in 4 hours?
1. 60º
2. 90º
3. 120º
4. 180º

2-46. Which of the following factors is NOT a cause of mechanical drift?
1. Unbalance
2. Friction
3. Apparent precession
4. Gimbal inertia

2-47. Which of the following is a purpose of a gyro-erection system?
1. To precess the gyro to its operating position
2. To prevent a gyro from precessing once the rotor is up to speed
3. To establish a vertical position to which the gyro position may be compared
4. Each of the above

2-48. Which of the following is an advantage that the mercury ballistic erection system has over the mercury erection system?
1. Greater sensitivity
2. Faster response time
3. Spin axis aligns in any desired position
4. Spin axis aligns north-south

2-49. What is the principal purpose of rate gyros?
1. To serve as gyroscopes
2. To serve as reference elements
3. To measure acceleration
4. To measure angular rates

2-50. In what maximum number of directions is a rate gyro free to precess?
1. One
2. Two
3. Three
4. Four

2-51. The amount of precession of a rate gyro is proportional to what input factor?
1. Rate of gyro case rotation
2. Amount of gyro case rotation
3. Rate of linear displacement
4. Amount of total movement

2-52. The operation of an accelerometer is based on what physical property?
1. Heat
2. Inertia
3. Gravity
4. Precession

2-53. Accelerometers find their greatest use in what type of system?
1. Navigation
2. Communication
3. Weapons control
4. Direction-indicating

2-54. Pulse-counting accelerometers are designed for use only with what type of equipment?
1. Radar sensors
2. Electronic compasses
3. Analog indicators
4. Digital computers

2-55. Which of the following is NOT a difference between IC synchros and standard synchros?

Prepared by: Harlem A. Agnote

1. Amount of torque available
2. Construction of the stator
3. Construction of the rotor
4. Principle of operation

USE THE FOLLOWING INFORMATION IN ANSWERING QUESTIONS 2-56 AND 2-57.
A SYNCHRO SYSTEM USING AN IC TRANSMITTER HAS THE REQUIREMENT THAT THE RECEIVER TURN IN THE OPPOSITE DIRECTION FROM THE TRANSMITTER.

2-56. If an IC receiver were used, what winding of the receiver would be connected to winding R1 of the IC transmitter?
1. R1
2. R3
3. S1
4. S1

2-57. If a standard synchro receiver were used, what winding of the receiver would be connected to winding R3 of the IC transmitter?
1. R1
2. R3
3. S1
4. S3

2-58. Angular data is to be transmitted and dc is the only power available. Which of the following systems should be used?
1. Resolver system
2. IC synchro system
3. Step-transmission system
4. Servo system using a CT and a dc servo motor

2-59. A step-transmission system is to be built in which the steps are to be smaller than the steps in the system shown on page 4-3 of the text. What must be done to the system shown in the text to accomplish this change?
1. Increase the number of coils
2. Decrease the number of coils
3. Increase the supply voltage
4. Decrease the supply voltage

2-60. Which of the following is an advantage that a step-transmission system has over a standard synchro system?
1. Smaller changes in data can be transmitted
2. Transmitted data is "smoother"
3. Synchronizing is not needed
4. Cost is considerably less

2-61. A resolver performs which of the following mathematical functions?
1. Differentiation
2. Trigonometric
3. Integration
4. Algebraic

2-62. Resolvers are used aboard a ship to keep a gun mount steady regardless of the pitch and roll of the ship. What characteristic of the resolver makes it especially useful for this application?
1. Provides instant solutions with constantly changing inputs
2. Provides higher power gain for greater accuracy
3. Uses error-rate damping for smoother solutions
4. Uses ac for greater efficiency

2-63. The (a) rotor and (b) stator of a resolver are best described by which of the following?
1. (a) A single coil
(b) Three coils, wye-connected
2. (a) Two coils in parallel
(b) Two coils in series
3. (a) Two coils in series
(b) Two coils in parallel
4. (a) Two coils at right angles
(b) Two coils at right angles

MODULE 16

RADIO FREQUENCY COMMUNICATIONS PRINCIPLES

PREPARED BY:

Riel Djosh Pante & Marvin Tua

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Test Equipment Administration and USE," pages 1-1 through 1-33. Chapter 2, "Miscellaneous Measurements," pages 2-1 through 2-27.

1-1. What system is currently used by U.S. military services to identify electronic equipment with standardized nomenclature?
1. Joint Electronic Type Designation System (JETDS)
2. Joint Electronics Type Category System (JETCS)
3. Army-Navy (AN) System
4. Navy Tactical Data Systems (NTDS)

1-2. Which of the following categories of test equipment is/are designed to test, without modification, a range of electronic parameters needed for two or more systems that are different in design?
1. GPETE 2. SPETE 3. Both 1 and 2 above 4. Installed

1-3.For what purpose was the ETE classification board established?
1. To control inventory limits
2. To control the increase of nonstandard GPETE
3. To control the increase of nonstandard SPETE
4. To become final approval authority for SPETE

1-4.Which of the following systems provides an inventory of test equipment actually located in the fleet?
1.3M
2. SCLSIS
3. STEED
4. SPETREL

1-5.You can determine if a piece of test equipment has been calibrated by checking which of the following documents?
1. The test equipment logbook
2. A directive from the EMO
3.The completed maintenance action form for the instrument
4. A tag or label attached to the instrument

1-6. What label is used to identify a test instrument that is within tolerance on all parameters?
1. INACTIVE
2. CALIBRATED
. CALIBRATED—Refer to report
4. ORGANIZATION LEVEL CALIBRATED

1-7. Which of the following conditions warrants the use of one of the SPECIAL CALIBRATION labels and/or tags?
1. Calibration deviates from the usual tolerances
2. The instrument has more than one calibration interval
3. The instrument is too large to move and requires in-place calibration
4. Each of the above

1-8. Under what circumstances should the USER CALIBRATION label be affixed to a piece of test equipment?
1. When a certain calibration schedule is assigned
2. Whenusercalibrationisrequired before, during, or after use
3. When the equipment is out for calibration
4. Each of the above

1-9. Which of the following statements must appear on the CALIBRATION NOT REQUIRED label affixed to an instrument?
1. By what authority the label was affixed
2. The reason no calibration is required
3. The date the label was affixed
4. TheMETRLpagenumber

Prepared by: Harlem A. Agnote

1-10. Which of the following labels is attached to an unusable instrument, and may have an additional tag attached?
1.INACTIVE 1-14.
2. REJECTED
3. CALIBRATED
4. SPECIAL CALIBRATION

1-11. A test instrument that has plug-in modules and/or easily accessible potentiometer or controls which affect the calibration of the instrument should have which of the following labels attached?
1. CALIBRATED 2. CALIBRATION NOT REQUIRED
3. CALIBRATED—REFER TO
REPORT **4. CALIBRATION VOID IF SEAL BROKEN**

1-12. A replacement part needed by an IMA to repair a piece of test equipment should be ordered by the activity sending the inoperative equipment for repair and calibration. For which of the following reasons is this a good practice?
1. IMAs are not allowed to order repair parts
2. The ship has more repair funds than the IMA
3. The ship is usually able to obtain the parts more quickly
4. It is more likely the technician on the ship will obtain the correct part

1-13. When maintenance personnel are not authorized to make repairs to a piece of test equipment, what items, if any, must be sent to the calibration repair facility with the equipment?
1. Theunitanditspower cord
2. All the accessories
3. Standards used to calibrate
4. None

1-14. In what type of environment should test equipment be stowed?
1. Dry
2. Dark and damp
3.High humidity and low temperature
4. High temperature and high humidity

1-15. In a stowage space aboard ship, what device(s) should be used to hold the test equipment in place?
1. Setclaspsprings
2. Tiedowncord
3. Steelstraps
4. Stretchseat-belt-typestraps

1-16.What system is used to provide for a standardized recall and scheduling of test equipment into calibration facilities?
1. MDCC
2. SCLSIS
3. METER
4. MEASURE

1-17. The meter card is used to provide what information concerning test equipment?
1. Changes
2. Additions
3. Deletions
4. All of the above

1-18. Which of the following actions would be classified as preventive maintenance?
1. Purchasing a new piece of test equipment
2. Isolating an equipment failure to the component level
3. Aligning a servo assembly after a repair
4. Replacing a defective transistor

1-19. Which of the following actions would be regarded as part of corrective maintenance?
1. Routine lubrication of a radar pedestal
2. Mechanical inspection of a bearing assembly in a motor housing
3. Alignment of a servo assembly after arepair
4. Cleaning a filter in accordance with amaintenance requirement card

1-20. Troubleshooting electrical and electronic equipment includes which of the following actions?
1. Fault isolation
2. Equipment repair
3.Equipment performance evaluation
4. Each of the above

Prepared by: Harlem A. Agnote

1-21. The initial operating conditions of newly installed equipment are referred to as
alignmentdata
manufacturer's specifications
baseline operating characteristics
expected operation characteristics

1-22. When working on energized equipment, you should follow which of the following practices?
1. Work alone 2. Work with both hands **3. Insulate yourself from ground** 4. Wear rubber gloves at all times

1-23. When measuring 300 volts or more, you should first take what step?
Turn off equipment power
2. Ground all components capable of retaining an electrical charge
3. Short-circuit all components capable of retaining an electrical charge
4. Connect the meter leads to the points to be measured.

1-24. Which of the following insulating materials is suitable for covering a grounded metal work bench?
1. Dry insulating material that contains no holes or conductors
2. Dry canvas that has holes in it 3. Dry phenolic material that has conductors embedded in it
4. Damp plywood

1-25. Prior to working on a circuit, you use a shorting probe discharge which of the following types of components?
1. Capacitorsonly
2.Cathode-ray tubes only
3.Capacitors and cathode-ray tubes
4. Inductors

1-26.If a 28 volt 6 ampere fuse blows, the proper procedure is to replace it with which of the following devices?
1. A larger fuse until the cause of the overload has been determined
2. A fuse of the same voltage and current rating
3. A fuse rated 20 percent lower than the blown fuse
4. Acopperstrapuntilthecauseofthe overload is determined

1-27. Before electrical equipment is overhauled or repaired, what general safetyprecaution,ifany,shouldbe followed?
1. The fuse for the associated circuits should be replaced with circuit breakers
2. The main supply switches should temporarily be shorted out
3. The power switches should be secured open and tagged out of service
4. None

1-28. After work on equipment is complete, who should remove any attached tags?
1. The job inspector
2. The repair crew leader
3.Any member of the repair crew
4. The person who signed and attached the tag

1-29. What is the purpose of the grounding cable attached to the frame of a generator aboard ship?
1. Createapotentialdifferencebetween the frame and the ship
2. Conductpowertothegeneratorunder emergency conditions
3. Ensureequipmentisatsameground potential as the ship
4. Breakthecircuitbetweentheframe and the power supply under emergency conditions

1-30.Which of the following steps should you take to help ensure that metal-case test equipments are safe to use?
1. Energize the instrument to test the ground
2. Ensure the equipment is grounded
3. Insulate the metal case from ground
4. Connect all metal cases to a commonungrounded lead

Prepared by: Harlem A. Agnote

1-31. Which of the following precautions should you observe when using measuring instruments?
1. Avoidstrongmagneticfields
2. Avoidexcessivecurrent
3. Avoidmechanicalshock
4. Eachoftheabove

1-32. The meter movement in a voltmeter can be easily damaged by excessive current if you do not follow certain procedures. When setting up the meter to read voltage, the RANGE SWITCH should first be set to (a) what relative range and then changed to (b) what relative range?
1. (a) Highest (b) Closest to the voltage to be read
2. (a)Highest (b) Lower than the voltage to be read
3. (a) Lowest (b) Lower than the voltage to be read
4. (a) Lowest (b) Closest to the voltage to be read

A. Place one hand in your pocket or behind your back.
B. Turn on the power.
C. Connect the meter ground to the equipment ground.
D. Place the positive meter lead on the test point; select for positive or negative polarity.

Figure 1A.—Procedures
IN ANSWERING QUESTION 1-33, REFER TO THE PROCEDURES IN FIGURE 1A.

1-33. When you measure voltages less than 300 volts, in what order should you complete the task?
1. ABCD
2. BCDA
3. CADB
4. DCBA

_____

IN ANSWERING QUESTIONS 1-34 THROUGH 1-37, SELECT FROM THE MEASUREMENT COLUMN BELOW THE ANSWER THAT MATCHES THE SITUATION BEING DESCRIBED.
MEASUREMENT
1. Current 2. Inductance 3. Resistance 4. Capacitance

_____

1-34. This measurement is rarely taken in preventive or corrective maintenance or testing because unsoldering is usually required. Ohm's law is normally applied to determine this value. RESISTANCE

1-35. This is a valuable aid in locating faults during corrective maintenance, but cannot be made with power applied. Many technical manuals contain charts that indicate the test points for this measurement. CURRENT

1-36. This measurement provides an indication of dielectric strength and is used to determine the power factor. CAPACITANCE

1-37. This measurement is seldom taken during troubleshooting. It can be taken using a bridge or another instrument that is primarily designed to measure another quantity; however, a conversion chart is required. INDUCTANCE

1-38. The power factor is an indication of the losses caused by which of the following conditions?
1. Excessivevoltage
2. Dielectricabsorption
3.Current leakage
4.Both 2 and 3 above

1-39. The Wheatstone bridge can be used for precision measurements of which of the following quantities?
1. Voltage
2. Current
3. Impedance
4. Resistance

1-44. Power in an audio-frequency circuit is stated in which of the following units?

1. Decibels (dB) only
2. Decibels referenced to 1 milliwatt (dBm) only
3. Both dB and dBm
4. Volt units (Vu)

1-45. The bel is a unit of measurement used with voltage, current, or power that compares which of the following circuit values?
1. The input to the output
2. The output to a reference
3.Thevoltagetopower
4.The current to power

1-46. What is the relationship between the values of the bel and the decibel?
1. The bel is twice the decibel
2. The decibel is twice the bel
3. Thebelis1/10thedecibel
4. Thedecibelis1/10thebel

1-47.What is the corresponding increase in dBm each time power is doubled?
1.+1 dB
2.+2 dB
3.+3 dB
4. +10 dB

1-48. A thermocouple ammeter is used to measure which of the following quantities?
1. Rfcurrent
2. Afcurrent
3. Motorcurrent
4. Generatorcurrent

1-49. A bolometer is a power meter that measures power in certain frequency ranges. Which of the following methods is/are used by the bolometer to measure power values?
1. A barretter detects increases in power when its resistance increases
2. A thermistor detects increases in power when its resistance decreases
3. Both 1 and 2 above
4. Powerismeasureddirectly

1-51. To measure shaft rotation rate on an engine, you should use, which, if any, of the following instruments?
1. Anammeter
2. Abolometer
3. Atachometer
4.Noneoftheabove

1-52.In the centrifugal tachometer, what component restricts the action on the lower collar that is produced by centrifugal force?
1. Thespring
2. Thepointer
3.Theuppercollar
4. Thelowercollar

1-53. What is the usual speed range (in feet per minute) of a chronometric tachometer?
1.0 to 30
2. 0 to 300
3.0 to 3,000
4.0 to 30,000

1-54. You are measuring the speed of a fan blade by using a stroboscopic tachometer. Setting the flash at a rate 5 rpm SLOWER than the fan speed will cause the blades to appear to move (a) in what relative direction and (b) at what speed?
1. (a) Forward (b) 5 rpm2.
(a) Forward (b) 10 rpm
3. (a) Backward (b) 10 rpm
4.(a) Backward (b) 5 rpm

1-55. The flashing rate of a strobotac controlled by which of the following circuits?
is
1. An electronic pulse generator
2. A frequency divider
3.A power supply
4. An amplifier

1-56. The flashing rate of the strobotron tube affects its life expectancy. What is the range (in hours) of life expectancy of the strobotron tube?
1. 15 to 24
2. 25 to 49

Prepared by: Harlem A. Agnote

3. 50 to 99
4.100 to 250

1-57. The vibrating-reed frequency meter is a delicate instrument and should not be subjected to vibrations, such as those associated with motor-generators or their associated control panels.
1. True
2. False

1-58. When using the vibrating-reed frequency meter, you take the reading in which of the following ways?
1. Readthedigitalreadout
2. Readthedialindication
3. Readthemechanicalsetting
4. Readthereedthatvibratesthemost

1-59.Bandpass filters and band reject filters are tuned circuits that either pass or reject specific frequencies. In these filters, (a) what type offers very high impedance to currents at its resonant frequency, and (b) what type offers a very low impedance to currents at its resonant frequency?
1. (a) Parallel-tuned (b) series-tuned
2. (a) Parallel-tuned(b) parallel-tuned
3. (a) Series-tuned (b) parallel-tuned
4. (a) Series-tuned (b) series-tuned

1-60. When you are zero beating an unknown frequency with a frequency provided by a calibrated, high-precision oscillator within a heterodyne frequency meter, what will be the indication when the two frequencies are matched?
1. One dot of light on the screen will be superimposed on the other
2. One vertical line on the screen will be superimposed on the other
3. The two tones in the headset will achieve the same pitch, at which time a series of clicks will begin
4. The tone in the headset will decrease in pitch and be replaced by clicks that will become slow or nonexistent

1-62. Which of the following instruments should be used to accurately measure a frequency in the shf range?
1. Absorptionwavemeter
2. Resonant,cavity-typewavemeter
3. Resonant,coaxial-line-type Wavemeter
4. Both 2 and 3 above

1-63.In a cavity wavemeter, moving the plunger farther into the cavity space causes which of the following changes to (a) the cavity size and (b) the resonant frequency of the cavity?
1. (a)Decrease (b)increase
2. (a)Decrease (b)decrease
3. (a)Increase (b)decrease
4. (a)Increase (b)increase

1-64. For which of the following purposes is a cathode-ray oscilloscope used?
1. To measure microwave energy
2. To visually analyze waveforms
3.To provide frequency modulation
4. To locate stray radio interference

1-65. The synchroscope contains which of the following circuits?
1. Retraceblankingcircuit
2. A wide band amplifier
3.Atriggersweep
4. Alloftheabove

1-67. An oscilloscope measures voltage and displays waveforms. It can be used to measure currents, temperatures, speeds, and accelerations if they are first converted to heat
2. light
3. voltages
4. Pressures

1-68. The spectrum analyzer is used to display which of the following quantities?
1. Amplitudewithineachfrequency component in a circuit
2. Proportions of power within each frequency component in the spectrum
3. Frequenciesproducedinacircuit
4. Eachoftheabove

1-69. While testing a semiconductor diode, you determine that the forward resistance value is 60 ohms. You should consider the diode good if the backward resistance is at least which of the following values?
1. 6 ohms
2.60 ohms
3.600 ohms
4. 6,000ohms

1-70. When you are using an oscilloscope to test a crystal diode, what is shown by (a) the vertical deflection and (b) the horizontal deflection?
1. (a)Crystalcurrent (b) voltage applied to the diode
2. (a)Crystalcurrent (b) power developed in the diode
3. (a)Crystalvoltage (b) power developed in the diode
4. (a)Crystalvoltage (b) voltage applied to the diode

1-71. When you are using the oscilloscope to test the Zener diode, what is represented by (a) vertical deflection and (b) horizontal deflection?
1. (a)Zenercurrent (b) Zener power
2. (a)Zenercurrent (b) applied voltage
3. (a)Appliedvoltage (b) Zener power
4. (a)Appliedvoltage(b) Zener current

1-72.When troubleshooting transistorized circuits, you should first check the condition of which of the following circuits?
1. Counters
2. Amplifiers
3. Oscillators
4. Power supplies

1-73. Which of the following instruments is used to check transistors for collector leakage current and current gain?
Ohmmeter
2. Voltmeter
3. Wheatstonebridge
4. Semiconductortestset

1-74.When making base-to-emitter bias voltage checks on a transistor, you should read which of the following voltage ranges?
1. 5 to 20 microvolts
2.50 to 200 millivolts
3. 5 to 20 volts
4.50 to 200 volts

1-75. When making resistance measurements on a transistor with an ohmmeter, you should allow what maximum current in the transistor?
1. milliampere
2. milliampere
3. microampere
4. microampere

Prepared by: Harlem A. Agnote

ASSIGNMENT 2
Textbook assignment: Chapter 3, "Basic Meters," pages 3-1 through 3-34. Chapter 4, "Common Test
Equipment," pages 4-1 through 4-10.

_____
_____
_____

2-1. What are the two basic components of a galvanometer?
1. A movable permanent magnet and a movable coil
2. A stationary permanent magnet and a stationary coil
3. A stationary permanent magnet and a movable coil
4. A stationary coil and a movable coil

2-2. The coil in a galvanometer rotates to allow measurement of current. Which of the following actions causes this reaction?
1. Current flowing in opposite directions through two coils
2. Tension of the hairspring and the magnetism produced by the permanent magnet
3. Magnetism produced by current flowing in the movable coil and the tension of the hairspring
4. Magnetism of the permanent magnet and magnetism produced by current in the movable coil

2-3. In a galvanometer, the phosphor bronze ribbon serves which of the following functions?
1. Provides a conduction path from the circuit being tested to the coil
2. Restores the coil to its original position
3. Allows the coil to twist
4. Each of the above

2-4. In galvanometers, which of the following components is/are used to indicate the value of the current being measured?
1. Pointer
2. Light and mirror
3. Both 1 and 2 above
4. Digital readout

2-5. The phosphor bronze ribbon in the galvanometer serves the same purpose as what component in the D'Arsonval meter?
1. Hairspring
2. Movable coil
3. Fixed iron core
4. Permanent magnet

2-6. The direction in which the D'Arsonval meter pointer deflects depends on what characteristic of the current applied to the coil?
1. Phase
2. Polarity
3. Frequency
4. Amplitude

2-7. The D'Arsonval meter movement is damped to prevent which of the following conditions?
1. Oscillating readings
2. Inconsistent readings
3. Consistently low readings
4. Consistently high readings
14

2-8. The weight of the rotating coil assembly and the type of bearings used in the D'Arsonval meter are factors that affect which of the following characteristics of the meter?
1. The accuracy and the linearity of the meter scales
2. The amount of restraining force required of the hairspring
3. The maximum current that can be measured
4. The sensitivity

2-9. For a meter to read linearly, its face is divided into equal segments. What meter feature makes this possible?
1. The curved poles of the permanent

magnet
2. The jeweled bearings in the meter movement
3. An additional coil placed in the meter circuit
4. A long, lightweight meter pointer

2-10. What is the purpose of a shunt in a dc ammeter?
1. To decrease the sensitivity of the meter
2. To increase the linearity of the meter movement
3. To increase the current range of the meter
4. To decrease meter damping

2-11. A particular D'Arsonval meter has a fullscale
current reading of 1 milliampere.
A full-scale reading of 100 milliamperes may be achieved by using which of the following components?
1. A low-value resistance placed in series with the meter terminals
2. A high-value resistance placed in series with the meter terminals
3. A movable coil composed of largediameter wire
4. A resistance of proper value placed in parallel with the meter terminals

2-12. To measure 10 milliamperes on a 1-milliampere D'Arsonval meter movement, a shunt resistance is added that will carry 9 milliamperes. What maximum value of current will pass through the meter movement?
1. 1 milliampere
2. 3 milliamperes
3. 6 milliamperes
4. 9 milliamperes

2-13. In a meter movement, shunt strips with a zero temperature coefficient are used instead of regular carbon resistance for which of the following reasons?
1. Because regular carbon resistances cause interfering magnetic fields
2. Because regular carbon resistances are too large to be used
3. Because regular carbon resistances are not able to handle the current changes
4. Because regular carbon resistances are affected by heat due to current and cause readings to vary

2-14. One consideration in choosing the value of a meter shunt resistance is that the meter readings should be in the midscale range. Which of the following factors is another consideration?
1. Meter switching is easier for midscale deflection
2. Meter shielding against magnetic interference is greatest near midscale
3. Minimum loading effect will be experienced near midscale
4. The meter is protected from unexpected surge currents

2-15. For which of the following current ranges would you likely use a meter that contains internal shunt?
1. 1 to 10 amperes
2. 11 to 30 amperes
3. 31 to 50 amperes
4. All of the above

Figure 2A.—Shunt ammeter.
IN ANSWERING QUESTIONS 2-16 THROUGH 2-19, REFER TO FIGURE 2A. THE METER IN THE CIRCUIT IS DESIGNED FOR MAXIMUM OF .001 AMPERE AND HAS AN INTERNAL RESISTANCE OF 10 OHMS. YOU ARE FIGURING THE SHUNT RESISTANCE NECESSARY TO MEASURE 5 AMPERES.

2-16. What is the voltage drop across the meter coil?
1. .01 volt
2. .005 volt
3. .0001 volt
4. .0005 volt

2-17. What is the voltage drop across the shunt resistance?
1. .01 volt
2. .005 volt
3. .0001 volt
4. .0005 volt

2-18. When the meter is deflected full scale and is measuring 5 amperes, what is the maximum value of current flow through the shunt resistance?
1. 0.010 ampere
2. 0.490 ampere
3. 4.999 ampere
4. 5 amperes

2-19. What is the approximate value of the shunt resistance?
1. .001 ohm
2. .002 ohm
3. .003 ohm
4. .004 ohm

2-20. Simple range-switching arrangements for current meters are less satisfactory than other methods of range switching for which of the following reasons?
1. Meter damage can occur when line current momentarily flows through the meter
2. Resistance in the contacts may cause inaccurate readings
3. Both 1 and 2 above
4. Resistor damage may occur

Figure 2B.—Ammeter connections.
IN ANSWERING QUESTION 2-21, REFER TO FIGURE 2B.

2-21. In the figure, five ammeters are connected to the circuit resistors. Of those five, which one(s) is/are connected correctly?
1. E only
2. A and E
3. A and C
4. A, B, and D

2-22. What will be the probable result of connecting an ammeter (or milliammeter) in PARALLEL with a source of voltage or a circuit component?
1. A burned-out meter that will provide no useful readings
2. A higher than normal meter reading
3. A lower than normal meter reading
4. A normal meter reading

Figure 2C.—Series-parallel circuit.
IN ANSWERING QUESTIONS 2-23 AND 2-24, REFER TO FIGURE 2C.

2-23. To measure total circuit current, you should break the circuit to connect an ammeter at which of the following points?
1. A only
2. B or C
3. C, D, or E
4. A, B, or F

2-24. To measure the current flow through resistor R2 only, you should break which of the following points to connect the ammeter?
1. A
2. B
3. C
4. F

2-25. Meter sensitivity is determined by the amount of current required by the ammeter coil to provide full-scale deflection of the pointer. An ammeter coil requiring which of the following current values provides the greatest sensitivity?
1. 1 milliampere
2. 10 milliamperes
3. 100 microamperes
4. 500 microamperes

2-26. Circuits in which low-sensitivity ammeters are used are said to be "loaded." Which of the following

statements describes the cause of circuit loading?
1. The ammeter circuit draws NO current from the circuit being tested
2. The ammeter circuit draws MINIMUM current from the circuit being tested
3. The ammeter circuit draws EXCESSIVE current from the circuit being tested
4. The ammeter circuit INDUCES current into the circuit being tested

2-27. In which of the following electronic circuits does the use of a meter with low sensitivity have the greatest loading effect?
1. High-power circuits
2. Low-current circuits
3. High-current circuits
4. High-voltage circuits

2-28. A basic D'Arsonval meter is used to measure voltage by connecting its meter coil to (a) what type of component in (b) what circuit arrangement?
1. (a) Multiplier resistor
(b) series
2. (a) Multiplier resistor
(b) parallel
3. (a) Capacitor
(b) parallel
4. (a) Capacitor
(b) series

2-29. In a voltmeter, the D'Arsonval meter movement is caused to move by what electrical action?
1. Power
2. Voltage
3. Current
4. Conductance

2-30. In a voltmeter, the meter scale is calibrated in which of the following categories?
1. Power
2. Voltage
3. Current
4. Conductance

2-31. To figure the total value of series resistance needed to extend the range of a voltmeter, you need to know the value of current to cause full-scale deflection of the meter and what other value?
1. Minimum applied voltage
2. Maximum applied voltage
3. Maximum applied current
4. Minimum applied current

2-32. Your voltmeter has four ranges: 1V, 10V, 100V, and 1,000V. To measure an unknown voltage in an amplifier, you should first select what range?
1. 1 V
2. 10 V
3. 100 V
4. 1,000 V

2-33. Which of the following types of circuits are most affected by the loading effect of voltmeters?
1. Low-voltage
2. Low-resistance
3. High-resistance
4. High-current

2-34. A voltmeter with a 10-microampere meter movement has a sensitivity of how many maximum ohms per volt?
1. 1,000
2. 10,000
3. 100,000
4. 1,000,000

2-35. A megger is widely used for which of the following purposes?
1. To make voltage checks
2. To make continuity checks
3. To measure insulation resistance
4. To measure resistance of components

2-36. Before you can take an accurate resistance measurement with an ohmmeter, what meter adjustment must

you complete?
1. Zero voltage
2. Zero resistance
3. Maximum voltage
4. Maximum resistance

2-37. When the leads of an ohmmeter are placed across a resistor, that resistor adds to the internal series coil resistance of the meter. The pointer is deflected to the left of its full-scale position, giving a reading in ohms for the resistor being tested. Which of the following reasons explains why the pointer moves to less than fullscale?
1. Because voltage in the meter circuit is greater than full-scale voltage
2. Because current in the meter circuit is greater than full-scale current
3. Because current in the meter circuit is less than full-scale current
4. Because voltage in the meter circuit is less than full-scale current

2-38. With the ohmmeter range switch set at R X 100, the pointer of the meter indicates 850. What is the actual value of the resistor?
1. 8.5 kilohms
2. 85 kilohms
3. 850 kilohms
4. 8.5 megohms

RANGE SCALE RESISTOR VALUE
A. R×1 50 kilohms
B. R×10 500 kilohms
C. R×100 5 megohms

Figure 2D.—Range scales and resistance values.
IN ANSWERING QUESTION 2-39, REFER TO FIGURE 2D.

2-39. You are measuring resistors using range settings as shown in the figure. What condition listed in the figure, if any, will cause the greatest amount of current to move through the ohmmeter coil circuit?

1. A
2. B
3. C
4. None; they all allow the same amount of current

2-40. Which of the following locations on the meter scale provides the most accurate reading for resistance?
1. To the far left side of the scale
2. To the far right side of the scale
3. Halfway between the left side and center of the scale
4. Near the center of the scale

2-41. An ordinary ohmmeter is unsuitable for measuring insulation resistance for which of the following reasons?
1. Voltage is present in the conductors attached to the insulating materials being measured
2. Insulation resistance values are too great for an ohmmeter to measure
3. Ohmmeter current will damage insulation material
4. The accuracy of an ohmmeter is too low to measure insulation resistance
19

Figure 2E.—Megger circuit.
IN ANSWERING QUESTION 2-42, REFER TO FIGURE 2E.

2-42. In the megger circuit, what component prevents leakage current from affecting ohmmeter measurements?
1. Guard ring
2. Generator
3. Resistor R3
4. Coil

2-43. When a megger is used to measure an unknown resistance, what circuit action causes the pointer to come to rest at the correct resistance value?
1. The current flow in coil A
2. The current flow in coil B
3. The interaction between the currents

in coils A and B
4. The interaction between the restraining springs of the meter and the current in coil A

2-44. A megger uses high voltage to check the insulation leakage in the megohm range. What is the source of this voltage?
1. Batteries
2. The ship's ac power
3. The ship's dc power
4. A hand-driven dc generator

2-45. Meggers with which of the following maximum voltage ratings are commonly found in the fleet?
1. 500 volts
2. 700 volts
3. 1,000 volts
4. 2,500 volts

2-46. When a megger is used to measure the resistance of an electrical cable, what does a reading of infinity indicate?
1. The meter is faulty
2. The cable is shorted
3. The cable is grounded
4. The resistance is too large to measure

2-47. A megger is prevented from exceeding its rated output voltage by which of the following actions?
1. Battery discharge limits the voltage
2. Tension in the cable
3. Friction clutch slippage
4. Current leaks through internal insulation

2-48. When the crank of a 500-volt megger is rotated faster than its designed rate, what maximum output voltage does it produce?
1. 100 volts
2. 500 volts
3. 520 volts
4. 550 volts

2-49. The galvanometer-type meter movement differs from the electrodynamometer meter movement in that the electrodynamometer type uses which of the following components to produce the magnetic field?
1. Two sets of coils
2. Two permanent magnets
3. One fixed and one movable coil
4. One movable coil and one permanent magnet

2-50. The fixed coils in the electrodynamometer-type movement are wound with heavy wire to enable the instrument to measure which of the following values?
1. Rf currents
2. High voltage
3. Large currents
4. High resistance

2-51. An advantage that the electrodynamometer has over the standard galvanometer in measuring ac is that the electrodynamometer requires
1. no rectifying device
2. a less complicated rectifying device
3. less current to obtain a full-scale deflection
4. fewer multiplier resistors to cover the measurement range

THIS SPACE LEFT BLANK INTENTIONALLY.

2-52. When power is being measured with a wattmeter, why is it important to strictly observe the safe rating limits for current and voltage?
1. Because the meter pointer will likely hit against the upper limit of the dial and be damaged
2. Because the pointer does not give an indication to alert the user when the internal coils are overloaded
3. Because a false reading may be obtained
4. Because the meter pointer will likely

hit against the lower limit of the dial and be damaged

2-53. The reading of a wattmeter is dependent upon which of the following circuit characteristics?
1. Current
2. Voltage
3. Power factor
4. All of the above

2-54. A continuity test is performed on a piece of electronic equipment to discover what kind of fault?
1. High voltage
2. Low voltage
3. Open circuits
4. Changes in component values

2-55. Which of the following meters is recommended for circuit continuity tests?
1. A megger
2. An ammeter
3. A voltmeter
4. An ohmmeter

2-56. When preparing to use an ohmmeter to test a circuit for grounds, you should first take which of the following actions?
1. Energize the circuit
2. Disconnect all intentional grounds
3. Measure the circuit voltage at the power source
4. Connect all intentional grounds

2-57. When preparing to use a voltmeter to measure voltage in a circuit, you should first take which of the following actions?
1. Set the meter to the lowest voltage range
2. Remove the suspected component from the circuit
3. Check the voltage from the power source to ensure it is correct
4. Check the current flow through the circuit with an ammeter

2-58. It is important to set a voltmeter on its highest range scale before taking a measurement for which of the following reasons?
1. To protect the meter from damage
2. To decrease the effects of input impedance
3. To increase the sensitivity of the measurement
4. To protect the equipment being tested from damage

THIS SPACE LEFT BLANK INTENTIONALLY.

2-59. An accurate measurement of a particular resistor in a set of parallel resistors may be obtained by performing which of the following procedural steps?
1. Connecting the ohmmeter leads across the resistor while in place
2. Disconnecting the resistor from the set before taking the measurement
3. Grounding the resistance set before taking the measurement
4. Using the highest ohmmeter range

Figure 2F.—Circuit.
IN ANSWERING QUESTION 2-60, REFER TO FIGURE 2F.

2-60. To measure R2 with an ohmmeter, (a) in what position should the ON/OFF switch be placed, and (b) where should the test probes be placed?
1. (a) Off (b) at B and C
2. (a) Off (b) at C and D
3. (a) On (b) at C and D
4. (a) On (b) at B and C

2-61. In what arrangement is an ammeter connected to a circuit?
1. In series
2. In parallel
3. In a series-parallel combination
4. In a parallel-series combination

2-62. When you are measuring voltage using a voltmeter, where should you stand to

view the meter reading?
1. To the right of the meter only
2. To the left of the meter only
3. To the right or left of the meter, depending on your handedness
4. Directly in front of the meter

2-63. A multimeter is used to measure which of the following electrical properties?
1. Voltage
2. Current
3. Resistance
4. Each of the above

2-64. Which of the following characteristics is an advantage of a volt-ohm meter?
1. It replaces three separate meters
2. There are no calibrations to be made
3. It is the most accurate meter available
4. It cannot be damaged

A. SELECT RANGE SCALE
B. SHORT ENDS OF PROBES TOGETHER
C. ZERO THE METER USING THE ZERO ADJUST CONTROL

Figure 2G.—Zeroadjust steps.

IN ANSWERING QUESTION 2-65, REFER TO FIGURE 2G.

2-65. Before you measure resistance, it is important that you calibrate (zero) the ohmmeter. In what order should the actions in the figure be performed?
1. A, B, and C
2. B, C, and A
3. C, B, and A
4. B, A, and C

2-66. On an ohmmeter, which of the following switches allows selection of ac or dc readings?
1. ZERO-OHMS
2. FUNCTION
3. RANGE
4. RESET

2-67. Which of the following actions MUST be taken before resistance measurements are made in a circuit?
1. All semiconductor devices must be removed from the circuit
2. Expected measurements must be recorded
3. The circuit must be completely deenergized
4. The high range of the ohmmeter must be selected

2-68. The power required to operate a basic ohmmeter comes from which of the following sources?
1. Batteries
2. An ac power supply
3. Both 1 and 2 above
4. A hand crank

THIS SPACE LEFT BLANK INTENTIONALLY.

POINTER LOCATION
1. EXTREME RIGHT
2. EXTREME LEFT
3. MIDSCALE

Figure 2H.—Ohmeter pointer location

IN ANSWERING QUESTIONS 2-69 THROUGH 2-72, REFER TO FIGURE 2H AND SELECT THE OHMMETER POINTER LOCATION THAT RESULTS FROM THE CONDITION GIVEN.

2-69. Both test leads are touching the metal chassis of a piece of equipment.
ANSWER: 1

2-70. The test leads are shorted together.
ANSWER: 3

2-71. The test leads are separated from each other and not touching anything else.
ANSWER: 3

2-72. An accurate resistance reading is being made.
ANSWER: 3

Prepared by: Harlem A. Agnote

2-73. The function of the ZERO OHM control on a multimeter is to compensate for which of the following conditions?
1. Meter battery aging
2. Large values of resistance in the circuit to be measured
3. Inter-electrode capacitance in the circuit to be measured
4. Stray voltages in the circuit under test

2-74. When using a multimeter to measure an output voltage, you should ensure that the dc voltage component does not exceed what maximum voltage?
1. 100 volts
2. 200 volts
3. 300 volts
4. 400 volts

2-75. When measuring unknown currents, you should determine the range scale that is appropriate in what way?
1. Start with the expected scale
2. Start with the lowest scale and work up
3. Start with the highest scale and work down
4. Use the highest scale only

ASSIGNMENT 3
Textbook assignment: Chapter 4, "Common Test Equipment," pages 4-11 through 4-28. Chapter 5,
"Special Application Test Equipment," pages 5-1 through 5-40. Chapter 6, "The Oscilloscope and Spectrum Analyzer," pages 6-1 through 6-46.

_____
_____
_____

3-1. Compared to the VOM, the electronic digital multimeter has which of the following advantages?
1. It has higher input impedance
2. It can be read directly without using a scale
3. It has little or no loading effect on the circuit under test
4. All of the above

3-2. Digital multimeters can be divided into three functional sections: (1) signal conditioning, (2) analog-to-digital, and what third section?
1. Display
2. Amplifier
3. Oscillator
4. Power supply

3-3. What section in the electronic multimeter decodes the digital (binary) information from the a/d converter section?
1. Display
2. Analog ic
3. Digital ic
4. Signal conditioning

3-4. The ac/dc differential voltmeter is capable of performing which of the following functions?
1. Voltage readings as an electronic voltmeter
2. Voltage readings as a precision potentiometer
3. Voltage variation readings about some known value
4. Each of the above

3-5. In a differential voltmeter, an adjustable reference voltage can be produced in increments as small as how many microvolts?
1. 1
2. 2
3. 5
4. 10

3-6. When you are taking ac or dc voltage readings, the differential voltmeter will not load the circuit under test.
1. True
2. False

3-7. Which of the following transistor

parameters are measured with the transistor tester?
1. Collector leakage and cutoff current
2. Collector leakage and maximum power dissipation
3. Collector leakage and current gain
4. Emitter leakage and power gain

3-8. When you are disconnecting a transistor from the transistor tester, in what position should the POLARITY switch be placed?
1. ON
2. OFF
3. PNP
4. NPN

3-9. When you are testing a transistor with a transistor tester, for the reading to have ±15 percent accuracy, the resistance from emitter to base must be what minimum value?
1. 100 ohms
2. 200 ohms
3. 300 ohms
4. 50 ohms

3-10. When you are testing an in-circuit diode with the transistor tester, the meter pointer deflects below the midscale point. What does this indicate?
1. The diode is normal
2. The diode is faulty
3. The circuit impedance is 8 ohms
4. The POLARITY switch is in the PNP position

3-11. The RCL bridge measures an unknown resistance by balancing the resistance value of the unknown component with that of known components inside the test set. What type of circuit is used in this method of measurement?
1. O'Neill bridge
2. Wheatstone bridge
3. Colpitts oscillator
4. D'Arsonval movement

3-12. The RCL bridge is used to measure which of the following quantities?
1. Resistance, capacitance, and inductance
2. Capacitor quality
3. The turns ratio of transformers
4. Each of the above

3-13. To make an inductance measurement on the model 250DE, you must first adjust the DET GAIN control to what position?
1. 1
2. 2
3. 3
4. 4

3-14. The direct-measuring power meter is used for which of the following types of measurements?
1. Incident power
2. Reflected power
3. Both 1 and 2 above
4. Average power

3-15. When you are selecting forward or reverse power measurements, what component(s) of the rf wattmeter is/are restricted to a 180°; rotation range?
1. The coupler-detector
2. The POWER RANGE knob
3. The u-type connector
4. Both 2 and 3 above

3-16. Of the following available rf wattmeter power ranges, which one should you select when measuring an unknown power?
1. 10 watts
2. 100 watts
3. 500 watts
4. 1000 watts

THIS SPACE LEFT BLANK INTENTIONALLY.

IN ANSWERING QUESTIONS 3-17 AND 3-18, ASSUME THAT YOU HAVE

OBTAINED THE FOLLOWING RF POWER MEASUREMENTS:
— INCIDENT POWER, 144 WATTS
— REFLECTED POWER, 1 WATT

3-17. What is the approximate standing wave ratio?
1. .85 to 1
2. 1 to 1
3. .08 to 1
4. 1.2 to 1

3-18. What total amount of power is absorbed by the load?
1. 1 watt
2. 13 watts
3. 143 watts
4. 173 watts

3-19. To take power readings, you connect an in-line rf power meter in what configuration in the transmission line?
1. Series
2. Parallel
3. Series-parallel
4. Horizontal

3-20. Which of the following test instruments produces a standard of measurement of ac energy for testing electronics equipment?
1. Power meter
2. Oscilloscope
3. Signal generator
4. Frequency counter

3-21. Signal generators are equipped with attenuators for which of the following purposes?
1. To regulate the output frequency
2. To regulate the output signal level
3. To determine the modulating frequency
4. To set the level of internal modulation

3-22. Which of the following signal generators should you select to test audio equipment?
1. Af signal generator
2. Fm signal generator
3. Rf signal generator
4. Video signal generator

Figure 3A.—Af signal generator block diagram.
IN ANSWERING QUESTION 3-23, REFER TO FIGURE 3A.

3-23. What section of the signal generator regulates the output to the equipment under test?
1. The amplifier
2. The attenuator
3. The oscillator
4. The output meter

3-24. Typical rf signal generators use which of the following methods for modulation?
1. Internal modulation
2. External modulation
3. Both 1 and 2 above
4. Power supply modulation

3-25. The modulating circuit in an rf signal generator serves which of the following purposes?
1. It produces an fm signal that can be superimposed on the rf signal
2. It produces a video signal that can be superimposed on the rf signal
3. It produces an audio signal that can be superimposed on the rf signal
4. Both 2 and 3 above

3-26. The output level meter of a signal generator reads 0. 10 with the attenuator set to 080. 0. What is the actual output in microvolts?
1. 00.08
2. 00.80
3. 08.00
4. 80.00

3-27. Frequency counters serve which of the following purposes?
1. Measure voltage in a circuit

2. Measure frequencies in a circuit
3. Produce voltages to test a circuit
4. Produce frequencies to power a circuit

3-28. In which of the following ways is a logic probe useful to a technician?
1. It detects steady logic levels
2. It detects a train of logic levels
3. Both 1 and 2 above
4. It displays the shape of high-speed transients

3-29. In logic probes, which of the following devices is used as an indicator?
1. A dial
2. An LED
3. A scale
4. A pointer

3-30. The Tracker 2000 is used to isolate defective components on de-energized circuits only.
1. True
2. False

3-31. The VERT control adjustment controls what position of the signal on the CRT display?
1. Horizontal
2. Vertical
3. Trace rotation left
4. Trace rotation right

3-32. The axes of the CRT display on the Tracker 2000 are divided into what number of quadrants?
1. 1
2. 2
3. 3
4. 4

3-33. Quadrant 2 on the Tracker 2000 CRT is used to display what signal information?
1. Positive voltage negative current
2. Positive voltage and positive current
3. Negative voltage and negative current
4. Negative voltage and positive current

3-34. When you are adjusting the level control on the Tracker 2000, the peak of each pulse will be from 0 volts to what maximum voltage level?
1. 1
2. 5
3. 3
4. 9

3-35. The medium 1 range on the Tracker 2000 is designed to test resistance values between what (a) minimum and (b) maximum values?
1. (a) 5 ohms (b) 1 kilohm
2. (a) 50 ohms (b) 10 kilohms
3. (a) 500 ohms (b) 100 kilohms
4. (a) 50 kilohms (b) 10 megohms

3-36. What is the principal use of the oscilloscope?
1. To measure microwave energy
2. To visually examine waveforms
3. To measure in-line power supply currents
4. To locate sources of radio interference

3-37. Cathode-ray tubes used in oscilloscopes contain which of the following components?
1. An electron gun
2. A deflection system
3. A fluorescent screen
4. All of the above

3-38. In a basic oscilloscope, what is the purpose of the deflection system?
1. To filter harmonic frequencies
2. To deflect harmonic frequencies
3. To position the beam on the screen
4. To deflect synchronous side effects

3-39. If the electron beam is left in one position on the CRT for long periods, damage is likely to occur to what component(s)?
1. Illuminating coating

Prepared by: Harlem A. Agnote

2. Deflection plates
3. Signal generator
4. Electron gun

3-40. Of the following factors, which one(s) control(s) the angle of deflection of the electron beam in the CRT?
1. Difference of potential between plates
2. Length of deflection field
3. Beam acceleration
4. All of the above

3-41. In an oscilloscope, which of the following waveform characteristics are represented by (a) vertical deflection and (b) horizontal deflection?
1. (a) Amplitude (b) frequency
2. (a) Power (b) amplitude
3. (a) Power (b) frequency
4. (a) Time (b) amplitude

3-42. In oscilloscopes using electrostatic CRTs, what type of signal is used to produce horizontal beam movement?
1. Dc
2. Sine wave
3. Square wave
4. Sawtooth wave

3-43. The length of time the phosphor coating on the CRT remains bright after the electron beam is removed depends on which of the following characteristics?
1. Persistence of the coating
2. Amplitude of the applied signal
3. Frequency of the applied signal
4. Synchronization frequency of the oscilloscope

3-44. An oscilloscope that can display two vertical input signals at the same time is said to be what type?
1. Two-function
2. Dual-trace
3. Single-function
4. Single-trace

3-45. The FOCUS control on the front of an oscilloscope is used to adjust what characteristic on the CRT display?
1. Beam size
2. Beam location
3. Trace position
4. Beam brilliance

Figure 3B.—CRT traces.

IN ANSWERING QUESTIONS 3-46 THROUGH 3-48, REFER TO FIGURE 3B.

3-46. What trace in the figure should you correct by adjusting ONLY the HORIZONTAL POSITION control?
1. A
2. B
3. C
4. D

3-47. What trace in the figure should you correct by adjusting ONLY the VERTICAL POSITION control?
1. A
2. B
3. C
4. D

3-48. In the figure, what trace would be corrected by adjusting both the HORIZONTAL POSITION and VERTICAL POSITION controls?
1. A
2. B
3. C
4. D

3-49. What is the purpose of the deflection amplifiers in a cathode-ray oscilloscope?
1. To isolate the input signal from the vertical deflection plates
2. To increase the amplitude of the signal applied to the vertical deflection plates
3. To eliminate distortion of the CRT beam
4. To position the beam on the CRT

3-50. What control on the front panel of an

oscilloscope limits the input signal amplitude and allows the oscilloscope to be used with a wide range of signals?
1. TIME/CM
2. TIME BASE
3. ATTENUATOR
4. TRIGGER

3-51. What is the purpose of a variable potentiometer mounted on the VOLTS/DIV control of an oscilloscope?
1. To provide definite step control of the input signal
2. To provide fine control of the input signal
3. To provide fine control of the output signal
4. To provide definite step control of the output signal

3-52. The time base of an oscilloscope is variable to enable the instrument to
1. measure low- and high-amplitude signal voltages
2. operate over a wide range of input frequencies
3. make accurate measurements of signal amplitudes
4. accurately position the presentation on the CRT

3-53. The triggered oscilloscope has which of the following advantages over a basic oscilloscope?
1. Better low-voltage input- handling capability
2. Lower distortion of input signal
3. Both 1 and 2 above
4. Improved presentation stability

3-54. The TRIGGER and LEVEL controls are used to synchronize the sweep generator with what signal?
1. Input
2. Output
3. Vertical deflection rate
4. Horizontal deflection rate

3-55. The setting of what control establishes the amplitude point of the input waveform at which the displayed sweep will begin?
1. TRIGGER LEVEL
2. TRIGGER SLOPE
3. AMPLITUDE
4. A delayed by B

Figure 3C.—Oscilloscope displays.

IN ANSWERING QUESTIONS 3-56 THROUGH 3-60, REFER TO FIGURE 3C. SELECT THE OSCILLOSCOPE DISPLAY THAT CORRESPONDS TO THE SETTING OF THE TRIGGER LEVEL AND SLOPE CONTROLS IN THE QUESTIONS.

3-56. TRIGGER LEVEL set to zero; SLOPE set to negative.
1. A
2. C
3. E
4. F

3-57. TRIGGER LEVEL set to positive; SLOPE set to negative.
1. A
2. D
3. E
4. F

3-58. TRIGGER LEVEL set to negative; SLOPE set to positive.
1. B
2. C
3. D
4. F

3-59. TRIGGER LEVEL set to negative; SLOPE set to negative.
1. A
2. B
3. C
4. D

3-60. TRIGGER LEVEL set to positive; SLOPE set to positive.
1. A

2. C
3. D
4. F

3-61. Which of the following electrical quantities can be measured using an oscilloscope?
1. Current
2. Frequency
3. Inductance
4. Capacitance

3-62. What effect does sweep frequency that is higher than the incoming signal frequency have on the displayed signal?
1. It produces a jittery view of the incoming signal
2. It produces a multiple view of the incoming signal
3. It produces an exact view of the incoming signal
4. It produces less than a complete view of the incoming signal

3-63. A dual-trace oscilloscope differs from a dual-beam oscilloscope in that the dualtrace device uses (a) what number of electron beams and (b) what number of channels?
1. (a) 1 (b) 1
2. (a) 2 (b) 1
3. (a) 2 (b) 2
4. (a) 1 (b) 2

3-64. What two modes are used to obtain the dual trace on an oscilloscope?
1. Chop and beam
2. Chop and alternate
3. Slow sweep and beam
4. Alternate and slow sweep

3-65. Of the following oscilloscope switch settings, which ones will provide desirable (a) slow sweep speeds and (b) high sweep speeds?
1. (a) CHOP
(b) ALTERNATE
2. (a) SLOW SWEEP
(b) ALTERNATE
3. (a) BEAM SWITCH
(b) SLOW SWEEP
4. (a) ALTERNATE
(b) CHOP

3-66. In a dual-trace oscilloscope, the gate that controls both sweeps is controlled by a multivibrator that operates at which of the following maximum frequencies?
1. 50 kHz
2. 100 kHz
3. 500 kHz
4. 1,200 kHz

3-67. What is the basic internal configuration of the typical dual-trace oscilloscope?
1. One gun assembly with two vertical channels
2. Two gun assemblies with two horizontal channels
3. One gun assembly with two vertical and horizontal channels
4. Two gun assemblies with one vertical and horizontal channel

3-68. The horizontal sweep channels of the dual-trace oscilloscopes have which of the following time base circuit configurations?
1. One time base circuit
2. Two interdependent time base circuits
3. Two independently controlled time base circuits
4. Variations of all the above configurations

3-69. Which of the following types of probes are commonly available for use with the oscilloscope?
1. Current
2. One-to-one
3. Attenuation
4. All of the above

3-70. On the spectrum analyzer, what information can be found on the (a) x axis and (b) y axis?

1. (a) Voltage (b) current
2. (a) Frequency (b) amplitude
3. (a) Amplitude (b) frequency
4. (a) Current (b) voltage

3-71. The intensity knob on the spectrum analyzer controls what display function(s)?
1. Focus
2. Brightness of the CRT trace
3. Brightness of the readout display
4. Both 2 and 3 above

3-72. On the spectrum analyzer, the RF input jack is used to accept what maximum frequency input signals?
1. 21 GHz or below
2. 21 GHz or above
3. 31 GHz or below
4. 31 GHz or above

3-73. The POSITION control on the spectrum analyzer is used to adjust which of the following CRT display features?
1. Vertical position only
2. Horizontal position only
3. Vertical and horizontal position
4. Beam focus

MODULE 17

RADIO FREQUENCY COMMUNICATIONS PRINCIPLES

PREPARED BY:

Toby Cabungcal

1-1. For naval communications to be effective, all involved must be top performers. Reliable, secure, and timely receiving and transmitting of information is the goal. Which of the following requirement standards are used to determine whether or not this goal has been met?
1. Wartime
2. Peacetime
3. Cold war less 10 percent
4. Nuclear war less 25 percent

1-2. What are the two types of electrical communications?
1. Radio and wire
2. Television and wire
3. Telegraph and radio
4. Television and radio

1-3. Which of the following terms includes intelligence produced by wire, radio, visual means, oral means or electromagnetic systems?
1. Telecommunications
2. Radiotelegraph
3. Electrolysis
4. Photocopy

1-4. Radiotelegraph (cw) is valuable when communicating to, from, and among widely separated naval units. What is the main advantage of the cw mode?
1. Cost
2. Speed
3. Security
4. Reliability

1-5. Tactical communications is usually considered as line-of-sight. What maximum distance is normally within the line-of-sight range?
1. 5 miles
2. 25 miles
3. 50 miles
4. 250 miles

1-6. You want to transmit high-speed automatic page or tape copy across an ocean area. Which of the following methods should you choose?
1. Facsimile
2. Radiotelegraph
3. Radiotelephone
4. Radioteletypewriter

1-7. What method is normally used to transmit graphs electronically?
1. Facsimile
2. Radio teletypewriter
3. Frequency-shift keying
4. Audio-frequency-tone shifting

1-8. When you use subdivisions to assign reference designators to equipment, what is the designator of (a) the largest and (b) the smallest?
1. (a) System (b) set
2. (a) Set (b) unit
3. (a) Unit (b) assembly
4. (a) System (b) part

1-9. When using the reference designator 1A6A4J6, what level does the number 1 refer to?
1. Subassembly
2. Assembly
3. Group
4. Unit

1-10. What is the total number of frequency bands the military is currently using for communications?
1. 5
2. 7
3. 9
4. 11

1-11. Extremely low-frequency transmissions are primarily directed at which of the following users?
1. Shore installations
2. Surface ships
3. Submarines
4. Aircraft

Prepared by: Harlem A. Agnote

1-12. Vlf transmitters are used primarily for which of the following purposes?
1. Navigation and fleet communications
2. Frequency standards and time signals
3. Astronomy and oscillator calibration
4. Aircraft control and space vehicle tracking

1-13. Navy use of the low-frequency band is mainly for which, if any, of the following broadcasts?
1. Ship to shore
2. Fleet multichannel
3. Space vehicle telemetry
4. None of the above

1-14. For which of the following reasons does the Navy use only the upper and lower ends of the mf band?
1. They are the most reliable
2. They produce the best propagation
3. The commercial fm band occupies the middle
4. The commercial AM band occupies the middle

1-15. Hf communications over long-distance trunks, or links between fixed terminals are examples of which of the following types of systems?
1. Fleet broadcast
2. Point-to-point
3. Ground-to-air
4. Ship-to-shore

1-16. Sending a message on several frequencies at once is an example of which of the following transmission types?
1. Time-diversity
2. Phase-diversity
3. Distance-diversity
4. Frequency-diversity

1-17. What type of diversity uses physically separated transmit or receive antennas to improve communications?
1. Time
2. Phase
3. Space
4. Frequency

1-18. Normally the transmission range of vhf is limited to line of sight. What technique is used to increase this range?
1. Tropospheric scatter
2. Atmospheric diversity
3. Ionospheric maneuvering
4. Each of the above

1-19. A complex of links make up a major communications system. The naval communications system is further broken down into what two groups?
1. Strategic and local
2. World-wide and local
3. Strategic and tactical
4. Tactical and world-wide

1-20. Communications links have many modes of operation. One terminal in a link has its equipment setup in simplex. The other terminal is using two channels or frequencies in a configuration that allows sending and receiving of different messages at the same time. These two terminals working together make up what mode of operation?
1. Full duplex
2. Half duplex
3. Quasiduplex
4. Semiduplex

1-21. What communications link mode of operation provides telecommunications capability between stations at the same time in both directions?
1. Half duplex
2. Semiduplex
3. Broadcast
4. Duplex

1-22. Aid in restoring downed fleet communications channels is furnished on a not-to-interfere basis by which of the following networks?
1. AUTOSEVOCOM
2. NORATS

3. HICOM
4. DSSCS

1-23. Which of the following switched networks extends tactical voice to shorebased operational commands?
1. NORATS
2. AUTOVON
3. AUTODIN
4. AUTOSEVOCOM

1-24. Of the following transmitter types, which are used for basic communications?
1. Cw, AM, fm, and ssb
2. Fsk, cw, AM, and tty
3. Cw, ssb, voice and fm
4. Voice, tty, fsk, and AM

1-25. Cw transmissions have narrow bandwidths and a high degree of intelligibility under severe noise conditions. What is the primary Navy use for cw?
1. Radioteletypewriter
2. Radiotelegraphy
3. Facsimile
4. Voice

1-26. A cw transmitter must contain which of the following components?
1. A traveling-wave tube
2. A demodulator
3. A combiner
4. A keyer

1-27. In a cw transmitter, a buffer stage performs which of the following functions?
1. Current divider
2. Voltage divider
3. Current amplifier
4. Voltage amplifier

1-28. There are differences between low- and high-power transmitters. The main difference is the high power transmitter contains a larger number of which of the following types of amplifiers?
1. Oscillator
2. Final power
3. Intermediate power
4. Intermediate frequency

1-29. In an AM transmitter, audio frequencies are converted into corresponding electrical energy by which of the following components?
1. An oscillator
2. A microphone
3. A modulator
4. A headset

1-30. In an fm transmitter, a varicap performs which of the following functions?
1. It amplifies the outgoing signal
2. It varies the oscillator frequency
3. It demodulates the outgoing signal
4. It multiplies the oscillator frequency

1-31. If an oscillator has a fundamental frequency of 3,550 megahertz, what is the frequency of the third harmonic?
1. 5,325 megahertz
2. 7,100 megahertz
3. 9,875 megahertz
4. 10,650 megahertz

1-32. If the fundamental frequency of an rf carrier is 1,000 kilohertz, what is the frequency of the fourth subharmonic?
1. 500 kilohertz
2. 333 kilohertz
3. 250 kilohertz
4. 200 kilohertz

1-33. Oscillator output frequencies are raised to usable values by frequency multipliers. To raise an oscillator frequency from 20 megahertz to 120 megahertz, what combination of frequency multipliers would be used?
1. Two doublers
2. A doubler and a tripler
3. A doubler and a quadruplet
4. A tripler and a quadruplet

1-34. When an AM signal leaves the antenna of a transmitter, which of the following frequency components does the signal contain?
1. The carrier
2. The upper sideband
3. The lower sideband
4. All of the above

1-35. In a single-sideband transmitter, selection of the desired sideband and suppression of the other is done by which of the following components?
1. Mixer
2. Filter
3. Detector
4. Oscillator

1-36. When compared to a conventional AM signal, an ssb signal provides which of the following advantages?
1. Improved frequency stability
2. Increased receiver gain
3. Reduced distortion
4. Reduced bandwidth

1-37. For ship-to-shore teletypewriter circuits, which of the following types of multiplexing is/are used?
1. Time and/or phase
2. Time and/or frequency
3. Phase and/or modulation
4. Frequency and/or modulation

1-38. Operators of transmitters and receivers use a circuit to coordinate the service of messages and to make frequency changes. What is the name of this circuit?
1. Order-wire circuit
2. Documentation circuit
3. Synchronization circuit
4. Operator-eyes-only circuit

1-39. A transmitted electromagnetic wave enters an antenna, induces a voltage into it, and passes that voltage to a receiver. What is this chain of events called?
1. Reproduction
2. Selection
3. Detection
4. Reception

1-40. When a receiver picks one frequency out from all other frequencies, it's performing which of the following basic functions?
1. Selection
2. Reception
3. Detection
4. Reproduction

1-41. When a receiver separates the audio frequencies from the radio-frequency carrier it is performing which of the following basic functions?
1. Reception
2. Selection
3. Detection
4. Reproduction

1-42. The receiver action of converting electrical energy to a usable format, such as sound, is an example of which of the following basic functions?
1. Reception
2. Selection
3. Detection
4. Reproduction

1-43. Which of the following measurements provides an indication of the ability of a receiver to reproduce weak signals?
1. Bandwidth
2. Sensitivity
3. Selectivity
4. Frequency response

1-44. Overall sensitivity of a receiver is limited by which of the following factors?
1. Noise
2. Bandwidth
3. Output power
4. Frequency response

1-45. How is a receiver's ability to reject unwanted signals and receive desired signals determined?

1. Noise
2. Fidelity
3. Selectivity
4. Sensitivity

1-46. When high fidelity is your prime consideration you should select a receiver that has been designed with which of the following features?
1. High gain
2. High output power
3. Broadband frequency selection circuits
4. Narrowband frequency selection circuits

1-47. The IF frequency in a receiver is produced by which of the following methods?
1. Modulation
2. Heterodyning
3. Frequency synthesis
4. Frequency multiplication

1-48. The process of heterodyning takes place in which of the following receiver circuits?
1. Mixer
2. Comparator
3. Oscillator
4. Second IF amplifier

1-49. Of the following frequencies, which one is a typical value of IF for AM communications receivers?
1. 455 kilohertz
2. 554 kilohertz
3. 455 megahertz
4. 554 megahertz

1-50. Two or more circuits within a receiver are varied by a single control through the use of which of the following processes?
1. Ganged tuning
2. Frequency synthesis
3. Automatic gain control
4. Automatic frequency control

1-51. There are electrical differences between AM and fm receivers. An fm receiver contains which of the following circuits?
1. Comparator
2. Discriminator
3. Limiter
4. Both 2 and 3 above

1-52. An fm signal has which of the following characteristics when compared to an AM signal?
1. More noise
2. Less static
3. A higher power output
4. A lower operating frequency

1-53. Ssb transmissions have which of the following characteristics when compared to AM transmissions?
1. Wide bandpass frequencies
2. Concentrated power
3. Less modulation
4. High fidelity

1-54. Single sideband receivers use a special oscillator. The output of that oscillator is fed directly to the detector circuit. What type of oscillator is used?
1. Local
2. High frequency
3. Variable frequency
4. Carrier reinsertion

1-55. A transmitter has a suppressed carrier frequency of 4 megahertz and is radiating only an upper sideband signal. When the intelligence is a 1-kilohertz tone, which of the following sideband frequencies will be transmitted?
1. 3,999 kilohertz
2. 4,000 kilohertz
3. 4,001 kilohertz
4. Both 2 and 3 above

1-56. Manual gain lets you adjust a receiver for maximum sensitivity and amplify weak input signals. Which of the following internal sections of the receiver are

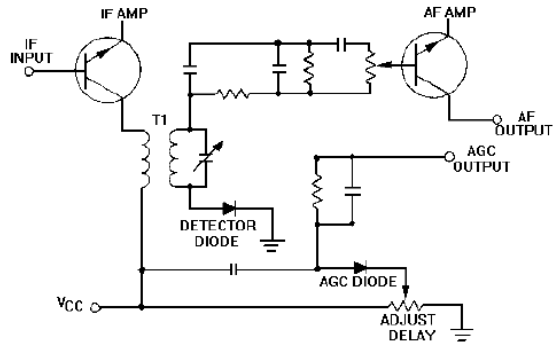
varied by this control?
1. Oscillator
2. Audio frequency
3. Radio frequency
4. Intermediate frequency

1-57. Manual volume control of a receiver internally varies the input to which of the following circuits?
1. Detector
2. Audio amplifier
3. Frequency converter
4. Radio frequency amplifier

1-58. Changes in receiver input strength due to changing atmospheric conditions is described by which of the following terms?
1. Gain
2. Fading
3. Ducting
4. Trapping

1-59. The rf amplifier connected to your receiving antenna has a voltage gain of 240. When the antenna is receiving a signal of 8 microvolts, what will be the maximum output voltage of the rf amplifier?
1. 1.92 millivolts
2. 2.91 microvolts
3. 30 microvolts
4. 33 millivolts

Figure 1A.



IN ANSWERING QUESTIONS 1-60 AND 1-61, REFER TO FIGURE 1A.

1-60. If the agc diode shorts, which of the following actions would result?
1. There would be no aqc
2. There would be no delay
3. The agc diode would be reverse biased
4. The polarity of the agc would be reversed

1-61. The amount of agc feedback depends on attaining an established received signal strength. If the established signal strength is set for 50 microvolts, and the input signal measures 44 microvolts, approximately which, if any, of the following values of agc is developed?
1. 44 microvolts
2. 50 microvolts
3. 94 microvolts
4. None of the above

1-62. To automatically compensate for input signal strength variations within a receiver, which of the following types of circuits are added?
1. Afc
2. Nfc
3. Agc
4. Nsu

1-63. AgC circuitry within a receiver uses a portion of which of the following detector voltage components as a feedback signal to preceding stages?
1. Dc
2. Ac
3. IF
4. Audio

1-64. Which of the following types of agc voltage drives an amplifier toward cutoff?
1. Saturation
2. Delayed
3. Reverse
4. Forward

1-65. What is the purpose of the squelch circuit in a receiver?
1. To attenuate very strong signals in order to prevent their overdriving the remaining stages in the receiver
2. To suppress receiver noise output when no input signal is being received
3. To suppress the electronic "whine" of the rf amplification stage
4. To reject signals of other than the desired frequency should the receiver drift off frequency

1-66. How does a receiver accomplish the squelch function?
1. By proportional blocking of the rf amplifier stage output
2. By blocking the detector or audio amplifier when there is no signal
3. By switching an inductive/capacitive filter into the output of the last rf amplifier
4. By switching in a matched-frequency stage which passes matching frequencies and rejects all others

1-67. A quartz crystal filter is used in a communications receiver to improve which of the following characteristics?
1. Fidelity
2. Sensitivity
3. Selectivity
4. Reproduction

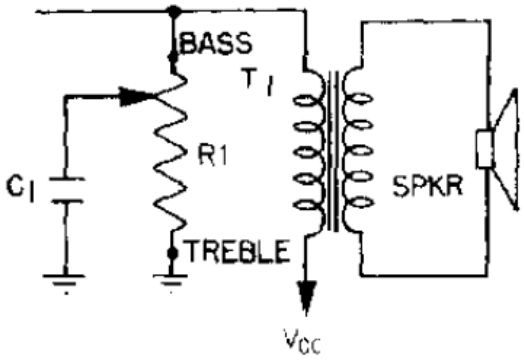


Figure 1B.
IN ANSWERING QUESTION 1-68, REFER TO FIGURE 1B.

1-68. When the wiper of R1 is placed in the full treble position, which of the following actions occur?
1. Bass response is improved
2. High frequency shunting is reduced
3. Higher frequencies are shunted to ground
4. The capacitor and resistor are placed in parallel

1-69. Automatic frequency control circuits are used in a receiver for which of the following purposes?
1. To adjust IF amplifier gain
2. To correct for oscillator frequency drift
3. To extend the frequency range of the receiver
4. To automatically tune the receiver to the desired frequency

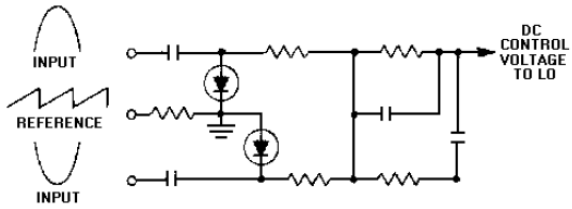


Figure 1C.
IN ANSWERING QUESTIONS 1-70 AND 1-71, REFER TO FIGURE 1C.
1-70. What is the phase relationship between the input signals fed to the diodes?
1. In phase
2. 90 degrees out of phase
3. 180 degrees out of phase
4. 270 degrees out of phase

1-71. A change in oscillator frequency will change which of the following input relationships between the sawtooth reference voltage and the incoming signal?
1. Phase
2. Voltage
3. Current

Prepared by: Harlem A. Agnote

4. Amplitude

1-72. How is the long term stability and accuracy required of modern communications receivers attained?
1. Through the use of a single, crystalcontrolled oscillator, as the local oscillator
2. Through the use of an electroncoupled oscillator, as the local oscillator
3. Through a process of automatic frequency control
4. Through a process known as frequency synthesis

1-73. When using the frequency synthesis process, a signal of the desired accuracy and stability is produced by which, if any, of the following methods?
1. Automatic frequency control, that is, by sensing the difference between the oscillator frequency and the desired frequency and automatically compensating for this difference
2. Using a crystal-controlled oscillator to produce a stable high frequency, and through the process of frequency division selecting a subharmonic of this frequency as the desired frequency
3. The heterodyning and selection of frequencies which are not harmonically related to each other
4. None of the above

1-74. Permanent magnet speakers respond quite well to which of the following audio frequency ranges?
1. Low
2. High
3. Mid band
4. Each of the above

1-75. For which of the following reasons do most standard Navy headphones respond poorly to low frequencies?
1. Small diaphragm size
2. Diaphragm inflexibility
3. Both 1 and 2 above
4. Input signal filte

ASSIGNMENT 2

Textbook assignment: Chapter 3, "Fundamental Systems Equipment," pages 3-1 through 3-47.

2-1. In a basic communications voice system, which of the following functions occur in the handset during the receive process?
1. Correction voltages are fed to the local oscillator
2. Phasing voltages are received from the master oscillator
3. Voice energy is transformed into electronic impulses
4. Electrical energy is converted to acoustical energy

2-2. Radio set control units are often used aboard ship to remotely control transmitters and receivers. Under standard operating conditions what is the maximum number of units that can be paralleled with a single transmitter and receiver group?
1. One
2. Two
3. Eight
4. Four

2-3. When you are using a transmitter transfer switchboard, what is the maximum number of transmitters that may be connected to a single remote control station?
1. One

2. Two
3. Eight
4. Four

2-4. You are using a radio set control unit to remotely control 1 of 8 transmitters. Operating knob number 1 on transmitter transfer switchboard number 1 is used to select transmitters 1 through 6. If you want to control transmitter number 7, what switch position must be selected?
1. 1
2. Any of 1-6
3. X
4. OFF

2-5. On a receiver transfer switchboard, each switch position is connected to what maximum number of receivers?
1. One
2. Two
3. Three
4. Four

IN ANSWERING QUESTIONS 2-6 THROUGH 2-13, REFER TO THE RADIO TRANSMITTING SET DISCUSSED IN CHAPTER 3.

2-6. The impedance matching of equipment to transmission line is accomplished by which of the following equipment groups?
1. A radio transmitter
2. An antenna coupler
3. An rf amplifier
4. A power supply

2-7. The output power of the transmitter unit drives which of the following units?
1. The rf amplifier
2. The power supply
3. The antenna coupler
4. The antenna coupler control

2-8. The rf amplifier receives digital tuning information that is generated in which of the following units?
1. The receiver
2. The transmitter
3. The coupler control
4. The radio set control

2-9. In some installations tuning must be done without the use of rf power, as rf is suppressed except during brief transmission periods. Under these conditions, which of the following methods of tuning should be used?
1. Silent
2. Anti-jam
3. Automatic
4. Semiautomatic

2-10. Operator controlled tuning of the antenna coupler group by the use of front panel controls is possible during which of the following modes of operation?
1. Silent and manual
2. Manual and automatic
3. Semiautomatic and silent
4. Automatic and semiautomatic

2-11. Once tuned, the antenna coupler is able to handle which of the following maximum amounts of power?
1. 500 watts average
2. 2,000 watts average
3. 250 watts peak envelope
4. 1,000 watts peak envelope

2-12. The antenna coupler is pressurized with dry nitrogen for which of the following reasons?
1. To prevent corona
2. To prevent arcing
3. To aid in internal heat transfer
4. Each of the above

2-13. You are using the cw mode of the radio transmitter unit. The 500-kilohertz local carrier is directly inserted into which of the following circuits?
1. The rf amplifiers
2. The IF amplifiers
3. The modulator

4. The detector

IN ANSWERING QUESTIONS 2-14 THROUGH 2-16, REFER TO THE RADIO RECEIVER DISCUSSED IN CHAPTER 3.

2-14. Adjacent-channel selectivity and image frequency suppression have been improved in this receiver by the addition of which of the following features?
1. Digital tuning
2. Triple conversion
3. Front panel readout
4. Very accurate frequency standard

2-15. The full accuracy of the frequency standard is sacrificed when which of the following types of tuning is used?
1. Vernier
2. Automatic
3. 1-kilohertz incremental
4. 100- or 500-hertz incremental

2-16. The receiver demodulates and provides audio outputs for which of the following types of received signals?
1. Fm, AM, and fsk
2. AM, cw, and isb
3. Cw, fm, and isb
4. Lsb, usb, and fm

2-17. A receiving antenna patch panel serves which of the following functions?
1. Terminates lines leading to receivers
2. Terminates incoming antenna transmission lines
3. Both 1 and 2 above
4. Physically connects transmitters to receivers

2-18. Transmitting antenna patch panels are interlocked with the transmitter for which of the following reasons?
1. Safety
2. Ease of operation
3. Ease of maintenance
4. Both 2 and 3 above

2-19. A transmit multicoupler provides which of the following functions?
1. Receiver isolation
2. Transmitter tuning
3. Additional amplification
4. Isolation between transmitters

2-20. In a manual telegraph circuit, the only two conditions are marking and spacing. Marking is characterized by which of the following descriptions?
1. The key is open
2. Current is flowing
3. Current is not flowing
4. The armature is retracted by a spring

2-21. A teletypewriter code signal consists of 7 units. Of the following functions, which describes the middle 5 units?
1. Provides channel data
2. Carries the intelligence
3. Signals stop information
4. Signals start information

2-22. Which of the following terms describe the time between a space and mark or mark and space condition in a teletypewriter?
1. Movement
2. Variation
3. Transition
4. Character interval

2-23. The time interval between words when using the Morse code is equal to which of the following durations?
1. 1 dot
2. 7 dots
3. 3 dashes
4. 5 dashes

2-24. When you are using the five-unit code in teletypewriter operation, what is the maximum number of combinations available that will print letters, figures, function signs, and numerals?
1. 30
2. 32

3. 60
4. 74

2-25. When you are using the teletypewriter five-unit code, which of the following signals are used to increase the printing capacity of the equipment?
1. Inverter
2. Combiner
3. Case-shift
4. Type-adjust

2-26. Which, if any, of the following modes of teletypewriter operation is more often used in high-speed data systems?
1. Start-stop
2. Synchronous
3. Asynchronous
4. None of the above

2-27. In teletypewriter operation, what term defines the length of time required to transmit one letter, figure, function sign or numeral?
1. Baud rate
2. Bit speed
3. Code length
4. Character interval

2-28. Synchronous teletypewriter systems are characterized by which of the following features when compared to asynchronous systems?
1. Internal timing signals are always used
2. Only the start-stop element must be transmitted
3. Only the intelligence elements must be transmitted
4. Signal quality determines receiver line signal condition

2-29. When you are referring to the unit of teletypewriter signaling speed, the reciprocal of the time (in seconds) of the shortest signal element is described by which of the following terms?
1. Unit code
2. Baud rate
3. Bits per second
4. Words per minute

2-30. The teletypewriter condition where current flow represents a mark and no current flow represents a space occurs in which of the following types of operation?
1. Polar
2. Arctic
3. Biased
4. Neutral

2-31. You are using neutral keying and the teletypewriter type hammer continually strikes the type box but there is no printing or type box movement across the page. What is the name of this condition?
1. Debugging
2. Running open
3. Baudot blanking
4. Decoding at random

2-32. Of the following equipment which one changes teletypewriter dc pulses to mark and space modulation for the transmitter carrier wave?
1. A comparator
2. A modulator
3. A converter
4. A keyer

2-33. To change an rf signal to do pulses for teletypewriter operation, you must use a receiver and what other piece of equipment?
1. A keyer
2. A converter
3. A comparator
4. A demodulator

2-34. A tone-modulated radio teletypewriter system uses what modulation method to change dc mark and space impulses into audio electrical impulses?
1. Amplitude

2. Frequency
3. Phase
4. Pulse

2-35. In a basic tone-modulated radio teletypewriter system, separation of the audio signal from the carrier is accomplished by what process?
1. Conversion
2. Modulation
3. Selection
4. Detection

2-36. In a radio-frequency-carrier shift system, what equipment is the source of radiofrequency excitation voltages?
1. The inverter
2. The converter
3. The comparator
4. The transmitter keyer

2-37. The keyer in a radio-frequency-carrier shift system is normally adjusted for which of the following maximum frequency spreads?
1. 425 hertz
2. 500 hertz
3. 750 hertz
4. 850 hertz

2-38. Of the following teletypewriter equipment, which one is used to store incoming teletypewriter messages on tapes for future transmission on a transmitter distributor?
1. A keyboard
2. A page printer
3. A typing reperforator
4. A communication patching panel

2-39. Teletypewriter patch panels perform which of the following functions?
1. They provide a means for connecting the teletypewriter equipment in various combinations
2. They provide a means for permanently connecting commonly used combinations of equipment
3. They provide a central point for connecting the dc supply voltage to the teletypewriter circuits
4. Each of the above

2-40. You are working with a teletypewriter patch panel. What color signifies that secure information is being passed?
1. Red
2. Gray
3. Black
4. Green

2-41. In any switching operation between plugs and jacks of a teletypewriter panel, if the cord plug is pulled from the set (machine) jack before the plug is removed from the looping jack, which of the following conditions will occur?
1. A dangerous dc voltage will be produced on the exposed plug
2. All teletypewriter messages in the channel will be interrupted
3. Both 1 and 2 above
4. Classified information will be Compromised

2-42. Cryptographic equipment performs which, if any, of the following functions?
1. Encodes and decodes messages
2. Reduces mean-time between messages
3. Acts as an additional power amplifier
4. None of the above

2-43. In the radio-frequency-carrier shift system, translation of an rf signal to an audio signal is done by which of the following equipment?
1. A converter
2. A comparator
3. A radio receiver
4. An antenna filter

2-44. A comparator compares signal strength during which of the following types of receiver operation?
1. Single
2. Space diversity

3. Frequency diversity
4. Both 2 and 3 above

2-45. In an afts transmit system, the conversion of dc signals into audio tone-shift signals is done by which of the following pieces of equipment?
1. Cryptographic
2. Tone terminal set
3. Converter/comparator
4. Modulator/demodulator

2-46. The process of simultaneous transmission of several intelligible signals on the same frequency during the same period of time is called
1. duplexing
2. simplexing
3. complexing
4. multiplexing

2-47. What are the two methods of multiplexing?
1. Time-division and frequencymultiplication
2. Time-division and frequency-division
3. Time-multiplication and frequencymultiplication
4. Time-multiplication and frequencydivision

2-48. In time-division multiplexing, assume that a 4,000-hertz tone is applied to each of six channels in a telegraph transmitter and that each channel is to be sampled at a rate of 2. 5 times during each cycle of the 4,000-hertz tone. At what speed, in revolutions per second, must the rotating switch turn to accomplish this sampling rate?
1. 3,000
2. 4,000
3. 7,200
4. 10,000

2-49. In time-division multiplexing, what drawback is encountered if an excessive number of frequency channels is used?
1. Static is increased
2. Bandwidth is increased
3. Switching becomes unreliable
4. Reception becomes unintelligible

2-50. How many times per cycle is a practical time-division multiplex system optimumly sampled?
1. 1.5
2. 2.0
3. 2.4
4. 3.1

2-51. Frequency-division multiplexing systems transmit and receive during a maximum of how many degrees of a sinewave?
1. 90
2. 180
3. 270
4. 360

2-52. By using frequency-division multiplexing, tty circuits may carry a maximum of how many single, 3,000-hertz channels?
1. 12
2. 16
3. 18
4. 24

2-53. In a 16-channel tty-multiplexing system, the maximum difference between a mark and a space, for any give channel, is how many hertz?
1. 85
2. 382.5
3. 425
4. 467.5

2-54. Weather charts and photographs are examples of materials transmitted by
1. aw telegraphy
2. FAX (facsimile)
3. landline teletypewriter
4. rttv (radio teletypewriter)

2-55. Which of the following facsimile transceiver operations consists of subdividing the picture in an orderly

manner and into a large number of segments?
1. Scanning
2. Recording
3. Receiving
4. Transmitting

2-56. The scanning operation is accomplished in the facsimile transmitter by a
1. scanning drum and a phototube arrangement
2. scanning drum and aperture tube
3. spiral drum and amplifier
4. phototube amplifier

2-57. The purpose of the phototube in facsimile equipment is to
1. illuminate a segment of the picture
2. produce the carrier signal for the exciter lamp
3. maintain the output voltage at a predetermined fixed value
4. transform varying amounts of light into electrical signals

2-58. Which of the following means is used to synchronize the receiving drum with the transmitting drum in a radio facsimile system?
1. The drums are mechanically linked
2. Each drum is started by an accurate clock
3. Both drums are operated by synchronous motors
4. Both drums are stepped around a precise number of steps by a relay

2-59. In a facsimile system, which of the following methods is used to accomplish framing at the receiver unit?
1. A synchronous clutch mechanism is actuated
2. A primary time/frequency standard is switched in
3. A series of phasing pulses are transmitted prior to image transmission
4. A synchronous motor at both the transmitter and receiver is engaged

2-60. Of the following terms, which one is primarily concerned with compromising emanations?
1. Tempest
2. Radiation hazard
3. Quality monitoring
4. Electromagnetic interference

2-61. Of the following fundamental requirements of a military communications system, which one, if any, is most important?
1. Speed
2. Security
3. Reliability
4. None of the above

2-62. What one assumption may be made regarding all military radio transmissions?
1. They are secure
2. They have been encrypted
3. They have been decrypted
4. They have been intercepted

2-63. Scheduled maintenance in support of QMCS is designed to alert you to which of the following problems?
1. Safety hazards
2. Equipment failure
3. System degradation
4. Improper operating procedures

2-64. Of the following terms, which one is defined as the ability of an electronic system to perform its individual functions without interference?
1. Electronic countermeasures
2. Electromagnetic interference
3. Electromagnetic compatibility
4. Electronic counter-countermeasures

2-65. The sources of electromagnetic radiations that reduce receiver performance are known by which of the following terms?

1. Electronic countermeasures
2. Electromagnetic interference
3. Electromagnetic compatibility
4. Electronic counter-countermeasures

2-66. Which of the following categories of electromagnetic interference includes interference generated by electrically charged raindrops?
1. Natural
2. Functional
3. Incidental
4. Hull-generated

2-67. Cross modulation is a form of emi where the desired carrier intermodulates with an undesired signal. Which of the following devices should minimize this interference?
1. Filters
2. Preselectors
3. Both 1 and 2 above
4. Preamplifiers

2-68. Shipboard receive systems are designed to include protective circuitry between the antenna and the receiver that prevent which of the following problems?
1. Degradation of overall receiver performance by processing of off frequency signals
2. Decrease of desired signal amplification
3. Burn out of front-end stages
4. Each of the above

2-69. Of the following body organs, which are considered the most vulnerable to radiation hazards (RADHAZ)?
1. Eyes and testes
2. Heart and lungs
3. Liver and spleen
4. Kidneys and brain

2-70. Which of the following methods of reducing rf burn hazards is the most useful and widespread technique used?
1. Operate receivers only
2. Vary the operating frequency
3. Bond and ground all metallic objects
4. Operate transmitters only at low power

2-71. The greatest hazard from thermal effects appears to come from equipment operated in which of the following frequency ranges?
1. 1 to 3 gigahertz
2. 2 to 30 megahertz
3. 30 to 300 kilohertz
4. 225 to 500 megahertz

2-72. You have been working on a piece of equipment and your eyes have been exposed to high-intensity microwaves. Which of the following types of eye problems may occur?
1. Detached retina
2. Conjunctivitis
3. Cataracts
4. Glaucoma

Prepared by: Harlem A. Agnote

ASSIGNMENT 3

Textbook assignment: Chapter 4, "Introduction to Satellite Communications," pages 4-1 through 4-21. Chapter 5, "Introduction to Miscellaneous Systems and Equipment," pages 5-1 through 5-20.

3-1. What artificial satellite is credited with starting the era of space technology?
1. Vela
2. Midas
3. Score
4. Sputnik

3-2. There are two types of communications satellites. What type acts as a repeater for the signal?
1. Active
2. Passive
3. Reflecting
4. Retransmitting

3-3. Transmission of information to a satellite is done on what frequency?
1. Up-link
2. Down-link
3. Transponder
4. Termination

3-4. An earth terminal receives signals on what frequency?
1. Up-link
2. Transmit
3. Down-link
4. Termination

3-5. Of the following orbit parameters, which one describes the basic orbit shape of a communications satellite?
1. Inclined or polar
2. Polar or equatorial
3. Elliptical or circular
4. Synchronous or nonsynchronous

3-6. When the period of an orbit is identical to that of the earth, the orbit is
1. synchronous
2. asynchronous
3. subsynchronous
4. near-synchronous

3-7. What is the parameter in the orbit of a satellite that refers to the point nearest the center of the earth?
1. Apogee
2. Perigee
3. Altitude
4. Inclination

3-8. As a reference, perigee and apogee are measured in which of the following units?
1. Nautical miles
2. Statute miles
3. Light years
4. Kilometers

3-9. A satellite which has a flight path that does not coincide with the equatorial plane of the earth is said to be in what type if orbit?
1. A circular
2. An inclined
3. An elliptical
4. An equatorial

3-10. A satellite orbiting with an angle of inclination of approximately 90 degrees describes which of the following types of orbit?
1. Polar
2. Equatorial
3. Synchronous
4. Asynchronous

3-11. In order to cover most of the earth except the polar regions, what is the minimum number of satellites that mast be orbited?
1. 5
2. 6
3. 3
4. 4

3-12. There were many limitations that caused problems on the first communications satellites. Of the following problems, which one was considered the most

severe?
1. The excessive size
2. The excessive weight
3. The too low orbit altitude
4. The lack of a suitable power source

3-13. Which of the following power sources is/are considered a practical choice for satellites?
1. Solar cells only
2. Storage batteries only
3. A combination of solar cells and storage batteries
4. Sunlight and leclanche cells

3-14. What development in satellite communications improved back-up power during eclipses?
1. The installation of a battery back-up
2. The installation of a nuclear power source
3. The continuous exposure of solar cells to the sun
4. The increase in solar cells mounted on the surface of the satellite

3-15. Why is satellite orientation in space so important?
1. Because it is a necessity for back-up power
2. To meet the requirements of spin stabilization
3. To ensure that sunlight converging on the solar cells is converted to electrical power
4. Because it is essential for maximum solar cell exposure to the sun and satellite antenna visibility to earth terminals

3-16. Why are communications satellite earth terminals generally located in areas remote from the actual users?
1. To minimize cost
2. To minimize jamming
3. To minimize rf interference
4. To allow for future expansion

3-17. Which of the following characteristics is a requirement for a satellite earth terminal antenna?
1. It must be omnidirectional
2. It must be of the Franklin collinear type
3. It must have low gain and be highly directional
4. It must be capable of transmitting and receiving signals simultaneously

3-18. One earth terminal antenna uses a cluster of four 10-foot parabolic antennas. This array is effectively a total of how many feet in diameter?
1. 18
2. 20
3. 32
4. 40

3-19. Why do satellite earth terminals require highly sensitive receivers?
1. To overcome the down-link power losses
2. To permit extraction of the desired communications information from the received signal
3. Both 1 and 2 above
4. Because of the signal scatter effect of the antennas

3-20. Which of the following functions is performed by the exciter stage of an earth terminal transmitter?
1. Modulation of the IF carrier
2. Translation of the IF signal to the uplink frequency
3. Amplification of the IF signal to the level required by the receiver
4. Conversion of the down-link frequency to an IF

3-21. Telemetery equipment used in satellite communications systems performs which of the following functions?
1. They monitor the operating conditions within the satellite
2. They provide local control for

satellite operations
3. They furnish high-capacity wide-band tty trunks
4. They measure ambient weather conditions

3-22. A typical shipboard receive-only satellite system uses which of the following types of modulation?
1. Pulsed or amplitude
2. Pulsed or frequency
3. Amplitude or phase-shift-key
4. Frequency or phase-shift-key

3-23. Locating a near-synchronous satellite is rather simple for which of the following reasons?
1. It is stationary
2. It is moving north to south
3. It has a slow relative motion
4. It has a fast relative motion

3-24. What is the name of the table that provides coordinates of a satellite at specific times?
1. Bearing location
2. Longitudinal
3. Propagation
4. Ephemeris

3-25. To establish radio contact with a satellite, an earth terminal must know which of the following satellite data?
1. Attitude
2. Elevation
3. Operating speed
4. Angle of inclination

3-26. Satellite down-link frequency variations occur most often from satellites in which of the following orbits?
1. Low altitude elliptical
2. Medium altitude circular
3. High altitude synchronous
4. Superhigh altitude near-synchronous

3-27. Of the following terms, which one describes the period of time required for one earth terminal to yield control of a satellite to another?
1. Slewing
2. Hand over
3. Control shift
4. Terminal continuity

3-28. When compared to hf communications, which of the following advantages are unique to satellite communications links?
1. They are more reliable and flexible
2. They are unaffected by propagation variations affecting hf
3. They do not require repeater stations or troposcatter links
4. Each of the above

3-29. Which of the following factors limits the reliability of active satellite communications system?
1. The reflection or refraction of signals
2. The reliability of the equipment used
3. The skill of the operating and maintenance personnel
4. Both 2 and 3 above

3-30. An increase of invulnerability to jamming of satellite communications systems is seen through the use of which of the following features?
1. Narrow bandwidths
2. Low transmitter output power
3. Antijamming modulation techniques
4. Omnidirectional earth terminal Antennas

3-31. Which of the following statements best describes the advantage of satellite communications in terms of flexibility?
1. The antenna group of any earth terminal can be mounted on the weather deck of a ship
2. Certain earth terminals are housed in vans and can be transported to remote areas
3. Military satellite communications are capable of handling hundreds of voice

channels
4. A high degree of protection from jamming is afforded by the highly Directional antennas at earth terminals

3-32. A satellite communications system is limited by which of the following characteristics?
1. The attitude of the satellite repeater
2. The technical design of the satellite
3. The immobility of the satellite
4. The mobility of the satellite

3-33. Active communications satellite systems have two major limitations. What are they?
1. Complex preamplifiers and high gain antennas
2. Up-link transmitter power and earth terminal antenna size
3. Down-link transmitter power and uplink receiver sensitivity
4. Down-link receiver sensitivity and external atmospheric noise

3-34. The rf power output of a satellite communications system is severely limited due to which of the following factors?
1. A lack of adequate jamming capabilities
2. An inefficient solar-cell package aboard the satellite
3. An unstable satellite orientation with respect to the horizon
4. A requirement for large antenna-farm earth-terminal systems

3-35. The availability of a satellite to act as a relay station between two earth terminals depends upon which of the following considerations?
1. The mobility of the satellite
2. The location of the earth terminals
3. The operating frequencies of the satellite
4. The electronic design of the earth terminals

3-36. What determines the length of time that a nonsynchronous satellite in a circular orbit will be in the zone of mutual visibility?
1. Height of the orbit
2. Earth terminal antenna size
3. Down-link transmitter power
4. Up-link receiver sensitivity

3-37. Satellite communications systems are being rapidly developed by the Navy for which of the following reasons?
1. To replace microwave links
2. To relieve dependence on hf communications
3. To reduce procurement and development costs
4. To replace all physically large size equipment

3-38. In an mf transmitter, the frequency generator is used during which of the following modes of operation?
1. AM
2. Fm
3. Cw
4. Fsk

3-39. The pre-ipa and ipa in an mf transmitter are which of the following types?
1. Linear, tuned
2. Linear, untuned
3. Non-linear, tuned
4. Non-linear, untuned

3-40. Of the following communications system components, which one is a device that is nonradiating, absorbs rf, and has the characteristic impedance of the antenna?
1. Helix
2. Dummy load
3. Rf tuning unit
4. Frequency synthesizer

3-41. Which of the following antenna arrays consists of quarter-wave, vertically

polarized stubs?
1. Broadside
2. Parasitic
3. Top-hat
4. Triatic

IN ANSWERING QUESTIONS 3-42 THROUGH 3-44, REFER TO THE MEDIUM FREQUENCY AND BELOW RECEIVER COVERED IN CHAPTER 5.

3-42. With one exception, the receiver has the same circuitry as any high frequency receiver. What is the one exception?
1. The components are doubled up
2. The local oscillator is eliminated
3. The radio-frequency amplifier is replaced by a video amplifier
4. The audio-frequency amplifier is replaced by a traveling-wave tube

3-43. The rejection of input frequencies above 900-kilohertz is performed by which of the following circuits?
1. An attenuator
2. A video amplifier
3. A low-pass filter
4. A calibration oscillator

3-44. The demodulation of ssb, cw, and fsk signals is performed by which of the following circuits?
1. An fm detector
2. A phase splitter
3. An audio amplifier
4. A product detector

3-45. Of the following amplifiers, which one has a high gain, low noise, wide bandwidth and is operated in the microwave region?
1. A magnetic
2. An operational
3. A differential
4. A traveling-wave-tube

3-46. In a line-of-sight communications system, propagation is affected by which of the following layers of the atmosphere?
1. Ionosphere
2. Troposphere
3. Stratosphere
4. Thermosphere

3-47. Horn-driven paraboloid antennas have which of the following characteristics?
1. High gain, narrow beam width
2. Low gain, narrow beam width
3. High gain, wide beam width
4. Low gain, wide beam width

3-48. Line-of-sight systems are configured in many ways with regards to channel width and number of channels. A voice system with a channel width of 4-kilohertz has a total of how many channels available for transmission?
1. 200
2. 400
3. 600
4. 800

3-49. A one-hop transmission of a tropo-scatter system can travel what maximum distance?
1. 1200 miles
2. 1000 miles
3. 800 miles
4. 500 miles

3-50. Of the following advantages, which one is primary to the NTDS when compared with conventional data systems?
1. Speed
2. Distance
3. Security
4. Reliability

3-51. The NTDS uses which of the following data transmission links?
1. 14, 11, 4A
2. 14A, 11, 4
3. 14, 11A, 4
4. 14A, 11A, 4A

3-52. Of the following NTDS links, which

one(s) is/are only used as a one-way broadcast?
1. 14
2. 4A
3. 11, 14
4. 4A, 11

3-53. Portable radio sets are used primarily for which of the following types of communications?
1. Amphibious
2. Air-to-air
3. Electronic warfare
4. Anti-submarine warfare

3-54. When designing portable and pack radios, which of the following characteristics is the prime consideration?
1. Must be solar powered
2. Must be heavy and rugged
3. Must have high output power
4. Must be light-weight and compact

IN ANSWERING QUESTIONS 3-55 THROUGH 3-58, REFER TO THE EMERGENCY LIFEBOAT TRANSMITTER COVERED IN CHAPTER 5.
3-55. Search and rescue stations are divided into groups that have distinct rescue functions. Emergency lifeboat transmissions are designed for reception by a total of how many of these groups?
1. 5
2. 2
3. 3
4. 4

3-56. What are the operating frequencies of the transmitter?
1. 8,364 kHz and 500 MHz
2. 500 MHz and 8,864 kHz
3. 500 kHz and 8,364 kHz
4. 500 kHz and 8,864 kHz

3-57. What is the primary source of power for the transmitter?
1. External ac
2. Wind generator
3. Internal battery
4. Handcrank generator

3-58. When in the automatic mode of operation, the transmitter transmits (a) while changing frequency every (b) seconds?
1. (a) The SOS distress signal
(b) 50
2. (a) Voice messages
(b) 20
3. (a) Voice messages
(b) 50
4. (a) The SOS distress signal
(b) 20

3-59. What is the maximum number of channels available when you are using the emergency portable transceiver covered in chapter 5?
1. 5
2. 2
3. 3
4. 4

3-60. A laser operates in which of the following areas of the light spectrum?
1. Red
2. Infrared
3. Ultraviolet
4. At or near visible light

3-61. The principle of the laser is much like that of, which of the following electronic components?
1. Hall generator
2. Reflex klystron
3. Traveling-wave-tube
4. Very high-Q cavity resonator

3-62. Which of the following components is a close relative of the laser?
1. Thyristor
2. Photo transistor
3. Light emitting diode
4. Photovoltaic transducer

3-63. Laser transmissions during adverse

weather conditions experience which of the following problems?

1. Absorption

2. Refraction
3. Reflection
4. Diffraction

MODULE 18

RADAR FUNDAMENTALS

PREPARED BY:

Dianne Rose R. Liu

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Radar Fundamentals," pages 1-1 through 1-45.

1-1. Radar uses what form of energy to detect ships, planes, and land masses?
1. Sound waves
2. Visible light
3. Infrared radiation
4. Electromagnetic energy

1-2. What radar measurement of an object is referenced to true north?
1. Height
2. Surface angle
3. Vertical angle
4. One-way distance

1-3. The elevation angle to the target is the angle between which of the following references?
1. Ship's heading and line of sight
2. Vertical plane and line of sight
3. Horizontal plane and line of sight
4. Vertical plane and horizontal plane

1-4. Electromagnetic energy travels through air at approximately what speed?
1. 984 feet per microsecond
2. 186,000 statute miles per second
3. 162,000 nautical miles per second
4. Each of the above is correct

1-5. For an object that is detected 15 miles from a radar set, what is the approximate time required for the rf energy to travel to and return from the object?
1. 7 microseconds
2. 185 microseconds
3. 271 microseconds
4. 927 microseconds

$$range = \frac{elapsed\ time}{12.36\ usec.per\ nautical\ mile}$$

1-6. The minimum range of a radar depends on the length of time of the transmitter pulse (pulse width) and recovery time. During this period, the radar can NOT receive energy. A radar set with a pulse width of 5 microseconds and a recovery time of 0. 2 microseconds has a minimum range of approximately
1. 614 yards
2. 787 yards
3. 852 yards
4. 4,100 yards

$$\min range = \frac{pw + recovery\ time}{2} x\ 328\ yards$$

1-7. Of the following radar characteristics, which has NO effect on maximum range capability?
1. Recovery time
2. Carrier frequency
3. Receiver sensitivity
4. Pulse-repetition frequency

1-8. Which of the following characteristics of a radar system determines the degree to which the radiated energy is affected by atmospheric conditions?
1. Pulse peak power
2. Carrier frequency
3. Receiver sensitivity
4. Pulse-repetition frequency

1-9. Pulse-repetition time is described as the
1. reciprocal of pulse width
2. period of time from the beginning to the end of a transmitter pulse
3. period of time required for the pulse to travel to the target and return
4. period of time from the beginning of one transmitter pulse to the beginning of the next

1-10. Which of the following terms describes radar returns that exceed the prt of the radar?
1. Clutter
2. Ambiguous

Prepared by: Harlem A. Agnote

3. Reciprocal
4. Acquisition

1-11. What type of transmitter power is measured over a period of time?
1. Peak
2. Return
3. Average
4. Reciprocal

1-12. Which of the following formulas can be used to compute the duty cycle of a radar set?

1. $\frac{\text{prt}}{\text{pw}}$
2. $\frac{\text{pw}}{\text{prt}}$
3. $\frac{\text{peak power}}{\text{average power}}$
4. $\text{average power} \times \text{peak power}$

ANS: pw/prt

IN ANSWERING QUESTIONS 1-13 AND 1-14, ASSUME THAT A RADAR SET HAS THE FOLLOWING CHARACTERISTICS:
AVERAGE POWER = 700 WATTS
PULSE WIDTH = 3. 5 MICROSECONDS
PRF = 400 HERTZ

1-13. What is the peak power (in kilowatts) for this radar set?
1. 500
2. 1,500
3. 2,000
4. 2,500

$$P_{pk} = \frac{P_{ave}}{Duty\ Cycle}$$

1-14. What is the pulse-repetition time (in microseconds) for this radar set?
1. 1,500
2. 2,000
3. 2,500
4. 4,000

$$prt = \frac{1}{prf}$$

1-15. For a radar set with a pulse width of 25 microseconds and a prf of 600 pulses per second, what is the duty cycle?
1. 0.015
2. 0.024
3. 0.15
4. 0.24

$$Duty\ Cycle = Pw\ x\ Prf$$

1-16. What is the maximum radar horizon distance for a radar set with an antenna 100 feet above the surface of the earth?
1. 8 miles
2. 12.5 miles
3. 80 miles
4. 125 miles

$$horizon\ distance_{nmiles} = 1.25\sqrt{height_{feet}}$$

1-17. A radar set with a prf of 1,000 pps and an antenna rotation rate of 15 rpm produces what maximum number of pulses per degree?
1. 2.7
2. 11.1
3. 14.4
4. 36

1-18. The relative bearing of a radar echo is measured with respect to which of the following reference points?
1. True north
2. Magnetic north
3. Centerline of your own ship
4. The position of the antenna

1-19. Altitude- or height-finding radar systems require a beam with which of the

following characteristics?
1. Narrow in the vertical plane
2. Narrow in the horizontal plane
3. Broad in the horizontal plane
4. Broad in the vertical plane

1-20. Target resolution is the ability of a radar to distinguish between targets that are at nearly the same range and/or bearing. Range resolution is dependent on which of the following factors?
1. Peak power and beam width
2. Pulse width and beam width
3. Pulse width and target size
4. Peak power and target size

1-21. What is the approximate range resolution (in yards) of a radar set with a pulse width of 15 microseconds and a peak power of 2 kilowatts?
1. 10
2. 24
3. 1,093
4. 2,460

$$range\ resolution_{yards} = pw\ x\ 164\ yards\ per\ usec$$

1-22. The width of a radar beam and range to a detected object are the determining factors in which of the following radar system characteristics?
1. Range resolution
2. Bearing resolution
3. Beam half-power points
4. Altitude detection accuracy

1-23. Which of the following factors has/have the greatest effect on the accuracy of a pulse radar?
1. Resolution
2. Average power
3. Atmospheric conditions
4. Each of the above

1-24. To detect nearby objects, the output pulse of a radar transmitter should possess which of the following characteristic shapes?
1. Narrow and square
2. Narrow with a sloping trailing edge
3. Wide and trapezoidal
4. Wide and square

1-25. Refractions and speed changes are known to occur in electromagnetic wavefronts. These phenomena are caused by which of the following conditions?
1. Temperature
2. Vapor content
3. Atmospheric pressure
4. All of the above

1-26. Temperature inversions and/or moisture lapses in the atmosphere may extend or reduce the range of a radar by creating
1. ducts
2. ionic layers
3. surface waves
4. reflective layers

1-27. In a pulse radar system, which of the following components should you expect to find?
1. Synchronizer and transmitter
2. Duplexer and antenna system
3. Receiver and indicator
4. All of the above

1-28. In a pulse radar system, what component controls timing throughout the system?
1. Power supply
2. Synchronizer
3. Indicator
4. Receiver

1-29. What component of the transmitter supplies the trigger pulse, which acts as a switch to turn the klystron on and off?
1. Magnetron
2. Modulator
3. Indicator
4. Power supply

1-30. Which of the following radar components allows the use of one antenna for both transmitting and receiving radar energy?
1. Synchronizer
2. Modulator
3. Duplexer
4. Mixer

1-31. To make amplification of received rf energy easier, the returning rf signal is converted to a lower, intermediate frequency. What component of the radar system performs this function?
1. A duo-diode duplexer
2. A three-stage synchronizer
3. A cross-field amplifier
4. A superheterodyne receiver

1-32. The sweep frequency of a radar indicator is determined by what parameter of the radar system?
1. Duty cycle
2. Pulse width
3. Carrier frequency
4. Pulse-repetition frequency

1-33. The type and method of scanning used by a radar system depend upon which of the following radar system design considerations?
1. Antenna size
2. Type of radar
3. Purpose of the radar
4. All of the above

1-34. In a single stationary-lobe scanning system, complete azimuth coverage is achieved by which of the following methods?
1. Multiple overlapping beams
2. An omnidirectional antenna
3. A continuously rotating antenna
4. Very wide, flat beams

1-35. Which of the following methods can be used to achieve radar-beam scanning?
1. Mechanical
2. Electronic
3. Combined mechanical and electronic
4. Each of the above

1-36. In a conical-scan antenna, nutation of the radar beam is usually accomplished by which of the following methods?
1. By moving the reflector
2. By moving the feed point
3. By varying the signal phase at the feed point
4. By moving both the feed point and the reflector

1-37. At any given distance from the antenna, the radar beam axis of a conical-scan antenna follows what pattern?
1. A circle around the scan axis
2. An ellipse in the vertical plane
3. An ellipse in the horizontal plane
4. Two circles covering the scan axis in figure eights

1-38. In a monopulse scanning radar, the relative position of a target with respect to the radar-beam axis is determined by comparing which of the following signal components?
1. The phases of the radiated rf energy
2. The phases of the returning rf energy
3. The amplitudes of the returning rf energy in each horn
4. The amplitudes of the returning rf energy in each successive pulse

1-39. In a monopulse scanning system, which of the following feedhorn signal combinations makes up the bearing signal?
1. (A + D) - (A + C)
2. (A + B) - (C + D)
3. (A + C) - (B + D)
4. A + B + C + D

1-40. In a monopulse scanning system, which of the following combinations make up the range signal?

1. (A + D) - (A + C)
2. (A + B) - (C + D)
3. (A + C) - (B + D)
4. A + B + C + D

1-41. Monopulse receivers use what signal as a phase reference?
1. Range
2. Traverse
3. Elevation
4. Angle-tracking

1-42. In the cw radar transmission method, the Doppler effect provides which of the following target information?
1. Speed of the target
2. Presence of the target
3. Both 1 and 2 above
4. Relative bearing of the target

1-43. The frequency of the returned signal increases when a target is approaching and decreases when a target is moving away in which of the following types of radar systems?
1. Search
2. Doppler
3. Pulse-modulation
4. Frequency-modulation

1-44. Continuous-wave radar that uses the Doppler effect is best used in detecting which of the following types of targets?
1. Stationary
2. Past-moving
3. Targets with a high degree of range resolution
4. Targets with a high degree of bearing Resolution

1-45. Range information can be obtained in a Doppler radar by which of the following methods?
1. Sweeping the transmitter frequency
2. Using two separate transmitters
3. Both 1 and 2 above
4. Using two separate antennas

1-46. Frequency-modulated radars transmit a wave that continuously changes in frequency about a center frequency. Using frequency modulation, the range to a target is determined by using which of the following methods?
1. By comparing the frequency of the transmitted signal with the returned frequency from the target
2. By comparing the magnitude of transmitted pulses with the magnitude of returned pulses
3. By comparing the velocity of the received energy with the velocity of the transmitted energy
4. By measuring the Doppler shift that occurs in the returning signal

1-47. Which of the following statements describes the advantage of using pulse modulation (pm) rather than continuouswave (cw) in a radar system?
1. Pm may be used to detect moving targets; cw is effective only against stationary targets
2. Pm may be used to determine relative velocity much more accurately than cw
3. Pm does not require frequency stabilization of the carrier wave; cw does
4. Pm does not depend on target motion; cw does

1-48. In Doppler radar, some definite relationship must exist between the transmitted frequency and the reference frequency. For what purpose is this relationship used?
1. To detect the heterodyning signal
2. To detect the continuous-wave signal
3. To detect the Doppler shift of the received signal
4. To detect the frequency shift of the transmitted frequency

1-49. Which of the following JETDS classifications identifies a shipboard fire

control radar set?
1. AN/SPS-39
2. AN/SPG-55
3. AN/APG-12
4. AN/MRC-20

1-50. For most military applications, which of the following radar systems is/are used?
1. Track radar only
2. Search radar only
3. Both track and search radars are used
4. Moving-target indicators

1-51. Detection of surface and low-altitude air targets is the primary purpose of which of the following types of radar?
1. Surface search
2. Height finding
3. Fire control
4. Air search

1-52. Which of the following are typical characteristics of surface-search radars?
1. High pulse-repetition rates
2. Narrow pulse widths
3. High frequencies
4. All of the above

1-53. Long-range aircraft detection is provided by which of the following types of radar?
1. Track
2. Air search
3. Fire control
4. Surface search

1-54. Which of the following are characteristics of a typical air-search radar?
1. Low frequency
2. Narrow pulse width
3. High pulse-repetition rate
4. All of the above

1-55. Which of the following types of radar provides accurate range, bearing, and altitude of aircraft?
1. Air search
2. Guidance
3. Height-finding
4. Surface search

1-56. Which of the following radars would most likely be used to direct CAP aircraft during an intercept?
1. Track radar
2. Fire-control radar
3. Surface-search radar
4. Three-coordinate radar

1-57. The range capability of a 3D radar is limited by which of the following characteristics?
1. Low prf
2. Long prt
3. Low output power
4. High operating frequency

1-58. Fire control radars must be directed to the general location of a desired target. This is because of which of the following characteristics?
1. Low output power level
2. Low degree of accuracy
3. Narrow beam pattern
4. Poor resolution

1-59. When a fire-control radar antenna approaches the general direction of a target, the radar enters which of the following modes of operation?
1. Acquisition
2. Designation
3. Lock-on
4. Track

1-60. Which of the following characteristics is/are typical of a fire-control radar?
1. Very high prf
2. Very narrow pw
3. Very narrow beam
4. All of the above

1-61. Complete control of a beam-rider missile requires what minimum number of radar beams?
1. 1

Prepared by: Harlem A. Agnote

2. 2
3. 3
4. 4

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Radar Subsystems," pages 2-1 through 2-51.

2-1. Which of the following units of a radar system determines timing for all units of the radar?
1. Automatic tracker
2. Synchronizer
3. Transmitter
4. Receiver

2-2. Which of the following classifications describes a radar system that uses a master oscillator to produce timing pulses?
1. Externally synchronized
2. Self-synchronized
3. Unsynchronized
4. Free-running

2-3. Which of the following oscillators may be used as the master oscillator in a radar system?
1. A stable multivibrator
2. Sine-wave oscillator
3. Blocking oscillator
4. Each of the above

2-4. Which of the following oscillators, used in a synchronizer to provide timing trigger pulses, does NOT require a pulseshaping circuit in its output?
1. Phase-shift oscillator
2. Square-wave oscillator
3. Sine-wave oscillator
4. Blocking oscillator

2-5. A radar system in which timing triggers are determined by the pulse-repetition rate of the modulator uses what type of synchronization?
1. Self
2. External
3. Free-running
4. Stable blocked

2-6. Which of the following radar indicator functions is/are controlled by gate pulses from the synchronizer?
1. Sweep duration
2. Sweep initiation
3. Range-mark generator gating
4. All of the above

2-7. Indicator sweep voltage in a radar is normally initiated at which of the following times?
1. At the same time as the transmitter trigger
2. Before the transmitter trigger
3. After the transmitter trigger
4. Each of the above

2-8. The flyback retrace of a radar system indicator is prevented from appearing on the cathode-ray tube by removing the
1. negative-intensity gate pulse applied to the control grid
2. positive-intensity gate pulse applied to the control grid
3. negative-intensity gate pulse applied to the cathode
4. positive-intensity gate pulse applied to the cathode

2-9. Which of the following characteristics is NOT a requirement of a basic radar system timing circuit?
1. It must be free-funning
2. Frequency must be variable
3. It must develop random frequencies
4. It should provide a stable frequency

2-10. Which of the following circuits converts square waves to positive and negative triggers?
1. A negative limiter
2. A positive limiter
3. A long-time-constant RC differentiator
4. A short-time-constant RC

Prepared by: Harlem A. Agnote

Differentiator

2-11. Which of the following circuits is used to remove either the negative or positive triggers from the output of a sine-wave oscillator?
1. A clipper
2. A limiter
3. An LC network
4. A differentiator

2-12. When the master oscillator in a multivibrator timer is asymmetrical, the output of the master oscillator is in the form of
1. rectangular waves
2. negative pulses
3. square waves
4. sine waves

2-13. The positive and negative output pulses of the astable multivibrator are sent to the indicator for which of the following purposes?
1. To intensify the crt beam
2. To gate the range-marker generator
3. Both 1 and 2 above
4. To gate the transmitter output

2-14. Which of the following oscillators generates sharp trigger pulses without additional circuitry?
1. Sine-wave oscillator
2. Wien-bridge oscillator
3. One-shot multivibrator
4. Single-swing blocking oscillator

2-15. A radar transmitter is triggered directly by high voltage pulses from what unit?
1. The timer
2. The antenna
3. The indicator
4. The modulator

2-16. The peak power of a transmitted rf pulse depends on which of the following factors?
1. Width of the modulator pulse
2. Amplitude of the modulator pulse
3. Prf of trigger pulses from the timer
4. Delay time between trigger and modulator pulse outputs

2-17. The transmitter range timing circuit must be triggered at the instant the transmitted pulse leaves the transmitter. For which of the following reasons is this timing so important?
1. To ensure accurate range
2. The ensure long range targets are detected
3. To ensure that the target is "painted" on the crt by each transmitted pulse
4. To keep the magnetron oscillating at a fixed frequency

2-18. For proper operation of the magnetron, the modulator pulse must have which of the following characteristics?
1. A flat top
2. A steep leading edge
3. A steep trailing edge
4. All of the above

2-19. In order that nearby targets may be detected, which of the following characteristics must the transmitted pulse have?
1. A steep leading edge
2. A steep trailing edge
3. A sloping leading edge
4. A sloping trailing edge

2-20. Compared to the hard-tube modulator, the line-pulsing modulator has which of the following advantages?
1. It is more complex
2. It is more efficient
3. It is more sensitive to voltage changes
4. It requires a higher power-supply Voltage

2-21. The modulator of a radar basically consists of a power supply, a switch, a storage element, and a/an

1. IF strip
2. oscillator
3. transmitter
4. charging impedance

2-22. Which of the following devices can be used as the storage element in a radar modulator?
1. A capacitor
2. A pulse-forming network
3. An artificial transmission line
4. Each of the above

2-23. A signal introduced at the input end of an artificial transmission line moves through the circuit to the output end and is reflected back to the input. The output end of an artificial transmission line appears to the input signal as what type of circuit?
1. Open
2. Short
3. Inductive reactance
4. Capacitive reactance

2-24. The discharge pulse from the artificial transmission line causes a voltage of what magnitude to appear across the primary of the pulse transformer?
1. Twice the original charge voltage
2. One-half the original charge voltage
3. The same as the original charge voltage
4. One-fourth the original charge Voltage

2-25. What parameter, if any, of the output pulse from an artificial transmission line is affected by the inductance and capacitance of each section of the line?
1. Width
2. Amplitude
3. Frequency
4. None of the above

2-26. A pulse-forming network exhibits electrical behavior similar to which of the following devices?
1. A resistance-capacitance network
2. An artificial transmission line
3. A capacitor
4. An inductor

2-27. The requirements of a modulator switch are to (1) reach full conduction quickly, (2) consume low power, (3) start and stop conduction suddenly, and (4) conduct high currents and handle high voltages. Which of the following tubes meets these requirements?
1. A tetrode
2. A thyratron
3. A magnetron
4. A beam-powered amplifier

2-28. What modulator circuit characteristic determines the charging rate of the storage element?
1. Resistance
2. Capacitance
3. Charging impedance
4. Pulse-repetition frequency

2-29. Which of the following types of instability are common to magnetron oscillators?
1. Mode skipping
2. Mode shifting
3. Both 1 and 2 above
4. Magnetic fluctuation

2-30. Which of the following magnetron characteristics can be caused by low magnetic field strength?
1. Low power output
2. Excessive plate current
3. Incorrect operating frequency
4. All of the above

2-31. Which of the following maximum tuning ranges is typical for a tunable magnetron?
1. +/- 10 percent around the center frequency
2. +/- 5 percent around the center frequency

3. 1 to 5 percent above the center frequency
4. 1 to 10 percent below the center Frequency

2-32. Compared to the keyed-oscillator transmitter, power-amplifier transmitters are used more often with mti radar systems because power-amplifier transmitters provide
1. better stability
2. lower output power
3. higher output power
4. greater frequency range

2-33. Which of the following tubes should be used as the power amplifier in a radar transmitter?
1. The magnetron
2. The thyratron
3. The reflex klystron
4. The multicavity klystron

2-34. Which of the following components determines the pulse width of a poweramplifier transmitter?
1. The modulator
2. The mixer-amplifier
3. The local oscillator
4. The power-amplifier tube

2-35. The intermediate stages of a poweramplifier
transmitter have operating power only during which of the following times?
1. When the coherent rf pulse is applied
2. When the local oscillator signal is applied
3. During the time the modulator pulse is applied
4. Immediately after the coherent rf pulse is removed

2-36. Using a frequency synthesizer instead of a heterodyning mixer as the frequency generating source for a power-amplifier transmitter is an advantage because the frequency synthesizer
1. is more stable
2. is simpler to construct
3. produces a single frequency
4. produces discrete frequencies over a wide band

2-37. Unwanted oscillations in an rf amplifier transmitter are prevented because of which of the following pulse relationships?
1. The rf pulse is wider than the modulator pulse
2. The rf pulse is narrower than the modulator pulse
3. The rf pulse frequency is equal to the local oscillator frequency
4. The rf pulse frequency is less than the local oscillator frequency

2-38. A power-amplifier transmitter that transmits a broad band of frequencies typically uses which of the following tubes as the final stage?
1. A crossed-field amplifier
2. A multicavity klystron
3. A magnetron
4. A twt

2-39. What is the primary function of the radar duplexing system?
1. To prevent the formation of standing waves in the waveguide system
2. To permit the use of one antenna for transmission and reception
3. To increase the effective range of the radar
4. To increase antenna directivity

2-40. A defective duplexer in a radar will most likely cause damage to which of the following components?
1. The receiver
2. The waveguide
3. The magnetron
4. The local oscillator

2-41. Why is it desirable that the duplexer quickly connect the receiver to the antenna after the transmitted pulse?
1. So that line-match will remain balanced
2. So that the transmitter power dissipated will be minimum
3. So that echoes from nearby targets will be received
4. So that echoes from nearby targets will not prolong ionization

2-42. The action of tr-atr circuits depends upon the impedance characteristics of which of the following lengths of transmission line segments?
1. 1 wave length
2. 1/2 wave length
3. 1/4 wave length
4. 1/8 wave length

2-43. Which of the following requirements is/are essential for proper tr spark gap operation?
1. High impedance during arc time
2. Low impedance during arc time
3. High impedance prior to arc time
4. Both 2 and 3 above

2-44. What is the purpose of introducing water vapor into a tr tube?
1. It increases recovery time
2. It prevents early ionization
3. It decreases deionization time
4. It increases the gap breakdown potential

2-45. Keep-alive voltage is applied to the tr tube for which of the following reasons?
1. To maintain ionization within the tube after the breakdown voltage is removed
2. To ensure that the tube will rapidly return to the deionized state
3. To maintain a glow discharge within the tube so that firing will occur rapidly
4. To prevent breakdown within the tube prior to pulse transmission so that firing will not be premature

2-46. Atr tubes generally have a longer duty life than tr tubes because atr tubes do NOT use
1. radioactive materials and chemically active gas
2. chemically active gas and keep-alive voltages
3. keep-alive voltages and radioactive materials
4. keep-alive voltages and pure inert gas

2-47. In a series-connected duplexer, what spark gap, if any, fires during reception?
1. The tr only
2. The atr only
3. Both the tr and atr
4. None of the above

2-48. Indirectly coupled waveguide duplexers are normally connected to the main waveguide by which of the following devices?
1. A two-wire line
2. A coaxial cable
3. A short quarter-wave stub
4. A short section of waveguide

2-49. The direct-coupled waveguide duplexer is connected to the waveguide at the location of
1. minimum current flow
2. minimum magnetic field intensity
3. maximum magnetic field intensity
4. maximum electric field intensity

2-50. In a hybrid-ring duplexer, the fields at the entrance of an arm must have what phase relationship to propagate energy down the arm?
1. 0 degrees
2. 90 degrees
3. 180 degrees
4. 270 degrees

2-51. Which of the following are requirements of a microwave receiver?
1. Amplify extremely high-frequency pulses
2. Detect and amplify pulses in the microvolt range
3. Detect pulses with a duration of a few microseconds
4. All of the above

2-52. The maximum range at which a radar receiver can detect an object is limited by which of the following factors?
1. Noise
2. Signal distortion
3. Receiver bandwidth
4. Transmitter frequency

2-53. An effective radar receiver should have a gain factor that is in which of the following ranges?
1. 10_1 to 10_2
2. 10_3 to 10_4
3. 10_6 to 10_8
4. 10_9 to 10_{10}

2-54. An overdriven amplifier stage in a receiver may cause which of the following conditions?
1. Blocking
2. Inaccurate ranges
3. Increased sensitivity
4. Large signal distortion

2-55. The intermediate frequency is produced in what stage of a microwave receiver?
1. The mixer
2. The IF amplifier
3. The second detector
4. The local oscillator

2-56. What section of a radar receiver usually determines the overall bandwidth?
1. The mixer
2. The IF amplifier
3. The video amplifier
4. The local oscillator

2-57. What component in a receiver afc circuit produces an output voltage proportional in amplitude and polarity to any change in the intermediate frequency?
1. The mixer
2. The IF amplifier
3. The discriminator
4. The local oscillator

2-58. An efficient local oscillator must have which of the following characteristics?
1. Tunable frequency
2. Stable output frequency
3. Operation in the 4,000 megahertz range
4. All of the above

2-59. Which of the following devices would be used as a local oscillator in a radar receiver?
1. A magnetron
2. A crystal diode
3. A reflex klystron
4. A parametric amplifier

2-60. Which of the following advantages is gained by using a crystal mixer in a microwave receiver?
1. Less noise
2. Reduced saturation
3. Increased overall gain
4. Improved oscillator stability

2-61. The resonant circuit at the output of an unbalanced crystal mixer serves which of the following purposes?
1. It amplifies the IF signal
2. It produces the IF signal
3. It eliminates unwanted signals
4. It amplifies the local oscillator signal

2-62. The balanced transformer connected to the crystals of a balanced mixer has a secondary that is tuned to what frequency?
1. The desired IF
2. The local oscillator frequency
3. The afc discriminator frequency

Prepared by: Harlem A. Agnote

4. The transmitter carrier frequency

2-63. The IF amplifier stage of a radar receiver determines which of the following receiver characteristics?
1. The gain
2. The effective bandwidth
3. The signal-to-noise ratio
4. All of the above

2-64. The detector in a radar receiver converts the IF pulses into what form?
1. Video pulses
2. Square waves
3. Dc voltage levels
4. Continuous-wave signals

2-65. Agc automatically adjusts the gain of the receiver by controlling which of the following quantities?
1. Detector bias
2. IF amplifier bias
3. Mixer output signal level
4. Video amplifier output signal level

2-66. A radar receiver uses iagc for which of the following purposes?
1. To reduce the amplitude of echoes from distant targets
2. To prevent full amplification of strong signals
3. To permit full amplification of weak signals
4. Both 2 and 3 above

2-67. In a radar receiver, which of the following purposes is served by using stc?
1. Prevents full amplification of echoes from nearby targets
2. Permits full amplification of echoes from distant targets
3. Both 1 and 2 above
4. Prevents target echoes within a selected range from being received

2-68. In the input of the first video amplifier of a radar receiver, the differentiator circuit performs which of the following functions?
1. Ftc
2. Gagc
3. Afc
4. Iagc

2-69. The primary function of the mti system is to display which of the following types of targets?
1. Moving targets only
2. Motionless targets only
3. Moving and motionless targets during each sweep
4. Moving and motionless targets during alternate sweeps

2-70. Delaying the received signals in the mti system permits them to be combined with the next set of received signals so that only desired signals are displayed. The signals displayed are formed by which of the following methods?
1. Division
2. Addition
3. Subtraction
4. Multiplication

2-71. In the mti system, what is the purpose of the coho lock pulse?
1. To synchronize the coho and transmitted frequency phase relationship
2. To control the transmitter pulserepetition frequency
3. To synchronize the phase of the timing circuits with the phase detector
4. To control the polarity of the coherent video

2-72. The amplitude of coherent video is determined by the phase difference between which of the following signals?
1. Coho reference and transmitted pulse
2. Coho reference and coho lock pulse

3. Coho reference and IF echo
4. IF echo and received echo

2-73. The purpose of the mti system timing circuits is to
1. synchronize the coho and transmitted frequency phase relationship
2. control the transmitter pulserepetition frequency
3. synchronize the phase of the video balancer with the phase detector
4. select the polarity of the coherent Video

2-74. The lin-log amplifier provides (a) a linear output voltage for what amplitude of input signal and (b) a logarithmic output voltage for what amplitude of input signal?
1. (a) Low (b) low
2. (a) Low (b) high
3. (a) High (b) high
4. (a) High (b) low

2-75. What channel in a monopulse receiver is used as the reference channel?
1. IF
2. Range
3. Bearing
4. Elevation

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Radar Indicators and Antennas," pages 3-1 through 3-22. Chapter 4, "Radar Maintenance," pages 4-1 through 4-23.

3-1. Which of the following geometrical quantities is/are used as coordinates for radar displays?
1. Range
2. Bearing
3. Elevation
4. All of the above

3-2. Of the following target parameters, which would most likely be displayed on all radar sets?
1. Altitude
2. Slant range
3. Ground range
4. All of the above

3-3. Which of the following quantities determines total distance represented on a crt display.
1. Crt size
2. Sweep speed
3. Sweep length
4. Echo spacing

3-4. To correctly represent the location of a target, a radar repeater must receive which of the following quantities?
1. Video
2. Timing pulses
3. Antenna information
4. All of the above

3-5. The A-scope crt normally uses what type of sweep deflection?
1. Mechanical
2. Electrostatic
3. Electromagnetic
4. Electromechanical

3-6. The rhi scope provides the operator with information concerning the target's
1. range only
2. altitude only
3. range and altitude
4. range and bearing

3-7. Own ship position is at the center of the scope in which of the following radar displays?
1. A-scope
2. B-scope
3. Rhi scope
4. Ppi scope

3-8. Synchronization of events in ppi circuitry is of special importance for which of the following reasons?
1. To ensure that bearing readings are accurate
2. To ensure that range readings are accurate
3. To ensure the deflection coils do not overheat
4. To ensure the power supply is activated at the instant the transmitter fires

3-9. Pulses used to synchronize the ppi with the transmitter are developed in which of the following circuits?
1. Gate
2. Sweep control
3. Sweep generator
4. Intensity gate generator

3-10. Which of the following circuits produces currents that deflect the electron beam across the crt?
1. Gate
2. Sweep control
3. Sweep generator
4. Intensity gate generator

3-11. Electromagnetic deflection is preferred over electrostatic deflection in ppi scopes because it provides which of the

Prepared by: Harlem A. Agnote

following advantages?
1. Better control of the beam
2. Better beam position accuracy
3. Better deflection sensitivity
4. All of the above

3-12. Focusing is accomplished in an electromagnetic crt by varying the
1. potential on the deflection plates
2. potential between the first anode and the cathode
3. current through the coil around the neck of the tube
4. do bias current in the deflection coils

3-13. Because the electromagnetic crt uses magnetic deflection, the sweep circuits must provide the deflection coils with which of the following signals?
1. Linear trace current
2. Trapezoidal voltage
3. Sinusoidal voltage
4. Direct current

3-14. In a ppi scope that uses electromagnetic deflection, the amplitudes and polarities of the sawtooth currents are determined by which of the following inputs?
1. Target position and speed
2. Antenna rotation speed
3. Antenna position
4. Both 2 and 3 above

3-15. On the screen of a ppi scope, range markers appear as
1. vertical pulses
2. radial grid lines
3. concentric circles
4. horizontal grid lines

3-16. The range sweep in a range-gate generator is started at the same time the transmitter fires. A pulse from which of the following circuits causes this timing?
1. Receiver
2. Indicator
3. Transmitter
4. Synchronizer

3-17. When used with a ppi presentation, a range gate must have which of the following characteristics?
1. Movable in range
2. Movable in bearing
3. Both 1 and 2 above
4. Fixed in range and bearing

3-18. Range-markers are produced on the basis of which of the following timing constants?
1. Radar mile
2. Transmitter prf
3. Receiver bandwidth
4. Transmitter pulse width

3-19. To read range directly, the range step is placed in what position relative to an echo pulse?
1. The range step is centered on the echo pulse
2. The range step coincides with the leading edge of the echo pulse
3. The range step coincides with the trailing edge of the echo pulse
4. The range step covers the entire echo pulse

3-20. Compared to omnidirectional antennas, directional antennas provide which of the following advantages?
1. Power gain and selectivity
2. Power gain and directivity
3. Sensitivity and selectivity
4. Sensitivity and directivity

3-21. If the vertical beam width of a radar antenna is decreased, what will be the effect on (a) power gain and (b) vertical directivity?
1. (a) Decrease (b) decrease
2. (a) Decrease (b) increase
3. (a) Increase (b) increase
4. (a) Increase (b) decrease

3-22. An array of twelve dipoles are set in the same position as a reference dipole and are fed with the same line. The power

gain will be
1. less than unity
2. one-twelfth the reference
3. twelve times the reference
4. dependent on the directivity of the Array

3-23. If the slant range and altitude of a target are known, which of the following coordinates can be computed using trigonometric functions?
1. Elevation angle
2. True-bearing angle
3. Relative-bearing angle
4. All of the above

3-24. To convert diverging waves into parallel waves, where must the radiating element be placed in relation to a parabolic reflector?
1. At the focal point of the reflector
2. 1/4 wavelength from the reflector
3. 1/2 wavelength from the reflector
4. At the focal point of the hemispherical shield

3-25. What is the function of the hemispherical shield of the parabolic reflector?
1. To polarize all reflected waves in the vertical plane
2. To polarize all reflected waves in the horizontal plane
3. To convert the spherical waves radiated by the dipole into vertical lines of rf energy
4. To reflect rf energy radiated forward of the dipole back to the parabolic reflector

3-26. Which of the following types of parabolic reflectors has a focal line rather than a single focal point?
1. Truncated
2. Rotational
3. Orange-peel
4. Cylindrical

3-27. A broadside array causes maximum energy to be radiated perpendicular to the plane of the dipole for which of the following reasons?
1. Because dipoles are excited in phase with each other
2. Because dipoles are parallel to each other
3. Because dipoles are 1/2 wavelength apart
4. Because dipoles are 1/8 wavelength away from the reflector

3-28. The directivity of a horn radiator is dependent on which of the following physical dimensions of the horn?
1. The shape
2. The length
3. The mouth size
4. All of the above

3-29. Feedhorn shadows can be eliminated by taking which of the following actions?
1. By making the horn smaller
2. By making the reflector smaller
3. By offsetting the horn from the center of the reflector
4. By putting the horn behind the Reflector

3-30. Airborne radars have unique physical design requirements. Which of the following functions is performed by the radome?
1. It serves as the antenna
2. It provides aerodynamic shape
3. It protects the antenna from low air pressure
4. All of the above

3-31. If a fixed-frequency radar transmitter is found to be off its normal operating band, which of the following corrective actions should be taken?
1. Retune the transmitter
2. Change the assigned frequency
3. Replace the defective part causing the error

4. Check the frequency again, an error has been made

3-32. If a transmitter carrier wave is modulated by a square wave, what maximum number of different frequencies will be produced?
1. An infinite number
2. 2
3. 3
4. 4

3-33. Which of the following statements describes a radar transmitter frequency spectrum?
1. The distribution of energy over a band of frequencies
2. The distribution of energy over time
3. The prf multiplied by the duty cycle
4. The pulse width versus peak power

3-34. What total number of modulating components are present in the output spectrum of a pulse radar transmitter?
1. 1
2. 2
3. 3
4. 4

3-35. An ideal radar frequency spectrum would be best described in which of the following ways?
1. It is symmetrical
2. It has a wide lobe
3. It has narrow side lobes
4. It has no minimum points

3-36. In a good spectrum curve the distance between the two minima is proportional to which of the following transmitter parameters?
1. Prt
2. Prf
3. Peak power
4. Pulse width

3-37. The echo box is a good instrument for measuring overall radar system performance because it indicates the combined effectiveness of which of the following components?
1. Antenna and duplexer
2. Transmitter and antenna
3. Transmitter and receiver
4. Receiver and synchronizer

3-38. Oscillations in an echo box are known as ringing. Which of the following conditions cause this ringing?
1. A weak transmitter
2. A saturated receiver
3. A normally operating receiver
4. A normally operating transmitter

3-39. What constitutes the single most useful measurement you can make with the echo box?
1. Ring time
2. Duty cycle
3. Power distribution
4. Frequency distribution

3-40. Desirable transmitter output power characteristics include what relative levels of (a) peak power and (b) average power?
1. (a) Low (b) low
2. (a) Low (b) high
3. (a) High (b) high
4. (a) High (b) low

3-41. Most transmitter power readings are referenced to which of the following quantities?
1. 1 microwatt
2. 1 milliwatt
3. 1 watt
4. 1 kilowatt

3-42. Which of the following factors determines the overall performance of a radar receiver?
1. Bandwidth
2. Sensitivity

3. Recovery time of the tr
4. All of the above

3-43. Of the following receiver special circuits, which one is used during sensitivity tests?
1. Afc
2. Agc
3. Ftc
4. Iagc

3-44. The ability of a receiver to detect weak signals can be determined by which of the following measurements?
1. Noise figure
2. Minimum discernable signal
3. Both 1 and 2 above
4. Bandwidth

3-45. When several mds checks are to be taken over a period of time, the length of the test pulse used in the tests should
1. be the same on each check
2. be different on each check
3. vary with the transmitter pulse length on each check
4. vary with the noise figure on each Check

3-46. When expressing the sensitivity of a radar receiver, which of the following quantities is used?
1. The signal generator reading
2. The combined attenuation value of the connecting cable and directional coupler
3. The sum of both 1 and 2 above
4. The attenuation value of the signal Generator

3-47. Tr recovery time places limits on which of the following quantities?
1. Minimum range
2. Maximum range
3. Receiver bandwidth
4. Receiver sensitivity

3-48. Which of the following methods is/are used to determine the effectiveness of a tr tube?
1. Measure the keep-alive current
2. Measure the keep-alive voltage
3. Graph the correlation between recovery time and leakage power
4. All of the above

3-49. The presence of standing waves on a transmission line indicates which of the following conditions?
1. Excessive output power
2. An impedance mismatch
3. Excessive pulse width
4. Excessive prf

3-50. Of the following conditions, which would be a likely indication of a high vswr?
1. Insufficient reflection
2. Cold spots in the transmission line
3. Arc-over at the maximum points
4. All of the above

3-51. Most primary shipboard ac distribution systems provide which of the following types of electrical power?
1. 60 Hz, 3 phase, ungrounded
2. 60 Hz, 1 phase, ungrounded
3. 400 Hz, 1 phase, ungrounded
4. 400 Hz, 3 phase, ungrounded

3-52. If your equipment is missing a certain voltage input, which of the following actions should you take first?
1. Call an electrician
2. Energize the emergency generator
3. Check the input to the switchboard
4. Check the power panel that feeds your equipment

3-53. What is the normal source of dry air for a shipboard radar system?
1. Compressed-air bottles
2. Central dry-air system
3. Dehumidifying ovens
4. Local dehydrators

Prepared by: Harlem A. Agnote

3-54. The air control panel is designed to regulate
1. flow
2. purity
3. pressure
4. dew point

3-55. Which of the following units may be available as an emergency back-up to the central dry-air system?
1. Nitrogen tank
2. Local dehydrator
3. Local compressor-dehydrator
4. Each of the above

3-56. Which of the following methods is used to cool radar system components?
1. Air blowers
2. Liquid-cooling loops
3. Air-conditioning systems
4. Each of the above

3-57. A radar cooling system has a low-flow alarm in the sea-water loop. What is the primary purpose of this alarm?
1. It allows correction before damage occurs
2. It increases the flow in the distilled water loop
3. It removes power from the system
4. It increases the sea-water pressure

3-58. Which of the following characteristics of cooling water for electronic equipment must be carefully controlled?
1. Purity
2. Pressure
3. Quantity
4. All of the above

3-59. For which of the following reasons do personnel sometimes develop a false sense of security concerning exposure to radiation?
1. Rf radiation does not always produce pain
2. Rf radiation is visible only at night
3. Only search radars are hazardous
4. Rf hazards occur only at night

3-60. Injury from X-rays would most likely result from which of the following actions?
1. Standing near unshielded highvoltage components
2. Working alone on low-voltage power supplies
3. Bypassing interlocks on shielded equipment
4. Working too close to a crt with a potential of 1,500 volts

Prepared by: Harlem A. Agnote

MODULE 21

TEST METHODS AND PRACTICES

PREPARED BY:

Mark Joseph Chico

Prepared by: Harlem A. Agnote

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Basic Measurements," pages 1-1 through 1-26. Chapter 2, "Component Testing," pages 2-1 through 2-8.

1-1. What is the purpose of the Navy's Metrology Calibration Program?
1. To provide the fleet with new types of test equipment
2. To provide quality control for your test equipment
3. To improve the efficiency of sophisticated electronic systems
4. To establish test equipment pools from which technicians can borrow

1-2. At each higher echelon METCAL calibration laboratory, the accuracy of the test equipment increases by a factor of
1. 10
2. 2
3. 100
4. 4

1-3. Most equipment technical manuals contain voltage charts. For which of the following purposes are they used?
1. To list the equipment's power supplies
2. To list the input power requirements of the equipment
3. To provide handy reference guides for calculating voltage drops across fixed impedances
4. To list correct voltages at major test points

THIS SPACE LEFT BLANK INTENTIONALLY.

1-4. Which, if any, of the following statements correctly describes the effect input impedance of test equipment can have on readings taken?
1. The greater the input impedance of your test equipment, the less accurate the readings
2. The lower the input impedance of your test equipment, the more accurate the readings
3. A piece of test equipment with an infinite input impedance will absorb no energy and readings will be more accurate
4. None of the above

1-5. A piece of test equipment with a low input impedance can cause readings taken to be inaccurate. To eliminate this problem, the input impedance of your test equipment should exceed the impedance of the circuit under test by what minimum ratio?
1. 1 to 1
2. 2 to 1
3. 10 to 1
4. 100 to 1

THIS SPACE LEFT BLANK INTENTIONALLY.

USE THE FOLLOWING INFORMATION TO ANSWER QUESTION 1-6: YOU NEED TO TAKE A CRITICAL VOLTAGE READING, BUT YOU DO NOT HAVE A HIGH IMPEDANCE METER AVAILABLE. INSTEAD, YOU CONNECT TWO LOWER IMPEDANCE METERS IN SERIES AND PLACE THEM ACROSS THE COMPONENT IN QUESTION. YOU ADD THE READINGS SHOWN ON THE TWO METERS TO GET YOUR MEASUREMENT.

1-6. Compared to using just one of the lower impedance meters, what is the advantage of using two meters connected in series?
1. Input impedance increases and voltage-measuring accuracy increases
2. Frequency response of the test setup

Prepared by: Harlem A. Agnote

doubles
3. Accuracy of current measurements decreases
4. Input impedance decreases and voltage-measuring accuracy increases

1-7. On an analog multimeter, where on the scale are the most accurate readings taken?
1. At the highest end of the scale
2. At the lowest end of the scale
3. Midscale
4. It makes no difference if the meter is properly calibrated

1-8. What can you do to reduce the problem of meter-reading errors caused by parallax?
1. Close one eye when reading the meter
2. Use short meter leads
3. Use a meter that has a mirror built into the scale
4. View the meter face from either the left or right side, but not directly in front

1-9. For what primary reason are oscilloscopes used in circuit testing?
1. They provide a visual presentation of the signal under test
2. They present a low input impedance to the circuit under test
3. They provide numerical readouts of signals under test
4. They measure voltages more accurately than other pieces of test equipment

1-10. THIS QUESTION HAS BEEN DELETED.

1-11. Digital multimeters effectively eliminate which of the following disadvantages of analog meters?
1. Parallax
2. Low impedance
3. Poor accuracy
4. All of the above

1-12. Which of the following pieces of test equipment is most accurate for measuring dc voltages?
1. Vtvm
2. Oscilloscope
3. Digital voltmeter
4. Differential voltmeter

1-13. If you exceed the frequency limitations of your voltmeter, which of the following results is likely?
1. The meter will be destroyed
2. The circuit under test will be damaged
3. The measurement will be inaccurate
4. The meter will indicate average voltage

1-14. When performing measurements with an oscilloscope, you should ensure that the trace extends across what minimum portion of the vertical viewing area?
1. 15%
2. 25%
3. 45%
4. 60%

1-15. When using an oscilloscope to measure a high voltage, you should use which of the following procedures?
1. Use the logic probe instead of the normal probe
2. Use the high voltage probe instead of the normal probe
3. Use two oscilloscopes connected in series
4. Place a 10-ohm shunt across the vertical input of the oscilloscope

1-16. Oscilloscopes are normally calibrated to display which of the following types of voltages?
1. Peak
2. Average

Prepared by: Harlem A. Agnote

3. Peak-to-peak
4. Both 2 and 3 above

1-17. When using an oscilloscope to observe a sine wave, what, if anything, must you do to determine the rms voltage?
1. Divide the observed peak-to-peak voltage by 3.65
2. Multiply the observed peak-to-peak voltage by 2; then divide by 1.414
3. Divide the observed peak-to-peak voltage by 2; then multiply by 0.707
4. Nothing

1-18. The frequency-measuring capabilities of a digital multimeter can be extended by using which of the following devices?
1. An rf probe
2. A frequency doubler
3. A high-voltage probe
4. A frequency divider network

1-19. When performing ac voltage measurements, you should use which of the following pieces of equipment to obtain the most accurate reading?
1. A differential voltmeter
2. An oscilloscope
3. A Simpson 260
4. A wattmeter

1-20. For which of the following purposes would you connect two ammeters in parallel?
1. To perform voltage measurements
2. To increase frequency-measuring capabilities
3. To decrease input impedance
4. To increase input impedance

1-21. When taking measurements with two ammeters connected in parallel, how do you determine the resulting readings?
1. The current equals the sum of both meter readings
2. The current equals the difference of the two meter readings
3. The current equals the product of the two readings divided by their sum
4. Read either meter directly; the same current flows through both meters

1-22. Current tracers indicate the presence of a current in which of the following ways?
1. By the lighting of an indicator lamp
2. By a clicking noise
3. Both 1 and 2 above
4. By the movement of a meter

1-23. Which of the following is an advantage of using a current probe?
1. It is the most accurate method of measuring current
2. It senses current by induction without being connected directly into the circuit
3. It is battery operated
4. It is capable of measuring current at frequencies above 40 GHz

1-24. When troubleshooting a specific piece of equipment, you can find an accurate listing of resistance readings for specific test points in which of the following documents?
1. In equipment PMS cards
2. In test equipment manuals
3. In equipment technical manuals
4. In Naval Ships Technical Manuals

1-25. An ohmmeter that is used for field work should meet which of the following criteria?
1. It should be extremely accurate
2. It should be portable
3. It should be simple to operate
4. Both 2 and 3 above

1-26. When you use an analog multimeter to measure resistance, which of the following actions should you take first?
1. Make sure the meter is zeroed
2. Set the meter for dc voltage
3. Set the meter for ac voltage
4. Make sure the meter leads do not exceed 36 inches

1-27. Digital multimeters are used to test semiconductors for which of the following reasons?
1. They produce voltage sufficient to gate all Zener diodes
2. Their LED displays are easier to read than analog displays
3. They typically limit the current flow through the semiconductor to less than 1 milliamp
4. They produce in excess of the 500 milliamps normally required to gate a PN junction

1-28. Compensation for the resistance in test leads of digital multimeters used to perform resistance measurements is accomplished by which, if any, of the following methods?
1. Short the leads, note the lead resistance displayed, and add this value to subsequent resistance measurements
2. Short the leads, note the lead resistance displayed, and subtract the value from subsequent resistance measurements
3. Add 10% to the reading
4. None of the above

1-29. Which of the following is a typical use for a megger?
1. Testing MOSFETs
2. Testing filter capacitors
3. Testing thermistor mounts
4. Testing an ac power cord for insulation breakdown

1-30. When large capacitors are stored as spare parts, why should their terminals be shorted with a piece of wire?
1. It prevents dielectric leakage
2. It prevents deterioration of the plates
3. It prevents the capacitors from becoming charged when in close proximity to an rf field
4. It prevents electrolytic capacitors from changing value during periods of storage

1-31. Capacitance meters can be grouped into which of the following basic categories?
1. Wheatstone type and Kelvin Varley type
2. Bridge-type and reactance-type
3. Depletion-type and enhancementtype
4. Resistive-type and reactive-type

1-32. Which of the following statements correctly describes the accuracy and use of a reactance-type capacitance meter?
1. It gives approximate values and is usually portable
2. It gives approximate values and is used in calibration laboratories only
3. It is very accurate and is usually portable
4. It is very accurate and is used to measure capacitors that have a high power factor

1-33. Which of the following types of inductor core materials produces the greatest inductance?
1. Mica
2. Magnetic metal
3. Polyparoloxylene
4. Nonmagnetic metal

1-34. As frequency increases, the inherent resistance of the inductor causes which of the following types of losses to become more critical?
1. Hysteresis
2. Skin effect
3. Eddy currents
4. Standing waves

1-35. Most capacitance test sets are capable of testing capacitors and what other type of component?
1. TRIACS
2. Inductors
3. Resistors
4. Barretters

Prepared by: Harlem A. Agnote

1-36. When using reactance-type test equipment to measure inductance, what relationship exists between the inductor and the voltage drop across the reactance of the inductor?
1. The voltage drop is directly proportional to the value of inductance
2. The voltage drop is inversely proportional to the value of inductance
3. The voltage drop is proportional to the dielectric constant (K) of the inductor
4. The voltage drop is inversely proportional to the frequency of the applied voltage

1-37. Aboard ship you should be able to troubleshoot equipment failures to the component level for which of the following reasons?
1. Ships must be self-sustaining units when deployed
2. Storage space on board ships limits the number of bulky items or electronic modules that can be stored
3. Individual components may be easier to obtain than modules or larger equipment pieces
4. All of the above

1-38. What is the most common cause of electron tube failures?
1. Vibration damage
2. Open filaments
3. Shorted elements
4. Power supply voltage surges

1-39. The simplest way to test a tube is by which of the following methods?
1. Using a tube tester
2. Measuring tube element voltages
3. Feeling for signs of overheating
4. Substituting tubes

1-40. Test conditions for the electron tube tester described in the text are set by which of the following methods?
1. By a technician setting switches
2. By using a magnetic tape program
3. By using a prepunched card program
4. By inserting the tube into the appropriate socket

1-41. The electron tube tester can be used to test common low-power tubes for which of the following conditions?
1. Gas
2. Quality
3. Leakage
4. Each of the above

1-42. Pushbuttons on the electron tube tester are used to test for which of the following conditions?
1. Emission
2. Transconductance
3. Other quality tests
4. Each of the above

1-43. Which of the following tests is automatically performed when the electron tube tester card switch is first actuated?
1. Gas
2. Shorts
3. Opens
4. Quality

1-44. Which of the following methods is normally used to test high-power amplifier tubes?
1. Using tube testers
2. Performing interelectrode resistance checks
3. Making gain measurements with an oscilloscope
4. Observing built-in meters that measure grid and plate current and power output

1-45. Which, if any, of the following problems occur when klystrons are left in storage or not used for more than 6 months?

1. They become gassy
2. The elements become tarnished and ruin the tube
3. All external metallic parts become tarnished and must be cleaned prior to use
4. None

1-46. Which of the following actions should you take to restore operation if the klystron is gassy?
1. Replace the klystron with a new one
2. Return it to the nearest depot for intermediate maintenance
3. Evacuate the gas by igniting the tube's getter
4. Operate it at reduced beam voltage for approximately 8 hours

1-47. Traveling-wave tubes (twt) should be replaced if they deviate from design specifications by what minimum percentage?
1. 1%
2. 10%
3. 25%
4. 33%

1-48. If a twt used as an oscillator fails, which of the following indications should you observe?
1. The twt will become noisy
2. Equipment line fuses will blow
3. The twt will have reduced output power
4. The twt will fail to break into oscillation when all other conditions are normal

1-49. Which of the following is an appropriate reason to use transistors instead of electron tubes?
1. Transistors are more rugged than electron tubes
2. Transistors are not as heat sensitive as electron tubes
3. Transistors are not as sensitive as electron tubes to voltage overloads
4. Transistors are capable of handling greater amounts of power than electron tubes

1-50. When using an ohmmeter to test a transistor's base-to-emitter or base-tocollector junction, what minimum backto-forward resistance ratio should you expect to read?
1. 5 to 1
2. 10 to 1
3. 50 to 1
4. 100 to 1

1-51. When taking forward and reverse resistance readings between a transistor's emitter and collector, what type of reading should you get?
1. Both the forward and reverse readings should be nearly the same
2. A short in both the forward and reverse directions
3. Less than 15 ohms when measuring in the forward direction and infinite in the reverse direction
4. Less than 15 ohms in the reverse direction and infinite in the forward direction

1-52. When using an ohmmeter to test transistors, you should avoid using R´1 range for which of the following reasons?
1. The R´1 range is not as accurate as the other ranges
2. Most ohmmeters do not produce sufficient voltage on the R´1 range to properly bias a transistor junction
3. Some ohmmeters produce in excess of 100 milliamps of current on the R´1 range and could possibly damage the transistor
4. The R´1 scale is not capable of measuring the high resistances that are typical of a PN junction when forward biased

1-53. When using a soldering iron to replace

transistors, you must be sure there is no current leakage between the power source and the tip of the iron. Which of the following actions should you take if current leakage is detected?
1. Reduce the wattage of the heating element
2. Use an isolation transformer to power the soldering iron
3. Use a soldering gun instead of a soldering iron
4. Isolate the soldering iron from ground by disconnecting the soldering iron safety ground wire

1-54. Which of the following is a description of ESDS devices?
1. Components that are sensitive to electrostatic discharge
2. Components that are sensitive to the electromagnetic pulse produced by a nuclear detonation
3. State-of-the-art devices used to detect electronic emissions
4. Devices designed to withstand any type of electromagnetic or electrostatic interference

1-55. MOS and CMOS devices without input diode protection circuitry belong in which, if any, of the following ESDS device categories?
1. Sensitive devices
2. Very sensitive devices
3. Moderately sensitive devices
4. None of the above

1-56. Wearing a grounded wrist strap when repairing electronic circuit boards serves which of the following purposes?
1. It identifies you as being 2M qualified
2. It protects ESDS devices from damage
3. It protects the technician from electrical shock
4. It protects you from rf burns when working near radar antennas

1-57. What, if any, precaution should you take before you open a package that contains an ESDS device?
1. Rub the package against a dissimilar material
2. Discharge any static electricity by connecting a grounded lead to the package
3. Measure the static charge on the package with an oscilloscope to ensure that it is within tolerance
4. None

Prepared by: Harlem A. Agnote

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Component Testing," pages 2-8 through 2-48. Chapter 3, "Quantitative Measurements," pages 3-1 through 3-15.

2-1. Which of the following servicing techniques applies to semiconductors?
1. Substituting a semiconductor with a known good semiconductor is a simple way to test them
2. Voltage and resistance measurements are taken prior to substituting semiconductors
3. Substituting semiconductors is cumbersome if more than one is bad or if they are soldered into the circuit
4. All of the above

2-2. What minimum ratio of back-to-forward resistance should you expect when testing a diode?
1. 1 to 1
2. 10 to 1
3. 50 to 1
4. 100 to 1

2-3. Which of the following characteristics of a diode cannot be determined by using a multimeter?
1. How the diode reacts to various voltages
2. How the diode reacts to various frequencies
3. Both 1 and 2 above
4. How the diode reacts to forward and reverse dc biasing

2-4. How are SCRs normally used in the Navy?
1. As rectifiers
2. As power control devices
3. As voltage regulators
4. As switching diodes in digital applications

Figure 2A. —Testing an SCR with an ohmmeter.
IN ANSWERING QUESTIONS 2-5 AND 2-6, REFER TO FIGURE 2A. NOTE THAT THE CONNECTIONS OF THE OHMMETER ARE ALREADY MADE.

2-5. To forward bias an SCR, which elements should you short together?
1. The gate and anode
2. The cathode and anode
3. The cathode and gate
4. All three elements

2-6. What, if anything, will be the result of removing the short after it has been made?
1. Current flow from the cathode to the anode will stop
2. Current flow from the anode to the cathode will stop
3. Current can flow in either direction between the anode and cathode
4. Nothing

Figure 2B. —Testing a TRIAC with an ohmmeter.
IN ANSWERING QUESTION 2-7, REFER TO FIGURE 2B.

2-7. With a momentary short connected between the gate and anode 2, the TRIAC will be forward biased and allow current to flow between what elements?
1. From the gate to anode 1
2. From the gate to anode 2
3. From anode 1 to anode 2 only
4. In either direction between the two anodes

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 2C. —Unijunction transistor.
IN ANSWERING QUESTIONS 2-8 AND 2-9, REFER TO FIGURE 2C.

2-8. What readings should you expect to find when you measure the resistance between bases 1 and 2 of a UJT?
1. A short regardless of the polarity of

Prepared by: Harlem A. Agnote

the meter leads
2. A high resistance value regardless of the polarity of the meter leads
3. Approximately 15 ohms between base 1 and base 2 with the negative meter lead connected to base 1
4. Approximately 15 ohms between the two bases with the negative meter lead connected to base 2

2-9. For which, if any, of the following reasons do JFETs have circuit applications similar to those of vacuum tubes?
`
2. JFETs have a low input impedance and a frequency response comparable to that of vacuum tubes
3. JFETs have a high input impedance and are current-responsive
4. None of the above

Figure 2D. —Junction FET.
IN ANSWERING QUESTION 2-10, REFER TO FIGURE 2E.

2-10. With the negative lead of an ohmmeter attached to the gate and the positive lead attached to the source, which of the JFETs in figure 2D would be good if the meter shows infinity?
1. P-channel
2. N-channel
3. Both 1 and 2 above
4. Neither 1 or 2

THIS SPACE LEFT BLANK INTENTIONALLY.

Figure 2E. —MOSFET (depletion/enhancement type)
and equivalent circuit.
IN ANSWERING QUESTIONS 2-11 AND 2-12, REFER TO FIGURE 2E.

2-11. When measuring resistance between the drain and source of a depletion/enhancement type of MOSFET, what readings should you expect?
1. 15 ohms in one direction and infinity in the other direction
2. The same value of resistance in both directions
3. A short in one direction and infinity in the other
4. Infinite reading regardless of meter lead polarities

2-12. When measuring resistance between the gate, source, and drain of a depletion/enhancement type of MOSFET with the negative lead attached to the gate, what readings should you expect?
1. Both readings should be infinity
2. Both readings should be between 15 ohms and 100 ohms
3. Both readings should be approximately 1,000 ohms
4. Both readings should be less than 10 ohms

2-13. When unsoldering a MOSFET from a printed circuit board, you should avoid using a vacuum plunger solder sucker for which of the following reasons?
1. Solder suckers can generate high electrostatic charges that can damage MOSFETs
2. Solder suckers create a vacuum that can physically damage MOSFETs
3. Solder suckers are not authorized for any type of equipment repair
4. Solder suckers require the use of a high wattage soldering iron that may damage MOSFETs

Figure 2F. —MOSFET (enhancement type) and equivalent circuit.
IN ANSWERING QUESTION 2-14, REFER TO FIGURE 2F.

2-14. When comparing resistance readings of an enhancement type of MOSFET to those of a depletion/enhancement type of MOSFET, which, if any, of the following

differences should you notice?
1. The resistance between the substrate and the gate of the enhancement type should be less than 15 ohms
2. The measurement between the drain and source of the enhancement type should read infinite regardless of meter lead polarity
3. The resistances between the gate and the drain and between the gate and the source of the enhancement type should be noticeably higher
4. None of the above

2-15. Which of the following is/are (an) advantage(s) of integrated circuits when compared to circuits made up of separate components and interconnections?
1. Lower power consumption
2. Smaller size of the equipment
3. Lower equipment cost
4. All of the above

2-16. Which of the following is a characteristic of linear ICs?
1. They do not require regulated power supplies
2. They are typically sensitive to their supply voltages
3. They are never classed as electrostatic discharge sensitive devices
4. They are comparable in size to their equivalent transistor circuits

2-17. For which of the following reasons would you classify an IC as a "black box" device?
1. Because ICs are always black in color
2. Because all you can check are the inputs and outputs, not the internal operation of ICs
3. Because printed circuit boards that contain ICs cannot be repaired
4. Because ICs are designed to be repairable components

2-18. Test equipment used to detect the logic state of a digital IC should have which of the following characteristics?
1. A capability of measuring rms voltages
2. A frequency response in excess of 40 GHz
3. A high input impedance
4. A low input impedance

2-19. Which of the following statements describes) the use of logic clips?
1. Logic clips are designed to monitor the input and output of an IC simultaneously
2. Logic clips can only be used to test an IC that is out of the circuit
3. Logic clips can only be used with flat pack ICs
4. All of the above

2-20. For which of the following purposes are logic comparators used?
1. To test linear ICs
2. To compare different types of ICs
3. To inject pulse trains into digital ICs
4. For in-circuit testing of digital ICs by comparing them with reference ICs

2-21. Which of the following is an advantage of using a logic probe instead of an oscilloscope to test a digital IC?
1. Logic probes are usually larger than an oscilloscope but much lighter
2. Logic probes have a low input impedance
3. Logic probes are battery powered and do not react to line voltage variations
4. Logic probes are capable of detecting short-duration pulses that most oscilloscopes cannot display

2-22. For which of the following purposes are logic pulsers used?
1. To detect the logic state of digital ICs
2. To detect the logic state of linear ICs
3. To inject a pulse or pulse train into a logic circuit
4. To inject a 1-kHz sine wave into a circuit for signal tracing

2-23. Which of the following is a typical application for a logic analyzer?
1. To program EPROMs
2. To test individual logic ICs
3. To analyze the spectral purity at the output of a logic IC
4. To perform timing analysis by monitoring and comparing more than one timing signal simultaneously

2-24. Which of the following instruments is used to test the specific gravity of a leadacid battery's electrolyte?
1. Hydrometer
2. Hygrometer
3. Electrometer
4. Gravitometer

2-25. Smoking is prohibited in the vicinity of lead-acid storage batteries for which of the following reasons?
1. Cigarette smoke neutralizes the electrolyte
2. Lead-acid batteries produce explosive hydrogen when they are being charged
3. Fumes produced by a lead-acid battery mixed with cigarette smoke produce a toxic by-product
4. All of the above

2-26. When testing dry cell batteries, which of the following procedures should you follow?
1. The battery should be tested under load conditions
2. The battery should not be tested under load conditions
3. The battery should be tested at various temperatures
4. Both 2 and 3 above

2-27. Which of the following dry cell batteries is rechargeable?
1. NICAD
2. Alkaline
3. Carbon-zinc
4. Mercury cells

2-28. Which of the following is the correct maximum charge rate for a NICAD battery rated at 300 milliampere hours?
1. 300 milliamperes for 15 hours
2. 60 milliamperes for 15 hours
3. 30 milliamperes for 15 hours
4. 600 milliamperes for 15 hours

2-29. Which of the following is a characteristic of fixed rf attenuators?
1. They are used to match impedances
2. They are designed to handle small amounts of rf power
3. They are usually built into the equipment in which they are used
4. They are capable of handling several kilowatts of power

2-30. Which of the following is an easy method of performing an operational test on a decade resistor?
1. Use an swr meter
2. Use the resistance substitution method
3. Read the resistance with an ohmmeter
4. Apply an rf voltage across the decade, measuring the voltage drop and computing the resistance

2-31. Which of the following is/are the disadvantages of glass-core, fiber-optic cables?
1. They are smaller in diameter than plastic-core fibers
2. They are extremely susceptible to mechanical damage
3. They exhibit signal losses as high as 25 dB/km
4. Both 2 and 3 above

2-32. Which of the following types of test equipment should you use to measure the losses in a fiber optic cable if only one end of the cable is accessible?
1. An optical ohmmeter
2. A Wheatstone bridge

Prepared by: Harlem A. Agnote

3. An optical power meter
4. An optical time-domain reflectometer

2-33. When using the AN/USM-465 portable service processor, which of the following procedures is possible?
1. Identifying faulty components on digital printed circuit boards
2. Troubleshooting its own printed circuit boards
3. When using the guided probe, it will tell you if you have placed the probe on the wrong test point
4. All of the above

2-34. Which of the following measurements add resistance and inductive and capacitive reactance?
1. Q
2. Resonance
3. Impedance
4. Figure of merit

2-35. Bridge circuits are used in the measurement of impedance for which of the following reasons?
1. Bridges are one of the most accurate devices for measuring impedance
2. Bridges are only slightly less accurate than vtvm's when measuring impedance
3. Bridges are useful in measuring frequency
4. Both 2 and 3 above

2-36. Bridge circuits typically contain which of the following sections?
1. A measuring circuit and comparing circuit
2. A detector circuit
3. A power circuit
4. All of the above

2-37. When approximate values for resistance, capacitance, or inductance to be measured by a bridge are unknown, which, if any, of the following actions should you take?
1. Connect two bridges in parallel to make the measurement
2. Assign a temporary value to the component and set up the bridge accordingly
3. Place an adjustable shunt across the meter terminals
4. None of the above

2-38. The most serious errors affecting the accuracy of bridge measurements can be attributed to which of the following problems?
1. The capacitive and inductive characteristics of the connecting leads
2. The resistance of the test leads
3. D'Arsonval meter movements used as detectors
4. Improper selection of meter shunts

2-39. Which of the following considerations should be given when applying external excitation to a bridge circuit?
1. The voltage applied should equal the maximum voltage rating of the component under test
2. The higher the voltage, the more accurate the measurement
3. Apply only enough voltage to obtain a reliable indicator deflection
4. External excitation should be limited to 115 v 60 Hz

2-40. It is difficult to measure resistances less than 1 ohm with a bridge because of which of the following factors?
1. Contact resistance is present between the resistor being measured and the binding posts of the bridge
2. Excessive supply voltage is required to excite the galvanometer
3. The frequency of the excitation source creates excessive skin currents in the resistor under test
4. The excitation voltage causes lowvalue resistors to heat excessively

2-41. What type of bridge is recommended for

measuring resistances less than 1 ohm?
1. Wheatstone bridge
2. Schering bridge
3. Maxwell bridge
4. Kelvin bridge

2-42. When using resistance-ratio bridges to measure capacitance, inductance, or resistance, you should compare the unknown component with which of the following components?
1. A capacitor
2. An inductor
3. A resistor
4. A similar standard

2-43. A Hay bridge measures unknown inductances by comparing them with which, if any, of the following components?
1. A standard inductor
2. A standard resistor
3. A standard capacitor
4. None of the above

2-44. What is the advantage of using a Maxwell bridge over a Hay bridge?
1. The Maxwell bridge can measure greater range of inductances
2. The Maxwell bridge can measure much smaller resistances
3. The Maxwell bridge can provide a greater accuracy over a smaller range
4. The Maxwell bridge can measure inductances having a high Q

2-45. Which of the following pieces of test equipment measure(s) the magnitude and phase angle of an unknown impedance?
1. The vector bridge
2. The impedance-angle meter
3. Both 1 and 2 above
4. The Hay bridge

2-46. Maximum transfer of rf energy between transmitter/receiver and antenna will occur under which of the following circumstances?
1. When the transmitter or receiver is properly matched to the antenna
2. When the receiver is tuned one sideband above the transmitter
3. When the transmitter is tuned one sideband above the receiver
4. Both 2 and 3 above

2-47. Rf impedance bridge measurements require the use of which of the following pieces of equipment?
1. An ac power source, a detector, and a Wheatstone bridge
2. An rf signal generator, an oscilloscope, and a power supply
3. An rf signal generator, an rf bridge, and a detector
4. A Schering bridge, a detector, and an rf power supply

2-48. What unit of measure is used to express the power level of a complex voice signal?
1. Vu
2. dB
3. dBm
4. Watt

2-49. The function of a dB meter is described in which of the following descriptions?
1. A current-measuring device
2. A user-calibrated constant current device
3. An electronic voltmeter calibrated in terms of dB
4. A frequency selective voltmeter calibrated in terms of true power

2-50. Electrodynamic wattmeters are used to measure which of the following types of power?
1. Ac power
2. Dc power
3. Both 1 and 2 above
4. Shf power in the 2-32 GHz frequency range

2-51. An electrodynamic wattmeter can be

converted into an instrument for measuring reactive power by which of the following methods?
1. Installing a capacitor in series with the input
2. Shunting the meter movement with a 0. 1 ufd capacitor
3. Replacing the resistor which is normally in series with the voltage coil with a large inductance
4. Shunting the input terminals with an LC network adjusted to the resonant frequency of the signal being measured

2-52. What precaution(s), if any, must be taken when checking components with the Huntron Tracker 2000?
1. Voltages must not exceed 5 V dc
2. Voltages must not exceed 5 V ac
3. Device to be tested must have all power turned off and capacitors discharged

4. None of the above
2-53. When you are testing components by comparison, what is the most common mode used on the Huntron Tracker?
1. Automatic
2. Pulse generator
3. Single sweep
4. Alternate

2-54. Why is it necessary to electrically isolate a component while testing individual components with the Huntron Tracker 2000?
1. A resistor in series may give you an inaccurate signature
2. A diode in series may give you an **inaccurate signature**
3. A resistor in parallel may give you an inaccurate signature
4. All of the above

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Quantitative Measurement," pages 3-26 through 3-39. Chapter 4, "Qualitative Measurements," pages 4-1 through 4-14. Chapter 5, "Introduction to Waveform Interpretation," pages 5-1 through 5-35.

3-1. The AN/URM-120 in-line wattmeter is capable of measuring which of the following values?
1. Rf levels up to 500 watts between 30 MHz and 1,000 MHz
2. Rf levels up to 1 kW between 2 MHz and 30 MHz
3. Both 1 and 2 above
4. Af levels up to 500 watts between 1 kHz and 15 kHz

3-2. When rf power is applied to a bolometer, the heat generated by the semiconductor bead results in which of the following characteristic changes?
1. A capacitive change
2. An inductive change
3. A resistive change
4. A frequency change

3-3. The Hewlett-Packard 431 C power meter is capable of measuring power within which of the following frequency ranges in a coaxial system?
1. 1 MHz to 9 MHz
2. 10 MHz to 18 GHz
3. 41 GHz to 100 GHz
4. 101 GHz to 1,000 GHz

3-4. Calorimeters measure power by converting the input electromagnetic energy into which of the following forms?
1. Heat
2. Dc power
3. Pulsed rf energy
4. Electrodynamic energy

3-5. Which of the following relationships exist(s) between the temperature increase of the calorimetric body of a static calorimeter and the applied power?
1. The temperature increase is proportional to the frequency of the applied power
2. The temperature increase is inversely proportional to the amount of applied power
3. The temperature increase is directly proportional to the time of the applied power
4. Both 2 and 3 above

3-6. Which of the following statements describe(s) the method of using a twin calorimeter?
1. Rf power is applied to one calorimetric body and the other body acts as a temperature reference
2. The steady-state temperature difference between the two calorimetric bodies is used as a measure of rf power
3. Both 1 and 2 above
4. Power is applied to both calorimetric bodies through a directional coupler

3-7. Flow calorimeters are classified by the type of measurement performed, the type of heating used, and what other characteristic?
1. Number of calorimetric bodies
2. Type of circulation method used
3. Type of rf loads that they employ
4. Number of calorimetric fluids used

3-8. When performing measurements above 1 GHz in a flow calorimeter, which of the following dielectrics do you normally use?
1. Water
2. Oil
3. MEK
4. H_2SO_4

3-9. Which of the following government

agencies is/are responsible for maintaining our primary?
1. U. S. National Bureau of Standards
2. U. S. Naval Observatory
3. Department of Weights and Measures
4. All of the above

3-10. When using a stroboscope to measure an unknown frequency, which, if any, of the following steps should you take?
1. Start the measurement at the lowest frequency that the stroboscope can deliver and increase the flashing rate until a single image is obtained
2. Start the measurement at the highest frequency that the stroboscope can deliver and reduce the flashing rate until a single stationary image is obtained
3. Start the measurement at the midscale range of the stroboscope and adjust the flashing rate, in either direction, until a harmonic of the primary frequency is obtained
4. None of the above

THIS SPACE LEFT BLANK INTENTIONALLY.

3-11. If you anticipate using a stroboscope over an extended period of time, which of the following actions can you take to extend flasher-tube life?
1. Operate the stroboscope at a submultiple of the fundamental synchronous speed
2. Lower the plate voltage of the flasher tube
3. Lower the filament voltage of the flasher tube
4. Operate the stroboscope at a multiple of the fundamental synchronous speed

3-12. Vibrating reed meters and moving disk meters are primarily used to measure which of the following values?
1. The frequency of 60-Hz ac power
2. The rotational speed of synchronous motors
3. Frequencies between 1 kHz and 10 MHz
4. The frequencies of multiplexed signals

3-13. When using an oscilloscope to measure frequencies, which of the following formulas should you use?
1. f = 1/t
2. f =t
3. f = t/1
4. f = (Nx) * (AB/A-B)

3-14. Most oscilloscopes are limited in their frequency-measuring capability to which of the following upper frequency limits?
1. 50 kHz
2. 100 kHz
3. 500 kHz
4. 100 MHz

3-15. Which of the following indications should you observe when a frequency meter is adjusted to the resonant frequency of the signal under test?
1. An audible beat-frequency signal
2. A pronounced dip in output at resonance
3. A pronounced increase in output power
4. A bright glow of the frequency meter glow lamp

3-16. What is the purpose of the time interval measurement of a frequency counter?
1. It indicates the wave period
2. It indicates the time between two events
3. It indicates the time between two functions of an event
4. Both 2 and 3 above

3-17. What are the three basic categories of wavemeters?
1. Resonant, active, and passive
2. Absorption, active, and passive

Prepared by: Harlem A. Agnote

3. Reaction, resonant, and absorption
4. Absorption, reaction, and transmission

3-18. In becoming a qualified technician, which of the following goals should you seek to achieve?
1. To be able to repair a specific piece of Equipment FIRST GOAL
2. To be able to isolate faults in an entire System ULTIMATE GOAL
3. To demonstrate a basic knowledge of system interconnections
4. To demonstrate minimum maintenance ability on a piece of equipment

3-19. When attempting to correct a technical problem, which of the following procedures should you follow?
1. Use short cuts
2. Do random testing
3. Use a logical approach
4. Do a self-test of the equipment

3-20. Efficient operation of equipment is assured by which of the following actions?
1. Using tricks of the trade
2. Making quick repairs when problems occur
3. Observing system quality figures during preventive maintenance
4. Monitoring all system test points continuously

3-21. The standing-wave ratio (swr) in a transmission line is figured by using which of the following ratios?
1. Maximum voltage to maximum current
2. Maximum voltage to minimum voltage
3. Maximum current to maximum voltage
4. Minimum voltage to minimum current

3-22. Swr measurements are taken for which of the following purposes?
1. To determine the output frequency of the system under test
2. To determine the matching quality of the transmission line termination
3. To determine the coupling quality of the transmission line
4. To determine system output power

3-23. Couplers containing slots are used with rf probes to provide access to which of the following components?
1. Wavemeters
2. Unidirectional couplers
3. Open transmission lines
4. Waveguides

3-24. The wavelength of a standing wave is measured on a short-circuited, terminated line using a magnetic or electric probe in which of the following ways?
1. By multiplying the average current by the peak current
2. By dividing the average voltage by the peak voltage
3. By measuring the distance between a maximum voltage point and a maximum current point
4. By measuring the distance between alternate maximum or minimum current points along the line

3-25. A neon lamp moved parallel to a twowire parallel transmission line will glow at its brightest at which of the following points?
1. Maximum current points
2. Maximum voltage points
3. Maximum voltage and current points
4. Maximum and minimum current points

3-26. A milliammeter moved parallel to a twowire
transmission line will show its highest indication at which of the following points?

Prepared by: Harlem A. Agnote

1. Maximum voltage points
2. Maximum current points
3. Maximum current and voltage points
4. Maximum and minimum voltage points

3-27. Which of the following devices may be used to measure swr without measuring the standing wave?
1. Bridge
2. Rf probe
3. Neon lamps
4. Milliammeter

3-28. When using an RC bridge to measure swr, which of the following factor(s) must you consider as the applied frequency increases?
1. Skin effect
2. Stray inductance
3. Stray capacitance
4. All of the above

3-29. Before a newly constructed bridge can be calibrated, adjustments must be made for which of the following reasons?
1. To determine the frequency range of the bridge
2. To keep stray effects at a minimum
3. To adjust the rf voltage amplitude
4. To determine the characteristic impedance of the circuit

3-30. Which of the following formulas apply(ies) when measuring swr with a bridge?
1. SWR = RL/RO
2. SWR = RO/RL
3. Both 1 and 2 above--use the one that yields an swr ratio greater than 1 to 1
4. SWR = (RO*RL/RO+RL)

3-31. The ideal impedance match between transmitter and load is
1. 1 to 1
2. 2 to 1
3. 3 to 1
4. 4 to 1

3-32. When comparing vswr and iswr, which, if any, of the following is the correct ratio?
1. Vswr will exceed iswr by a minimum of 100%
2. Vswr will exceed iswr by a minimum of 50%
3. Vswr and iswr ratios will be equal
4. None of the above

3-33. Electrical losses caused by transmission line deterioration are best measured using which of the following pieces of equipment?
1. A signal generator and a power meter
2. A signal generator and a frequency counter
3. An swr meter and an oscilloscope
4. A frequency counter and a power meter

3-34. If a 9.5 GHz, 20 watt signal is inserted into a transmission line, approximately what signal should be measured at the other end of the transmission line?
1. 5 GHz, 10 watts
2. 5 GHz, 20 watts
3. 0 GHz, 10 watts
4. 0 GHz, 20 watts

3-35. To accurately determine transmission line losses, you should perform insertion losses at which of the following frequencies?
1. Midrange of the transmission line's frequency spectrum
2. At the upper and lower entrances of the transmission line's frequency spectrum
3. Across the entire frequency spectrum of the transmission line
4. Midrange of the transmission line's frequency spectrum, plus and minus 10 kHz

3-36. Which of the following transmission line specifications is/are considered

important?
1. Frequency
2. Characteristic impedance
3. Power-handling capabilities
4. All of the above

3-37. Mixing two or more frequencies across a nonlinear device produces which of the following signals?
1. Crosstalk
2. Intermodulation distortion
3. Single sideband (ssb) transmission
4. Undesirable carrier frequency deviation

3-38. Which of the following statements describes cross modulation?
1. Degenerative feedback that causes a circuit to oscillate
2. Overmodulation that produces an echo
3. The signal from one channel that modulates the signal on an adjacent channel
4. Oscillation that is caused by system misalignment

3-39. Distortion caused by excessive regenerative feedback is called
1. echo
2. crosstalk
3. detected distortion
4. parasitic generation

3-40. When using a two-tone test to detect intermodulation distortion, what is the ideal indication you should see on a spectrum analyzer?
1. An exact reproduction of the input frequencies
2. The sum and difference of the input frequencies
3. A single frequency with the amplitude equal to the sum of the input frequencies
4. The beat frequency of the two inputs

3-41. Which of the following actions minimizes the effects of intermodulation distortion?
1. Using proper antenna spacing
2. Shielding components and circuitry
3. Using parasitic suppression circuits
4. All of the above

3-42. At what point does an amplitudemodulated signal begin to produce distortion?
1. Below 50% modulation
2. At 65% modulation
3. At 95% modulation
4. Above 100% modulation

3-43. To obtain 100% amplitude modulation of an rf carrier with a sine wave, the modulating power must equal what minimum percent of the rf carrier power?
1. 10%
2. 15%
3. 25%
4. 50%

3-44. The damping of a meter movement that is being used to measure modulation has which of the following disadvantages?
1. The frequency response of the meter is reduced
2. The accuracy of the meter movement is reduced
3. An average reading does not disclose transient overmodulation
4. The amount of current required to drive the meter is reduced

3-45. Which of the following modulation patterns can be observed on an oscilloscope?
1. Wave-envelope and trapezoidal
2. Lissajous and wave-envelope
3. Time division and frequency division
4. Lissajous and trapezoidal

3-46. The frequency response of most oscilloscopes limits the capability of measuring percentage of modulation to

which of the following frequency bands?
1. Lf and hf
2. Slf and shf
3. Uhf
4. Vhf

3-47. When using the two-tone test (trapezoidal method) to check a transmitter, you should see what pattern on the oscilloscope?
1. A series of fully modulated sine waves
2. A 100% amplitude-modulated signal
3. Two pulses of equal amplitude and duration
4. Two opposing triangles that are mirror images of each other

3-48. Frequency deviation of an fm signal is usually expressed in which of the following units of measurements?
1. Kilohertz
2. dB
3. dBm
4. Volts

3-49. What limits an fm transmitter's maximum frequency deviation?
1. The width of the band assigned for station operation
2. The maximum power output rating of the transmitter
3. The distortion that occurs at 100% modulation
4. The transmitting antenna height

3-50. Spectrum analysis is a graphic plot of
1. amplitude versus time
2. time versus frequency
3. amplitude versus frequency
4. amplitude versus power

3-51. Time-domain plots are used by technicians to graphically view which of the following waveform parameters?
1. Amplitude versus time
2. Frequency versus time
3. Frequency versus distance
4. Amplitude versus power

3-52. Frequency-domain plots are used by technicians to graphically view which of the following waveform parameters?
1. Amplitude versus time
2. Amplitude versus frequency
3. Frequency versus distance
4. Amplitude versus power

3-53. Which of the following pieces of test equipment should you use to determine what signals make up a complex signal?
1. Oscilloscope
2. Sweep oscillator
3. Spectrum analyzer
4. Time-domain reflectometer

3-54. At 100% amplitude modulation, the total power in the sidebands equals what percentage of the carrier power?
1. 6%
2. 50%
3. 66%
4. 100%

3-55. When viewing a 100% amplitudemodulated signal with a spectrum analyzer, what type of display should you observe?
1. A center frequency and both the upper and lower sidebands 6 dB down from the center frequency
2. A center frequency and both the upper and lower sidebands of equal amplitude
3. A center frequency that is -6 dB down from both the upper and lower sidebands
4. A suppressed carrier with both the upper and lower sidebands of equal amplitude

3-56. Which of the following is/are an advantage of ssb transmission?
1. The voice quality of ssb transmissions is superior to both AM and fm

Prepared by: Harlem A. Agnote

transmissions
2. Ssb transmissions are not susceptible to interference caused by sun spots and atmospherics
3. Ssb requires one-sixth of the output power and less than half the bandwidth required by AM to transmit the same amount of intelligence power
4. All of the above

3-57. In fm, the AMOUNT of frequency deviation (shift) is proportional to
1. the frequency of the carrier
2. the amplitude of the modulating signal
3. the frequency of the modulating signal
4. the plate current of the transmitter's linear amplifier

3-58. In fm, the RATE of frequency deviation (shift) is proportional to
1. the impedance of the antenna
2. the power output of the transmitter
3. the amplitude of the modulating signal
4. the frequency of the modulating signal

3-59. When analyzing the composition of a rectangular wave with a spectrum analyzer, which of the following types of displays will you see?
1. A fundamental frequency and its odd harmonics only
2. A fundamental frequency and its even harmonics only
3. A fundamental frequency and its combined even and odd harmonics
4. An infinite number of fundamental frequencies

3-60. The ability of a spectrum analyzer to resolve signals refers to its ability to
1. distinguish one signal from other signals
2. shape signals through the use of filters
3. determine a receiver's minimum discernible signal
4. measure the frequency of a signal

3-61. The ability of a spectrum analyzer to resolve signals is limited by which of the following factors?
1. The amplitude of the signal under test
2. The narrowest bandwith of the spectrum analyzer
3. The upper frequency limits of the spectrum analyzer
4. The lower frequency limits of the spectrum analyzer

3-62. Which of the following characteristics of a transmission line fault can be observed using time-domain reflectometry?
1. Nature of the fault
2. Distance to the fault
3. Both 1 and 2 above
4. Figure of merit of the fault

3-63. What is the primary application of sweptfrequency
testing?
1. To determine the broadband frequency response of a device
2. To determine the characteristics of a device at a specific frequency
3. To determine the impedance of a transmission line
4. To determine the swr of a transmission line

3-64. You should perform an initial power check on a transmitting antenna before sweeping the antenna for which of the following reasons?
1. To prevent damage to the test equipment
2. To ensure the transmitter is deenergized
3. To ensure the transmitter is energized
4. To ensure the transmitter is keyed

MODULE 22

INTRODUCTION TO DIGITAL COMPUTERS

PREPARED BY:

Ray Aldrin Sierra

Prepared by: Harlem A. Agnote

ASSIGNMENT 1

1-1. When was the first mechanical adding machine invented?
1. 1264
2. 1426
3. 1462
4. 1642

1-2. What year did electronics enter the computer scene?
1. 1918
2. 1919
3. 1920
4. 1921

1-3. In modern digital computers, circuits that store information, perform arithmetic operations, and control the timing sequences are known as what?
1. Flip-flops
2. Amplifiers
3. Oscillators
4. Multipliers

1-4. When was the UNIVAC I developed?
1. 1944
2. 1946
3. 1950
4. 1951

1-5. The field of research that is developing computer systems which mimic human thought in a specific area and improve performance with experience and operation is what field of research?
1. Human intelligence
2. Artificial intelligence
3. Animal intelligence
4. Computer intelligence

1-6. Mechanical computers are what type of devices?
1. Digital
2. Electrical
3. Analog
4. Electromechanical

1-7. What determines the size of an analog computer?
1. Where it will be installed

2. Number of operators using it
3. Cost
4. Number of functions it has to perform

1-8. What is the primary use of analog computers in the Navy?
1. Gun fire control
2. Data processing
3. Ships steering
4. Missile fire control

1-9. Compared to mechanical computers, electromechanical computers are different in which of the following ways?
1. They cost more
2. They are bigger
3. They are less accurate
4. They use electrical components to perform some of the calculations and to increase the accuracy

1-10. In early electronic computers, what was the weak link in electrical computations?
1. Transistors
2. Resistors
3. Vacuum tubes
4. Capacitors

1-11. A computer that is designed to perform a specific operation is what kind of computer?
1. All-purpose
2. General-purpose
3. Special-purpose
4. Single-purpose

1-12. How are the instructions that control a computer applied to a special-purpose computer?
1. From a stored program
2. From a keyboard

Prepared by: Harlem A. Agnote

3. From an input device
4. From built-in instructions

1-13. What is a drawback to the specialization of a special-purpose computer?
1. Low speed
2. Lack of versatility
3. Large size
4. High cost

1-14. What gives a general-purpose computer the ability to perform a wide variety of operations?
1. It can store and execute different programs in its internal storage
2. It is a much larger computer
3. It has a huge built-in program
4. It can operate faster than other computers

1-15. All analog computers are what type?
1. Mechanical
2. Electromechanical
3. Special-purpose
4. General-purpose

1-16. What are computers called that combine the functions of both analog and digital?
1. Analog-digital computers
2. Mixed computers
3. Duplexed computers
4. Hybrid computers

1-17. A digital computer knows how to do its work by what means?
1. By a list of instructions called a program
2. By a list of instructions called a job sequence
3. By its hardware
4. By its peripheral equipment

1-18. What is the most popular generic term for computer programs?
1. Hardware
2. Software
3. Wordprocessing
4. Graphics

1-19. First generation computers were characterized by what technology?
1. Transistors
2. Resistors
3. Vacuum tubes
4. Printed circuits

1-20. What type of computer language was used with first generation computers?
1. Machine
2. COBOL
3. BASIC
4. Fortran

1-21. Computers of the second generation were characterized by what technology?
1. Vacuum tubes
2. Capacitors
3. Transistors
4. Resistors

1-22. The small, long lasting transistors used in second generation computers had which of the following effects?
1. They increased processing speeds and reliability
2. They decreased processing speeds and increased reliability
3. They increased processing speeds and decreased reliability
4. They decreased processing speeds and reliability

1-23. Internal processing speeds of second generation computers were measured at what speed?
1. Hundredths of a second
2. Thousandths of a second
3. Millionths of a second
4. Billionths of a second

1-24. Third generation computers are characterized by what technology?
1. Capacitors
2. Transistors
3. Resistors
4. Miniaturized circuits

1-25. A circuit and its components can be

etched onto which of the following materials?
1. Plastic
2. Silicon
3. Gold
4. Pressed fiber

1-26. The internal processing speeds of third generation computers are measured at what speed?
1. Hundredths of a second
2. Thousandths of a second
3. Millionths of a second
4. Billionths of a second

1-27. Fourth generation technology has which of the following results for the computer industry?
1. Computers that are significantly smaller and lower in cost
2. Computers that are significantly larger and lower in cost
3. Computers that are significantly smaller and higher in cost
4. Computers that are significantly larger and higher in cost

1-28. What does the acronym ROM stand for?
1. Run-on manual
2. Read-only minutes
3. Read-only memory
4. Read-only manual

1-29. Which of the following will be one of the future challenges involving computer power?
1. How to properly and effectively use the computing power available
2. How to increase computer storage capacity
3. How to increase computer power
4. How to properly install the computers available

1-30. What term is used for programs such as assemblers, compilers, operating systems, and applications programs?
1. Hardware
2. Peripheral devices
3. Software
4. Sub-systems

1-31. Which of the following is one of the more widespread uses of the computer in the Navy?
1. Research
2. Word processing
3. Manufacturing
4. Games

1-32. Computers have an advantage over typewriters in what area?
1. Cost
2. Speed
3. Reliability
4. Correcting errors

1-33. What does the acronym S-N-A-P stand for?
1. Shipboard navigational aid package
2. Shipboard Navy applied program
3. Shipboard non-tactical ADP program
4. Shipboard nuclear active program

1-34. Which computer is used with the SNAP II system?
1. UYK-4
2. UYK-7
3. UYK-20
4. AN/UYK-62 (V)

1-35. Where are the user terminals for SNAP II placed on board ship?
1. Engineering spaces
2. Work centers
3. Supply spaces
4. Electronics spaces

1-36. The work center supervisor can update which of the following items from a user terminal?
1. COSAL, APL, EIC, and CSMP only
2. APL, EIC, SHIP'S FORCE WORK LIST, and CSMP only
3. COSAL, APL, SHIP'S FORCE WORK LIST, and CSMP only

Prepared by: Harlem A. Agnote

4. COSAL, APL, EIC, SHIP'S FORCE WORK LIST, and CSMP

1-37. What type of classified use does SNAP II allow?
1. Unclassified
2. Confidential
3. Secret
4. Top Secret

1-38. What is a central set of programs called that manages execution of other programs and performs common functions like read, write, and print?
1. Managing system
2. Execution system
3. Operating system
4. Word processing system

1-39. What is the function of a built-in program called a bootstrap loader?
1. To load a word processor into the computer's internal memory
2. To load an external operating system into the computer's internal memory
3. To load a graphics program into the computer's internal memory
4. To load a bootstrap program into the computer's internal memory

1-40. When an error message such as device error is shown on the display screen, which of the following problems could be the cause?
1. No floppy disk in drive A
2. Floppy disk inserted incorrectly in drive
3. Lock handle on drive A not lowered
4. Each of the above

1-41. A display similar to this A> means what in computer terminology?
1. A device error
2. No system
3. A prompt
4. Run again

1-42. What does it mean when the computer displays a prompt on the screen?
1. The computer has made an error
2. There is no system in the computer
3. You need to stop putting information into the computer
4. You can tell the computer what to do next

1-43. To tell the operating system what program to run, you should take which of the following actions following the operating system prompt A>?
1. Type help
2. Reboot the computer
3. Press the execute key
4. Type the program name

1-44. Online HELP screens serve what purpose?
1. Display the contents of memory
2. Display the operating system directory
3. Tell the operator how to perform a given function
4. Stop computer processing so the operator can read the instruction manual

1-45. Floppy disks provide which of the following functions?
1. Store data
2. Perform arithmetic operations
3. Provide alternate power to the computer
4. Check the accuracy of computer operations

1-46. Touching the exposed area seen through the timing hole and the read/write slots on a floppy disk can do what, if anything, to the data in that area?
1. Ruin it
2. Add to it
3. Move it
4. Nothing

1-47. What maximum number of disks should be stacked horizontally?

1. 5
2. 10
3. 15
4. 20

1-48. What is perhaps the most common source of a magnetic field that can affect a floppy disk?
1. Crt's
2. Printer
3. Telephone
4. Disk drives

1-49. In which of the following ways does smoke affect a computer?
1. It damages the electronics
2. It causes the monitor to fail
3. It coats the keyboard
4. It causes buildup on disks and disk drives

1-50. What, if anything, can happen to a floppy disk when it is exposed to direct sunlight or excessive heat?
1. It can become warped or distorted so it cannot be used
2. It can become sticky, which stops the drive
3. It can lose part of the data recorded on it
4. Nothing, it is not affected

1-51. Typically, floppy disks will operate only in what temperature range?
1. 40 to 120 degrees Fahrenheit
2. 50 to 120 degrees Fahrenheit
3. 60 to 120 degrees Fahrenheit
4. 70 to 120 degrees Fahrenheit

1-52. A floppy disk will accept what relative humidity range?
1. 5% to 60%
2. 10% to 70%
3. 10% to 80%
4. 10% to 90%

1-53. When a pencil or ballpoint pen is used to write on the label after it is attached to the disk, what, if anything, can happen to a disk?
1. Some of the data written on the label can be added to the disk
2. All of the data can be lost, but the disk can be used again
3. The disk can be destroyed
4. Nothing; there can be no effect

1-54. In the computer world, what method provides a means to ensure that any data lost can be recovered?
1. Records
2. Backup files
3. Tracks
4. Blocks

1-55. What two media are commonly used for backup?
1. Paper tape and punched cards
2. Magnetic tape and punched cards
3. Disk and magnetic tape
4. Disk and drum

1-56. What is the most common method of creating a backup for a microcomputer?
1. Copying the disk onto a magnetic tape
2. Copying the disk onto a paper tape
3. Copying the disk onto a punched card
4. Copying the disk onto another disk

ASSIGNMENT 2

Textbook assignment: Chapter 2, "Hardware," pages 2-1 through 2-35.

2-1. The components or tools of a computer system can be grouped into what two categories?
1. Hardware and software
2. Hardware and firmware
3. Firmware and software
4. Software and programs

2-2. What section/unit is the brain of a computer system?
1. Control section
2. Arithmetic-logic section
3. Central processing unit
4. Input unit

2-3. What section/unit is the computing center of a computer system?
1. Arithmetic-logic section
2. Central processing unit
3. Control section
4. Output unit

2-4. The central processing unit is made up of which of the following sections?
1. Control and internal storage only
2. Central and arithmetic-logic only
3. Arithmetic-logic and internal storage only
4. Control, internal storage, and arithmetic-logic

2-5. When a program is so large and complex that it exceeds the memory capacity of a stored-program computer, where is the overflow stored?
1. Input storage area
2. Output storage area
3. Primary memory
4. Auxiliary memory

2-6. What part of the computer dictates how and when each specific operation is to be performed?
1. Control section
2. Arithmetic-logic section
3. Input storage area
4. Output storage area

2-7. Of the four major types of instructions, which one has the basic function of moving data from one location to another?
1. Control
2. Logic
3. Arithmetic
4. Transfer

2-8. To send commands to devices not under direct command of the control section, what type of instructions are used?
1. Control
2. Logic
3. Arithmetic
4. Transfer

2-9. Operations like adding and multiplying are performed by what section?
1. Control-logic
2. Storage-logic
3. Arithmetic-logic
4. Transfer-logic

2-10. When processing is taking place, data is transferred back and forth between what two sections?
1. Control and internal storage
2. Internal storage and arithmetic-logic
3. Control and arithmetic
4. Arithmetic and output

2-11. The process by which instructions and data are read into a computer is called what?
1. Moving
2. Storing
3. Inputting
4. Loading

2-12. An auxiliary (wired) memory is used in some computers to permanently store a

small program that makes manual loading unnecessary. What is this program called?
1. Operating system
2. Bootstrap
3. Word processing
4. Graphics

2-13. The tiny doughnut-shaped rings used to make up magnetic core storage are made of what material?
1. Aluminum
2. Steel
3. Tin
4. Ferrite

2-14. Data is stored in computers in what form?
1. Binary
2. Decimal
3. Octal
4. Hexadecimal

2-15. The state of each core in magnetic core storage is changed by what?
1. The amount of magnetism
2. The amount of current
3. The direction of magnetism
4. The direction of current

2-16. Electronic circuits are placed on a silicon chip by what method?
1. Wired
2. Drawn
3. Etched
4. Printed

2-17. Each of the individual electronic circuits on a silicon chip is called what?
1. A memory cell
2. A bit cell
3. A byte cell
4. A holding cell

2-18. Semiconductor storage has which of the following drawbacks?
1. It is too slow
2. It is expensive
3. It is volatile
4. It is unreliable

2-19. Using a very thin crystal made of semiconductor material, what type of memory can be created?
1. Bubble
2. Magnetic core
3. Semiconductor
4. Capacitive

2-20. In bubble memory, where is the control circuit imprinted on the crystal of semiconductor material?
1. The side
2. The bottom
3. The middle
4. The top

2-21. Who installs the programs in read-only memory?
1. The programmer
2. The manufacturer
3. The operator
4. The dealer

2-22. Programs that are tailored to certain needs and permanently installed in ROM by the manufacturer are called what?
1. Firmware
2. Software
3. Hardware
4. Diskware

2-23. What kind of memory used inside computers has a read/write capability without any additional special equipment?
1. ROM
2. RAM
3. EPROM
4. PROM

2-24. A special device is needed to burn the program into what type of memory?
1. ROM
2. PROM
3. ERAM

4. RAM

2-25. EPROM can be erased by what method?
1. With a current charge
2. With a voltage change
3. With a burst of ultra-violet light
4. With a special program

2-26. To coat magnetic disks, what magnetizable recording material is used?
1. Plastic
2. Mylar®
3. Aluminum oxide
4. Iron oxide

2-27. What is the size range of the diameters of magnetic disks?
1. 3 inches to 4 feet
2. 4 inches to 3 feet
3. 5 inches to 6 feet
4. 6 inches to 5 feet

2-28. Data is stored on all disks in a number of invisible concentric circles called what?
1. Cracks
2. Grooves
3. Paths
4. Tracks

2-29. A floppy disk surface has what maximum number of tracks?
1. 66
2. 77
3. 88
4. 99

2-30. When data is written on a disk in the same area where data is already stored, the old data is affected in which of the following ways, if at all?
1. It is moved to a new area
2. It is mixed with the new data
3. It is replaced
4. It is not affected

2-31. How are records on a track separated?
1. By a gap in which no data is recorded
2. By a gap in which the name of the record is recorded
3. By a gap in which the record is numbered
4. By a gap in which the operator's name is placed

2-32. To increase the amount of data we can store on one track, what technique can be used?
1. Records
2. Files
3. Disk address
4. Blocking

2-33. Designers were able to increase the data density of a disk by increasing the number of tracks. What code name was given to this technology?
1. Computer
2. Winchester
3. Solid state
4. Colt

2-34. During reading and writing, which of the following changes are achieved by reducing the distance of the read/write heads over the disk surface?
1. Data density can be improved and storage capacity decreased
2. Data density is lessened and storage capacity increased
3. Data density can be improved and storage capacity increased
4. Data density is lessened and storage capacity decreased

2-35. To physically organize data on diskettes, what method is used?
1. Records
2. Cylinder
3. Files
4. Sector

2-36. The lengths of magnetic tapes used with computers have what range?
1. From 400 to 1,000 feet
2. From 500 to 2,000 feet

Prepared by: Harlem A. Agnote

3. From 600 to 3,000 feet
4. From 700 to 4,000 feet

2-37. Magnetic tapes can be packaged in which of the following ways?
1. Open reel only
2. Cartridge and cassette only
3. Open reel and cartridge only
4. Open reel, cartridge, and cassette

2-38. By which of the following methods are magnetic tape units categorized?
1. Type of packaging used for tape
2. Size of tape
3. Speed of tape
4. Cost of tape

2-39. What determines if a standard 1/2-inch tape will have either seven or nine tracks of data?
1. The brand of tape
2. The read/write heads installed in the tape unit
3. The type of computer used
4. The speed at which the tape unit is run

2-40. Formultitrack tapes, what is the range of common recording densities in bits/bytes per inch (bpi)?
1. From 200 to 6,250 bpi
2. From 300 to 6,275 bpi
3. From 400 to 6,300 bpi
4. From 500 to 6,350 bpi

2-41. On magnetic tape, the size of a record that holds the data is restricted in what two ways?
1. By the thickness of the tape and the capacity of internal storage
2. By the length of the tape and the speed of internal storage
3. By the width of the tape and the speed of internal storage
4. By the length of the tape and the capacity of internal storage

2-42. In computer terminology, what is called a file?
1. A collection of tapes
2. A collection of disks
3. A collection of records
4. A collection of characters

2-43. In order for data to be read from or written on a magnetic tape, the tape must do what?
1. Speed up
2. Move at a predetermined speed
3. Slow down
4. Stop

2-44. Storing single records on a magnetic tape has which of the following disadvantages?
1. It takes too long to record the data
2. It takes too long to recover the data
3. Too much of the recording surface is wasted
4. Too much of the recording surface is used

2-45. The magnetic drum is another example of what type of access storage device?
1. Random
2. Direct
3. Multiple
4. Single

2-46. What is the speed range of a magnetic drum?
1. 300 to 3,000 rpm
2. 400 to 4,000 rpm
3. 500 to 5,000 rpm
4. 600 to 6,000 rpm

2-47. When using a magnetic drum, what is rotational delay?
1. Time that occurs in coming up to speed
2. Time that occurs in slowing down
3. Time that occurs in reaching a desired record location
4. Time that occurs in changing a drum

2-48. What is the storage capacity range of

magnetic drums in characters or bytes of data?
1. From 20 million to more than 150,000 million
2. From 30 million to more than 150,000 million
3. From 40 million to more than 200,000 million
4. From 50 million to more than 200,000 million

2-49. Input data may be in any one of how many forms?
1. Five
2. Two
3. Three
4. Four

2-50. When data is input from a keyboard, a high average speed is how many characters per second?
1. One to two
2. Two to three
3. Three to four
4. Four to five

2-51. Output information is made available in how many forms?
1. One
2. Two
3. Three
4. Four

2-52. Magnetic tape stores data in what manner?
1. Sequential
2. Non-sequential
3. Direct
4. Random

2-53. The magnetic tape unit reads and writes data in channels or tracks along the length of the tape. How are these tracks referenced to each other?
1. Perpendicular
2. Parallel
3. Vertical
4. Random

2-54. How does a two gap head allow for increased speed?
1. By checking before writing
2. By using two gaps to write
3. By checking while writing
4. By using two gaps to check

2-55. What are the most common tape densities in bits/bytes per inch?
1. 500 and 1,000 bpi
2. 600 and 1,200 bpi
3. 700 and 1,500 bpi
4. 800 and 1,600 bpi

2-56. The drive motor of a disk drive unit rotates the disk at a constant speed, normally how many revolutions per minute?
1. 2,000 rpm
2. 2,500 rpm
3. 3,000 rpm
4. 3,600 rpm

2-57. The usual range of rotational speed for floppy disks is what?
1. 100 to 200 rpm
2. 200 to 300 rpm
3. 300 to 400 rpm
4. 400 to 500 rpm

2-58. The distance between the read/write head and the surface of a hard disk is called what?
1. The flying height
2. The disk height
3. The head height
4. The recording height

2-59. Floppy disks come in several sizes with diameters of what size range?
1. 2 to 6 inches
2. 3 to 8 inches
3. 4 to 9 inches
4. 5 to 10 inches

2-60. In the character-at-a-time impact printer

class, which printer has the most professional-looking, pleasing-to-the-eye print?
1. Dot-matrix
2. Ink jet
3. Daisy-wheel
4. Laser

2-61. What is another name for the dot-matrix printer?
1. Hammer-matrix
2. Pin-matrix
3. Ink-matrix
4. Wire-matrix

2-62. Dot-matrix printers have which of the following ranges of speeds in characters per second?
1. 50 to 200 cps
2. 60 to 350 cps
3. 70 to 400 cps
4. 80 to 450 cps

2-63. Ink jet printers have what maximum speed in characters per seconds?
1. 300 cps
2. 400 cps
3. 500 cps
4. 600 cps

2-64. Laser printers can print up to approximately what total number of characters per second?
1. 20,666 cps
2. 22,666 cps
3. 24,666 cps
4. 26,666 cps

2-65. What are the two styles of typewriter keyboard arrangements used with a computer?
1. QWERYT or DVORAK
2. QWERTY or DVORAK
3. ABCDEF or DVORAK
4. ABCDEF or DVOARK

2-66. When working with display devices, what does the term soft-copy mean?
1. The information displayed is not permanent
2. The information displayed is permanent
3. The information displayed has a soft glow
4. The information displayed has no glow

2-67. On a raster scan crt, a raster is a series of what type of lines across the face of a crt?
1. Diagonal
2. Vertical
3. Horizontal
4. Wavy

2-68. Each field of a raster scan crt is made up of approximately how many lines?
1. 525
2. 550
3. 575
4. 600

2-69. In a video monitor, what do the frequency bandwidth, the number of characters to be displayed on a line, and the physical size of the screen determine?
1. Actual level of brightness
2. Actual number of picture elements
3. Actual speed of scan rate
4. Actual number of vertical lines that can be displayed

2-70. A monitor that uses 1,000 picture elements per line with a horizontal resolution of 1,000 can display what total number of vertical lines?
1. 10
2. 100
3. 1,000
4. 10,000

2-71. A raster frame is displayed approximately how many times a second?
1. 5
2. 10
3. 20

Prepared by: Harlem A. Agnote

4. 30

2-72. To reduce the depth of the crt caused by the length of the tube, what type of displays were designed?
1. Wide panel
2. Flat panel
3. Narrow panel
4. Short panel

2-73. Compared to the gas plasma and electroluminescent displays, a liquid crystal display differs in which of the following ways?
1. It does not use as many picture elements
2. It does not use a light for the picture elements
3. It does not generate its own light for the picture elements
4. It does not have a backlight

2-74. The operation of an electroluminescent display requires what total number of volts?
1. 5
2. 10
3. 15
4. 20

ASSIGNMENT 3

Textbook assignment: Chapter 3, "Software," pages 3-1 through 3-29.

3-1. What must you load into a computer to manage its resources and operations?
1. Bootstrap program
2. Word processor
3. Graphics program
4. Operating system

3-2. What program controls the execution of other programs according to job information?
1. An operating system
2. A bootstrap program
3. A word processor
4. A utility program

3-3. The simplest and most commonly used operating systems on microcomputers are which of the following types?
1. Multiuser/single tasking
2. Single user/single tasking
3. Single user/multitasking
4. Multiuser/multitasking

3-4. Which of the following programs must be compatible with the operating system in use?
1. CP/M-86
2. UNIX
3. Applications
4. MS-DOS

THIS SPACE LEFT BLANK INTENTIONALLY.

3-5. To overcome the applications software compatibility problem, which of the following is done so the application can be run under several different operating systems?
1. Some software comes in several versions
2. Computers are designed to accept all applications software
3. Software comes in a universal version
4. Operating systems are changed to be compatible

3-6. What is another term for "initial program load" the system?
1. Start
2. Boot
3. Kick
4. Run

3-7. When the symbol A> is on the screen of a computer crt, it tells the operator/user which of the following information?
1. The system is not ready, and drive A is busy
2. The system is ready, and drive A is assigned as your secondary drive
3. The system is ready, and drive A is assigned as your primary drive
4. The system is activating, and no drive is available

3-8. The three characters following each directory entry are called what?
1. Files
2. Records
3. Locators
4. Extensions

3-9. Commands built into the operating system that control actions, like diskcopy and rename, are what type of commands?
1. Independent
2. Copy
3. Spread
4. Utility

3-10. To eliminate the need for programmers to write new programs when all they want to do is copy, print, or sort a data file, which of the following types of programs can be used?
1. Word processor
2. Graphics
3. Utility
4. Spreadsheet

Prepared by: Harlem A. Agnote

3-11. What is the term given to arranging records in a predefined sequence or order?
1. Sorting
2. Merging
3. Writing
4. Shifting

3-12. On a computer, what is the sequence of characters called?
1. Numerical sequence
2. Collating sequence
3. Random sequence
4. Alphabetic sequence

3-13. To sort a data file, what must you tell the sort program?
1. How many characters are in the file
2. How many records are in the file
3. The length of the data file
4. The data field or fields to sort on

3-14. Sort-merge programs usually have which of the following characteristics?
1. Specific file length
2. Specific run time
3. Phases
4. Names

3-15. What personnel or methods are used to generate programs to print detail and summary reports of data files?
1. Programmers
2. Operating systems
3. Sort-merge programs
4. Report program generators

3-16. What are report program generators designed to save?
1. Run time
2. Programming time
3. Operator time
4. Printer time

3-17. Each time there is a control break, what does the program developed by the report program generator print?
1. Input information
2. Output information
3. Summary information
4. Programming information

3-18. A computer language that is a string of numbers which represents the instruction code and operand addresses is what type?
1. Machine
2. Printed
3. Symbolic
4. Procedure-oriented

3-19. Mnemonic instruction codes and symbolic addresses were developed early in what decade?
1. 1940s
2. 1950s
3. 1960s
4. 1970s

3-20. Compared to machine language coding, symbolic languages have which of the following advantages?
1. Detail is reduced
2. Fewer errors are made
3. Less time is required to write a program
4. All of the above

3-21. An instruction that allows the programmer to write a single instruction which is equivalent to a specified sequence of machine instructions is what type of instruction?
1. Machine language instruction
2. Graphic language instruction
3. Macroinstruction
4. Scientific instruction

3-22. What does the acronym COBOL stand for?
1. Computer ordered byte oriented language
2. Computer ordered business oriented language
3. Common business oriented language
4. Common business ordered language

Prepared by: Harlem A. Agnote

3-23. PASCAL is being used by many colleges and universities to teach programming for which of the following reasons?
1. It is fairly easy to learn and more powerful than BASIC
2. It is hard to learn and weaker than BASIC
3. It is easy to learn and cheaper than BASIC
4. It is a shorter course and produces better programmers

3-24. The development of Ada was initiated by what organization?
1. U. S. Navy
2. U. S. Army
3. U. S. Department of Defense
4. U. S. Department of Transportation

3-25. What are the two most familiar of the procedure-oriented languages used for scientific or mathematical problems?
1. PASCAL and FORTRAN
2. PASCAL and COBOL
3. COBOL and FORTRAN
4. BASIC and FORTRAN

3-26. Compared with programs written in symbolic languages, programs written in procedure-oriented languages differ in which of the following ways?
1. They can only be used with small computers
2. They can only be used with large computers
3. They can only be used with the computer for which the program was written
4**. They can be used with a number of different computer makes and models**

3-27. Compared with symbolic languages, procedure-oriented languages have which of the following disadvantages?
1. They require more space in memory, and they process data at a slower rate
2. They require more space in memory, and they process data too fast for some printers
3. They require a special memory, and they process data at a slower rate
4. They require a special memory, and they process data too fast for some printers

3-28. Which of the following is a simple definition of programming?
1. The process of planning which computer system to use
2. The process of planning the computer solution to a problem
3. The process of planning the mathematical solution to a problem
4. The process of planning which computer program to use

3-29. Which of the following is NOT a basic characteristic of a computer?
1. It needs commands
2. It needs specifically defined operations
3. It can think
4. It can understand instructions only in an acceptable form

3-30. How many fundamental and discrete steps are involved in solving a problem on a computer?
1. Five
2. Two
3. Three
4. Four

3-31. In the advance planning phase of programming, what are the first two steps?
1. Program coding and machine readable coding preparation
2. Problem understanding/ definition and flowcharting
3. Test data preparation and test run performance
4. Documentation completion and operator procedures preparation

Prepared by: Harlem A. Agnote

3-32. Which of the following is NOT part of defining every aspect of a problem?
1. What information (or data) is needed
2. Where and how will the information be obtained
3. What is the desired output
4. What is the computation time

3-33. Once you have a thorough understanding of the problem, what is the next step in programming?
1. Gathering information
2. Coding the program
3. Flowcharting
4. Debugging

3-34. The method of pictorially representing a step-by-step solution to a problem before computer instructions are written to produce the desired results is called what?
1. Flowcharting
2. Constructing
3. Documenting
4. Debugging

3-35. What two types of flowcharts are there?
1. System and programming
2. System and data
3. Processing and programming
4. Processing and data

3-36. What are the four basic tools used in flowcharting?
1. Advanced symbols, graphic symbols, flowcharting template, and flowcharting worksheet
2. Fundamental symbols, graphic symbols, flowcharting template, and flowcharting worksheet
3. Fundamental symbols, mathematical symbols, flowcharting symbols, and flowcharting worksheet
4. Fundamental symbols, advanced symbols, flowcharting template, and flowcharting worksheet

QUESTION 3-37 IS TO BE JUDGED TRUE OR FALSE.

3-37. Fundamental symbols are standard for the military, as directed by Department of the Navy Automated Data Systems Documentation Standards, SECNAVINST 5233.1.
1. True
2. False

3-38. Within a flowchart, what type of symbols are used to specify arithmetic operations and relational conditions?
1. Fundamental symbols
2. Graphic symbols
3. Arithmetic symbols
4. Arabic symbols

3-39. What is the graphic symbol for less than or equal to?
1. >
2. <
3. □
4. □

QUESTION 3-40 IS TO BE JUDGED TRUE OR FALSE.

3-40. The flowchart worksheet is a means of standardizing documentation.
1. True
2. False

3-41. To develop a flowchart, which of the following must you know first?
1. What type of computer is to be used
2. What problem you are to solve
3. What code you are going to use
4. What logic the computer will use to solve a problem

3-42. In solving a problem, which of the following ways does a computer operate?
1. Two steps at a time in random order
2. It processes the problem as a whole
3. One step after another in specified order
4. One step after another in random

Prepared by: Harlem A. Agnote

order

3-43. What is the step called in which you code a program that can be translated by a computer into a set of instructions it can execute?
1. Program booting
2. Program execution
3. Program logic
4. Program coding

QUESTION 3-44 IS TO BE JUDGED TRUE OR FALSE.

3-44. It is important to remember program coding is the first step of programming.
1. True
2. False

3-45. Before sitting down to code the computer instructions to solve a problem, you should complete which of the following activities?
1. A course in computer operation
2. A course in mathematics
3. Planning and coding
4. Planning and preparation

3-46. What is the fundamental element in program preparation?
1. Subject
2. Predicate
3. Computer
4. Instruction

3-47. The first part of a computer instruction, which answers the question what, is known by which of the following terms?
1. Operation only
2. Command only
3. Command or operation
4. Operand

3-48. The second specific part of the predicate in a computer instruction, known as the operand, in general answers what question?
1. Who
2. What
3. When
4. Where

3-49. What part of the program must the programmer prepare according to the format required by the language and the computer to be used?
1. Documentation
2. Implementation
3. Instructions
4. Length

3-50. To copy data from one storage location to another and to rearrange and change data elements in some prescribed manner, what type of instructions are used?
1. Input/output
2. Data movement
3. Transfer of control
4. Conditional logic

3-51. Transfer of control instructions are classified as which of the following types?
1. Conditional only
2. Unconditional only
3. Conditional and unconditional
4. Conditional and distributed

3-52. Errors caused by faulty logic and coding mistakes are referred to as what?
1. Mistakes
2. Errors
3. Faults
4. Bugs

3-53. The process of carefully checking the coding sheets before they are keyed into the computer is known as what?
1. Desk-checking
2. Code-checking
3. Program-checking
4. Computer-checking

3-54. A definition of the problem, a description of the system, a description of the

program, and operator instructions make up what package?
1. Training
2. Security
3. Orientation
4. Documentation

3-55. Which of the following is another name for packaged software?
1. Rented programs
2. Manufactured programs
3. Off-the-shelf programs
4. On-the-shelf programs

3-56. Under the word processing software control, you generally enter the text using what method?
1. Tape
2. Disk
3. Drum
4. Keyboard

QUESTION 3-57 IS TO BE JUDGED TRUE OR FALSE.

3-57. Spelling checker software helps find misspelled words not misused words.
1. True
2. False

3-58. What type of software allows you to enter data and then retrieve it in a variety of ways?
1. Communications
2. Data retrieval
3. Data management
4. Document compilation

QUESTIONS 3-59 AND 3-60 ARE TO BE JUDGED TRUE OR FALSE.

3-59. Spreadsheets are tables of rows and columns of text.
1. True
2. False

3-60. You can use all printers for graphics output.
1. True
2. False

Prepared by: Harlem A. Agnote

Assignment 4

Assignment: Topic 4, "Data Representation and Communications"
Pages: 4-1 through 4-17

4-1. In using a digital computer, which of the following is one of the major problems we face?
1. F i n d i n g d i s k s t o f i t t h e drives
2. Locating a stable power source
3. Communicating with the computer
4. Arranging the proper environment

4-2. In computer terminology, what is a general term to describe raw facts?
1. Characters
2. Bits
3. Bytes
4. Data

4-3. In computer terminology, when data has been processed with other facts and has meaning, it is described as which of the following?
1. Information only the computer can understand and properly use
2. Information we can understand and properly use
3. Information the input device can understand and properly use
4. Information the output device can understand and properly use

4-4. Data is represented by which of the following means?
1. By symbols
2. B y e l e c t r i c i t y
3. By magnetics
4. By mechanics

QUESTION 4-5 IS TO BE JUDGED TRUE OR FALSE.
4-5. The first computers were designed to manipulate numbers to solve arithmetic problems.
1. True
2. False

4-6. What is data to be represented called?
1. Numeric data
2. Alphanumeric data
3. Information data
4. Source data

4-7. Raw data is typically written on some type of paper document referred to as what type of document?
1. End document
2. Source document
3. Classified document
4. Unclassified document

4-8. Numeric, alphabetic, and special characters are represented in a computer's internal storage and on magnetic media through the use of what kind of system?
1. Coding
2. Reading
3. Writing
4. Labeling

4-9. I t i s p o s s i b l e t o r e p r e s e n t a maximum of 256 different characters or bit combinations by using which of the following codes?
1. 8 - b i t
2. 16-bit
3. 32-bit
4. 64-bit

Prepared by: Harlem A. Agnote

4-10. In addition to four numeric bits, there are four other bit positions used in an a-bit code, what are they called?
1. Area bits
2. Zone bits
3. Region bits
4. District bits

4-11. Which of the following numbering systems has a base of 16?
1. Octal
2. Binary
3. Decimal
4. Hexadecimal

4-12. Representing two numeric characters in one byte (eight bits) is referred to as what?
1. Packing
2. Stacking
3. Doubling
4. Crowding

4-13. By packing data within an 8-bit code, which of the following results are achieved?
1. Storage space required increases and processing speed increases
2. Storage space required increases and processing speed decreases
3. Storage space required decreases and processing speed increases
4. Storage space required decreases and processing speed decreases

4-14. Through the cooperation of several manufacturers, what a-bit code was developed for transmitting and processing data?
1. EBCDIC
2. EBCDTC
3. ASCIT
4. ASCII

QUESTION 4-15 IS TO BE JUDGED TRUE OR FALSE.

4-15. The concepts and advantages of ASCII are identical to those of EBCDIC.
1.TRUE
2.FALSE

4-16. The letter D is represented by what coding in (a) EBCDIC and (b) ASCII?

1.	(a)	1111 0011
	(b)	0011 0011
2.	(a)	0011 0011
	(b)	1111 0011
3.	(a)	0100 0100
	(b)	1100 0100
4.	(a)	1100 0100
	(b)	0100 0100

ANSWER: 3

4-17. An additional bit in each storage location called a parity bit is used for what purpose?
1. To stop errors
2. To erase errors
3. To detect errors
4. To reroute errors

4-18. The parity bit is also called what?
1. Odd bit
2. Even bit
3. Code bit
4. Check bit

4-19. The test for bit count is called what?
1. Odd check
2. Even check
3. Stop check
4. Parity check

Prepared by: Harlem A. Agnote

4-20. What storage area accepts and holds input data to be processed?
1. Input
2. Output
3. Working
4. Program

4-21. A single binary digit is called what?
1. B i t
2. Byte
3. Word
4. Record

4-22. What symbol is used when we refer to the size of computer memory?
1. M
2. m
3. K
4. k

4-23. When many magnetic cores are strung together on a screen of wire, what type of plane is formed?
1. A wire plane
2. A core plane
3. A screen plane
4. A magnetic plane

4-24. When a core is magnetized, what characteristic of magnetism determines whether it contains a binary 0 or a binary 1?
1. Amount
2. Duration
3. Direction
4. Saturation

4-25. The storage capacity of an address is designed and built into the computer by which of the following people or organizations?
1. Operator
2. I n s t a l l e r
3. Programmer
4. Manufacturer

4-26. Computers that are built to r e t r i e v e , manipulate, and store a fixed number of characters in each address are said to be which of the following types of computers?
1. Fixed-bit-length
2. Fixed-word-length
3. F i x e d - f i l e - l e n g t h
4. Fixed-number-length

4-27. Computers that store a single character in each address location are said to be which of the following types of computers?
1. Variable-addressable
2. D a t a - a d d r e s s a b l e
3. Fixed-addressable
4. Character-addressable

QUESTION 4-28 IS TO BE JUDGED TRUE OR FALSE.

4-28. Fixed-word-length computers have slower calculating speeds than character-addressable computers.
1. True
2. False

4-29. Flexible computers that are byte oriented can operate in either a f i x e d - or variable-word-length mode by which of the following techniques?
1. Proper program length
2. Proper program density
3. Proper program instructions
4. Proper program flexibility

4-30. Different word lengths, such as half-word, full-word, and doubleword, are possible with what type of computer?
1. Bit-addressable
2. Byte-addressable
3. File-addressable

Prepared by: Harlem A. Agnote

4. Record-addressable

4-31. When a flexible computer is working in a fixed-word-length environment, each address identifies what group of elements that can be operated on as a unit?
1. B i t s
2. Bytes
3. F i l e s
4. Records

4-32. To automatically retrieve, manipulate, and store a fixed word of data as a unit on a flexible computer, what means can a programmer use?
1. P a r i t y b i t
2. Program length
3. Storage capacity
4. Program instructions

4-33. In computer terminology, a group of related bits is known by which of the following terms?
1. Word
2. F i l e
3. Record
4. Character

4-34. What group of related items form a record?
1. B i t s
2. Bytes
3. F i e l d s
4. Characters

4-35. The variations in how data files are stored in secondary storage is determined by what?
1. Types of media and devices used
2. C o s t o f t h e i n s t a l l a t i o n
3. S i z e o f t h e i n s t a l l a t i o n
4. Type of power available

4-36. When you store a file on tape, the 125th record cannot be read until the 124 records in front of i t a r e r e a d . This is called what type of storage?
1. Input-access
2. Direct-access
3. Random-access
4. Sequential-access

4-37. When data can be obtained quickly from anywhere on the media without having to read the r e c o r d s i n f r o n t o f i t , which of the following types of storage is being used?
1. Reading-access
2. Direct-access
3. Sequential-access
4. Processing-access

4-38. Which of the following is an example of random-access storage?
1. Disk
2. Thin film
3. Paper tape
4. Magnetic tape

4-39. Any system composed of one or more computers and terminals is the definition for what?
1. Network
2. ADP system
3. Computer system
4. Supply system

4-40. A network that consists of various machines linked together within a building or adjacent buildings is what type?
1. Wide area
2. Linked area
3. Local area
4. Narrow area

4-41. When dissimilar machines have the ability to communicate, they act in which of the following ways?

1. Human
2. As a team
3. Individually
4. Against each other

4-42. For local area networks, what two designs are used?
1. Broadband and bandpass
2. Broadpass and bandpass
3. Broadbase and baseband
4. Broadband and baseband

4-43. The communications channel that uses the basic frequency band of radio waves and a coaxial cable is what type?
1. Broadband
2. Broadpass
3. Baseband
4. Bandpass

4-44. The transmission of voice as well as data and text can be handled by what type of communications channels?
1. Broadband
2. Broadpass
3. Baseband
4. Bandpass

4-45. Wide area networks are sometimes referred to as which of the following networks?
1. Local
2. Global
3. S a t e l l i t e
4. Telephone

4-46. The first successful communic a t i o n s s a t e l l i t e f o r b u s i n e s s applications was launched in what year?
1. 1955
2. 1959
3. 1962
4. 1965

4-47. When we transmit data directly to a computer over long distances, it becomes necessary to add two other devices, one at each end of the communications line. These devices are called what?
1. Modems
2. Printers
3. Converters
4. Input/output buffers

4-48. A modem converts the digital signal produced by your terminal or the computer to what type of signal suitable for transmission over the communications line?
1. Video
2. Audio
3. Carrier
4. Hybrid

4-49. If conversion of the digital signal to be transmitted were not carried out, it would degenerate and become what?
1. Lost
2. Strong
3. Doubled
4. Garbled

4-50. Telephone lines are a frequently used type of communications channel. They are often referred to by which of the following terms?
1. Land lines
2. Microwave link
3. High frequency link
4. Communications lines

4-51. In communications, what name is given to those devices that serve to interconnect?
1. Connectors
2. System controllers
3. Interface elements
4. Impedance matchers

4-52. When using a modem, what are the

two methods of data transmission?
1. Digital and analog
2. Mechanical and light
3. Continuous and noncontinuous
4. Asynchronous and synchronous

4-53. The transmission method that uses a single set of start and stop message characters per block of data is which of the following types?
1. Synchronous
2. Asynchronous
3. Microwave link

characters is called what?
1. Sending
2. Protocol
3. Modulator
4. Transmitting

4. Frequency modulated

4-54. Whenever data is transferred between devices, it also involves an exchange of prearranged signals known as what?
1. Nodding
2. Spacing
3. Handshaking
4. Coordinating

4-55. The specific set of rules used to govern handshaking and message

MODULE 23

MAGNETIC RECORDING

PREPARED BY:

Darrell Jon Biscocho

Prepared by: Harlem A. Agnote

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Introduction to Magnetic Recording," pages 1-1 through 1-7. Chapter 2, "Magnetic Tape," pages 2-1 through 2-158. Chapter 3, "Magnetic Tape Recorder Heads," pages 3-1 through 3-9. Chapter 4 "Magnetic Tape Recorder Transports," pages 4-1 through 4-17.

1-1. In what year did Oberlin Smith originate the idea of using permanent magnetic impressions to record sound?
1. 1880
2. 1888
3. 1900
4. 1908

1-2. In 1925, magnetic recording began receiving attention when what device was invented?
1. Magnetic tape
2. Magnetic disk
3. Electronic amplifiers
4. Video recorders

1-3. In 1907, Mr. Poulsen discovered dc bias. How did adding dc bias to the input signal solve the distortion problem for magnetic recording?
1. It moved the input signal away from the step in the magnetism curve
2. It moved the input signal directly onto the step in the magnetism curve
3. It moved the output signal directly over the step in the magnetism curve
4. It straightened the step in the magnetism curve

1-4. After 1925, the Naval Research Laboratory greatly improved the signalto-noise ratio of magnetic recording by adding what component?
1. Ac bias
2. Electronic amplifiers
3. Transistors
4. Dc motors

1-5. In what year was plastic based tape introduced?
1. 1900
2. 1925
3. 1939
4. 1947

1-6. In 1956, IBM introduced what major contribution to magnetic recording?
1. The magnetic tape drive
2. The floppy disk drive
3. The hard disk drive
4. Each of the above

1-7. In 1966, IBM introduced the first removable-pack hard disk drive.
1. True
2. False

1-8. In what year was the 5 1/4" floppy disk drive invented?
1. 1956
2. 1976
3. 1980
4. 1988

1-9. Which of the following is a prerequisite for magnetic recording?
1. An input signal
2. A recording medium
3. A magnetic head
4. Each of the above

1-10. A magnetic recording medium is any material that has the ability to become magnetized, in set amounts, in large sections along its entire length.
1. True
2. False

1-11. Magnetic heads are transducers that convert the electrical variations of your input signal into what type of variations that are stored on a recording medium?
1. Magnetic
2. Electrical
3. Electrical and magnetic combined

Prepared by: Harlem A. Agnote

4. Direct current

1-12. What factor determines the number of turns of wire placed on the core of a magnetic head?
1. The size of the magnetic head
2. The size of the head-gap
3. The purpose of the magnetic head
4. Each of the above

1-13. All magnetic heads operate the same way. An electric current passes through the coil. Magnetic field lines associated with the electric current follow paths through the core material. When the magnetic field lines get to the head-gap, some of them spread outside the core to form a fringing field. When a recording medium is passed through this fringing field, magnetic recording happens.
1. True
2. False

1-14. Which of the following materials is used to make magnetic tape?
1. Base material
2. Magnetic oxide coating
3. Glue
4. Each of the above

1-15. The base material of magnetic tape is made with what material?
1. Plastic
2. Metal
3. Either 1 or 2
4. Paper

1-16. Which of the following can happen if the magnetic particles used to make magnetic tape aren't uniform in size?
1. The tape's surface will be abrasive which reduces the magnetic head's life
2. The frequency response of the tape will be distorted
3. The glue will not hold the particles in place
4. The oxide coating cannot be magnetized

1-17. Generally, short magnetic oxide particles are used on magnetic tape to record lowfrequency signals and long particles are used to record high-frequency signals.
1. True
2. False

1-18. Why does digital magnetic tape use a base material about 50 percent thicker than analog magnetic tape?
1. Thicker tape is needed to hold the long magnetic oxide particles
2. Thicker tape allows the tape to withstand the more strenuous starts and stops
3. Thicker tape is needed for instrumentation type signals
4. Thicker tape can store more digital data

1-19. There are four types of tape errors that can degrade the performance of a magnetic recording system. Which of the following tape errors is the most common and causes a 50% or more drop in signal strength?
1. Noise
2. Skew
3. Signal dropout
4. Level

1-20. Which of the following contaminants can cause signal dropouts?
1. Dust
2. Lint
3. Oil
4. Each of the above

1-21. Which of the following items on magnetic tape will cause noise errors?
1. Dust or lint
2. A cut
3. A scratch
4. Both 2 and 3 above

1-22. Brand "X" magnetic tape is rated for 5 volts (± 10%). Which of the following minimum and maximum voltage levels is what the output signal level could vary before it is considered a level error?
1. 4.95/5.05
2. 4.75/5.25
3. 4.5/5.5
4. 4/6

1-23. Magnetic tape can eventually become unusable when it comes in contact with the fixed surfaces of a recorder over long periods of time. What causes this type of tape failure?
1. Environmental damage
2. Normal wear
3. Winding errors
4. Accidental damage

1-24. Ideally, magnetic tape should be used and stored within what temperature and humidity range?
1. 40 - 80º F, 60 - 80% humidity
2. 50 - 70º F, 60 - 80% humidity
3. 60 - 80º F, 60 - 80% humidity
4. 60 - 80º F, 40 - 60% humidity

1-25. Using magnetic tape in a workplace that exceeds the ideal temperature and humidity ranges can cause which of the following types of environmental damage to the tape?
1. Dirt build-up
2. Layer-to-layer sticking
3. Tape deformation
4. Each of the above

1-26. At temperatures above 130 degrees, what happens to a tape's oxide coating?
1. Becomes soft
2. Separates from the base material
3. Both 1 and 2 above
4. Becomes brittle

1-27. What causes head-to-tape sticking?
1. Temperatures below 2º F
2. Dirty record/reproduce heads
3. The tape binder glue softens
4. Static electricity

1-28. Which of the following environmental conditions could create static electricity which attracts dirt build-up on the tape and tape recorder parts?
1. Relative humidity of 5%
2. Temperature of 28º F
3. Relative humidity of 96%
4. Temperature of 135º F

1-29. Excessive tape and head wear caused by increased friction as the tape passes over the heads can happen if the relative humidity is more that what maximum percent?
1. 70%
2. 85%
3. 95%
4. 90%

1-30. Winding errors can happen when improper winding practices create an excessive or uneven force as the tape is being wound onto a tape reel.
1. True
2. False

1-31. When winding a tape onto a reel, you notice that a sudden stop causes the outer layers of the tape to continue to spin after the inner layers have stopped. What type of deformed tape pack does this cause?
1. Pack-slip
2. Cinching
3. Spoking
4. Windowing

1-32. The magnetic tape on your reel is unwinding unevenly and rubbing against the sides of the reel and the recorder's tape guides. What type of deformed tape pack could cause this condition?
1. Spoking
2. Windowing
3. Pack-slip
4. Skewing

Prepared by: Harlem A. Agnote

1-33. You notice a spoked tape pack on the take-up reel of your recorder. What causes a spoked tape pack?
1. Tape is wound over a small particle on the reel hub
2. A distorted reel hub creates uneven pressures as the tape is wound onto the reel
3. Tape is wound with increasing tension toward the end of the winding
4. Each of the above

1-34. Which of the following tape pack deformities is an example of windowing?
1. The inner part of the tape pack is buckled and deformed
2. The tape pack contains steps caused by the tape shifting from side to side during winding
3. The tape pack contains voids or seethrough air gaps
4. Each of the above

1-35. Which of the following materials can be used to make tape reels?
1. Plastic
2. Metal
3. Glass
4. Each of the above

1-36. The flanges of a magnetic tape reel are designed to guide the magnetic tape onto the reel.
1. True
2. False

1-37. Magnetic tape is erased by exposing it to what type of magnetic field?
1. A gradually decreasing dc field
2. A gradually increasing dc field
3. A gradually decreasing ac field
4. A gradually increasing ac field

1-38. Which of the following is a disadvantage of using a tape recorder's erase head to erase magnetic tape?
1. It causes a distorted tape pack
2. It's slow
3. It may not do a complete erasure
4. Both 2 and 3 above

1-39. Both manual and automatic tape degaussers use the same electronic principles for erasing magnetic tape.
1. True
2. False

1-40. Which of the following is NOT an appropriate place to keep a magnetic tape reel or cartridge?
1. Mounted on a magnetic tape recorder
2. Stored in a plastic bag
3. Laying on top of a magnetic tape recorder
4. Both 2 and 3 above

1-41. Which of the following is a CORRECT method for handling magnetic tape?
1. Never let any part of the tape, except the end, trail on the floor
2. Always hold a tape reel by the flanges
3. Never handle or touch a tape's working surface
4. Each of the above

1-42. Which of the following is a CORRECT method for storing magnetic tape?
1. Always store tape reels laying on their sides, never vertically
2. Store tapes away from equipment that generates stray magnetic fields
3. Keep the storage area at 40 to 80% relative humidity
4. All of the above

1-43. Which of the following is a CORRECT method for packaging magnetic tape for shipping?
1. Always use reel bands where available
2. Always package reels supported by their hubs and in a vertical position
3. Always package cartridges in their

shipping cases
4. Each of the above

1-44. What parts of a magnetic tape recorder are considered the heart of magnetic tape recording?
1. Magnetic tape reel
2. Magnetic heads
3. Transport electronics
4. Operator control panel

1-45. The heads of a magnetic tape recorder perform what part of the overall tape recording process?
1. Record signal or data onto magnetic tape
2. Reproduce signal or data from magnetic tape
3. Erase signal or data from magnetic tape
4. Each of the above

1-46. All magnetic heads are made using a plastic core wrapped with a few turns of very thin wire.
1. True
2. False

1-47. What specification of a magnetic head determines the maximum frequency the head will be able to transfer onto and off of the magnetic tape?
1. Headgap
2. Size of the core
3. Number of turns of wire on the core
4. Each of the above

1-48. What is the only physical difference between a record head and a reproduce head?
1. Number of turns of wire on the core
2. Size of the core material
3. Type of core material used
4. Each of the above

1-49. A certain magnetic recorder has a maximum recording frequency response of 500 kHz. Which of the following frequencies would be a good frequency to use as an erase signal?
1. 500 kHz
2. 1200 kHz
3. 1900 kHz
4. Either 2 or 3

1-50. If you do NOT regularly clean a recorder's magnetic heads, what is the probable consequence?
1. Dirt, dust, lint, etc. will collect on the heads
2. Signal dropout errors will occur
3. Both 1 and 2 above
4. The tape pack will become skewed

1-51. What materials should you use to clean magnetic heads?
1. A bristled brush and non-detergent cleaner
2. A cotton-tipped applicator soaked in isopropyl alcohol
3. A cotton-tipped applicator soaked in a magnetic head cleaner recommended by the manufacturer
4. Either 2 or 3 above

1-52. Magnetic heads can become magnetized from many sources. Which of the following sources, if any, could magnetize a magnetic head?
1. Stray magnetic fields
2. Excessive humidity
3. Poor quality magnetic tape
4. None of the above

1-53. Magnetic head degaussers generate a strong ac magnetic field that dcmagnetizes the metal parts of a magnetic head.
1. True
2. False

1-54. Which of the following is NOT a procedure for demagnetizing magnetic heads?
1. Remove the tape reel or cartridge from the recorder

2. Touch the energized degausser to the head
3. Move the degausser back and forth across the head for 15 to 30 seconds
4. De-energize the degausser when it's an arms length away

1-55. Which of the following is a function of magnetic tape transports?
1. Moves the magnetic tape across the magnetic heads
2. Holds the moving tape
3. Protects the moving tape
4. Each of the above

IN ANSWERING QUESTIONS 1-56 THROUGH 1-59, SELECT THE DESCRIPTION IN COLUMN B THAT BEST DESCRIBES THE MAGNETIC TAPE RECORDER TRANSPORT PART LISTED IN COLUMN A.

1-56. Tape reeling System **ANSWER: 4**

1-57. Tape speed control system **ANSWER: 1**

1-58. Electronic sub-system **ANSWER: 3**

1-59. Basic Enclosure **ANSWER: 2**

1. Monitors and controls the movement of magnetic tape
2. Holds and protects the reels or cartridges of magnetic tape
3. Activates the reeling device to move the magnetic tape
4. Physically moves the magnetic tape across the magnetic heads

---

1-60. What type of tape reeling system uses a "free-spooling" supply reel and a motorized take-up reel?
1. Take-up control
2. Two-motor reeling
3. Tape buffering
4. Both 2 and 3 above

1-61. What type of tape reeling system was invented to overcome the problems of uneven tape tension and stretched tape?
1. Take-up control
2. Two-motor reeling
3. Tape buffering
4. Both 2 and 3 above

1-62. Magnetic tape reeling systems that use the spring tension method of tape buffering use what type of device to sense changes in tape tension?
1. Vacuum air column
2. Electro-mechanical
3. Photo-sensitive
4. Variable-static-sensor

1-63. What are the two types of tape guides used on magnetic tape reeling systems?
1. Variable and stable
2. Round and square
3. Single and dual
4. Fixed and rotary

1-64. A co-axial tape reeling configuration places the supply and take-up reels side by side.
1. True
2. False

1-65. In which of the following types of tape transport capstan drive configurations is the tape tension and head-to-tape contact most likely to vary?
1. Dual-motor dual capstan drive
2. Peripheral drive capstan
3. Open-loop capstan drive
4. Closed-loop capstan drive

Prepared by: Harlem A. Agnote

1-66. Which of the following closed-loop capstan drive tape transports will NOT work in reverse?
1. Differential velocity capstan
2. Peripheral drive capstan
3. Both 1 and 2 above
4. Dual-motors dual capstan

1-67. What type of capstan drive tape transport moves the magnetic tape by placing the capstan directly against the tape reel or tape pack?
1. Open-loop capstan drive
2. Peripheral drive capstan
3. Dual-motors dual capstan
4. Differential velocity capstan

1-68. Capstan speed control is a very important function of the magnetic tape transport system. Which of the following is NOT one of the six parts of a capstan speed control?
1. Capstan speed monitor
2. Speed select network
3. Comparison network
4. Reel motor drive circuit

1-69. What part of the capstan speed control function normally uses a photo-optical tachometer attached to the shaft of the capstan motor?
1. Precision frequency source
2. Speed select circuit
3. Capstan speed monitor
4. Comparison network

1-70. On some recorders, a servo control from tape signal is supplied to the comparison network of the capstan speed control function. What is the purpose of this signal?
1. Speeds up or slows down the capstan motor
2. Compensates for capstan speed differences when a recorded tape is played back on a different recorder
3. Monitors the true capstan motor speed
4. Provides a reference frequency that the speed select network uses to drive the capstan motor

1-71. Which of the following items can be used to clean most magnetic tape transports?
1. Isopropyl alcohol
2. Cotton swabs
3. Lint-free cloths
4. Each of the above

1-72. Which of the following is NOT a correct procedure for cleaning a magnetic tape transport?
1. When available, always use cotton swabs vice lint-free cloths
2. Apply the cleaner onto the cotton swab or lint-free cloth
3. Clean the flanged parts of the tape guides
4. While cleaning, switch swabs and cloths often

1-73. Magnetic tape transports should be demagnetized periodically. To do this, use a hand-held degausser and follow the procedures for demagnetizing magnetic heads.
1. True
2. False

Prepared by: Harlem A. Agnote

ASSIGNMENT 2

Textbook assignment: Chapter 5, "Magnetic Tape Recorder Record and Reproduce Electronics," pages 5-1 through 5-6. Chapter 6, "Magnetic Tape Recording Specifications," pages 6-1 through 6-15. Chapter 7, "Digital Magnetic Tape Recording," pages 7-1 through 7-9. Chapter 8 " Magnetic Disk Recording," pages 8-1 through 8-25.

2-1. Magnetic tape recorders use what type of electronic circuits to record and reproduce analog input signals?
1. Continuous wave
2. Frequency modulation
3. Amplitude modulation
4. Both 2 and 3 above

2-2. Direct record electronics record input signals onto magnetic tape just as they appeared at the recorder's input.
1. True
2. False

2-3. Which part of the direct record electronics component takes the input signal and the bias signal and mixes them together?
1. Input pre-amplifier circuit
2. Bias source
3. Summing network
4. Head driver circuit

2-4. Which part of the direct record electronics amplifies the signal from the summing network and sends it to the record head?
1. Bias source circuit
2. Head driver circuit
3. Input pre-amplifier circuit
4. Low-pass filter circuit

2-5. The pre-amplifier circuit of the direct reproduce electronics does which of the following functions?
1. Amplifies the reproduced signal
2. Removes the bias signal
3. Both 1 and 2 above
4. Corrects phase errors

2-6. What circuit in the direct reproduce electronics takes the pre-amplified signal and fixes frequency response problems

the reproduce magnetic head may have caused?
1. Equalization and phase correction circuit
2. Output amplifier circuit
3. Head driver circuit
4. Summing network

2-7. What circuit of the direct reproduce electronics serves as an impedance matcher?
1. Pre-amplifier circuit
2. Output amplifier circuit
3. Equalization and phase correction circuit
4. Head driver circuit

2-8. How do FM record electronics process the incoming signal before sending it to the record head?
1. A high frequency, negative bias is added to the input signal
2. A summing network mixes the bias and input signal
3. Both 1 and 2 above
4. The input signal is frequency modulated onto the carrier frequency of a record oscillator

2-9. In the FM record electronics, what is the output of the record oscillator circuit?
1. The demodulated input signal
2. The frequency modulated carrier signal
3. A clean input signal with the negative bias removed
4. A combined input signal and equalization signal
THIS SPACE LEFT BLANK

Prepared by: Harlem A. Agnote

INTENTIONALLY.

IN ANSWERING QUESTIONS 2-10 THROUGH 2-13, SELECT THE DESCRIPTION IN COLUMN B THAT BEST DESCRIBES THE PART OF FM REPRODUCE ELECTRONICS LISTED IN COLUMN A.

2-10. Pre-amplifier Circuit **ANSWER: 3**

2-11. Limiter/ demodulator circuit **ANSWER: 4**

2-12. Low-pass filter circuit **ANSWER: 1**

2-13. Output Amplifier **ANSWER:2**

1. Takes the signal from the limiter/ demodulator and cleans-up any noise or left over carrier signal
2. Takes the output from the low-pass filter and amplifies it for output
3. Takes the reproduce signal from the magnetic head and amplifies it
4. Stabilizes the amplitude level and demodulates the signal intelligence from the carrier signal

---

2-14. Which of the following generates the noise part of a recorder's SNR?

1. Magnetic heads
2. Magnetic tape
3. **Both 1 and 2 above**
4. Nearby equipment

2-15. The SNR can be stated in three different ways. Which of the following is NOT one of these ways?

1. **Mean signal to RMS noise**
2. Peak-to-peak signal to RMS noise
3. RMS signal to RMS noise
4. Peak signal-to-RMS noise

2-16. Which of the following data should be included with all SNR specifications?

1. **Record level**
2. Reproduce level
3. Bandwidth
4. Tape speed

2-17. What is the magnetic tape recording specification which gives a recorder's amplitude variation with frequency over a specified bandwidth?

1. Record level
2. Frequency response
3. Bandwidth
4. **Both 2 and 3 above**

2-18. Your LPO tells you to test the frequency response of a particular magnetic tape recorder. You use a signal generator to sweep through the frequencies as you monitor the recorder's output amplitude on a VTVM. Which of the following readings in output amplitude would indicate the upper and lower end of the recorders bandwidth?

1. □ □ 2-dB
2. **□□ □3□dB**
3. □ □ 5-dB
4. □ □ 10□dB

2-19. Which of the following factors can limit or degrade the frequency response of a magnetic tape recorder?

1. The record head
2. The reproduce head
3. Magnetic head-to-tape contact
4. **Each of the above**

Prepared by: Harlem A. Agnote

2-20. If the frequencies of the harmonic distortion are 2, 4, and 6 times the center frequency, what type of harmonic distortion is this?
1. Linear
2. Spatial
3. Even-order
4. Center frequency

2-21. Which of the following is a cause of even-order harmonics during magnetic tape recording?
1. Defective magnetic tape
2. Frequency response too low
3. Permanently magnetized heads
4. Each of the above

2-22. If you increase a magnetic tape recorder's signal bias level, what happens to the harmonic distortion?
1. Increases
2. Remains the same
3. Decreases
4. Increases odd-order harmonic distortion

2-23. When measuring the amount of harmonic distortion in a magnetic tape recorder, what electronic test equipment should you use?
1. Wave analyzer
2. VTVM
3. Spectrum analyzer
4. All of the above

2-24. When measuring harmonic distortion, you set the signal generator to input a 12-kHz test signal. At the recorder's output, what will be the frequency of the thirdorder harmonic?
1. 33-kHz
2. 18-kHz
3. 38-kHz
4. 36 kHz

2-25. What magnetic tape recorder specification expresses the variation of the phase shift with respect to frequency?
1. Frequency response
2. Phase response
3. Wow and Flutter
4. Each of the above

2-26. Which of the following conditions indicates that a magnetic tape recorder has a good phase response specification?
1. The SNR and frequency response are within tolerance
2. The wave analyzer shows a perfect sine wave
3. The recorder reproduces an undistorted square wave
4. Each of the above

2-27. What magnetic tape recorder specification expresses the result of nonuniform tape motion caused by variations in tape speed that produces frequency modulation of signals recorded onto magnetic tape?
1. Frequency response
2. Phase response
3. Flutter
4. Time-base error

2-28. Which of the following magnetic tape recorder transport parts can cause high frequency flutter (above 1000 Hz)?
1. Magnetic heads
2. Rotating tape guides
3. Fixed tape guides
4. Both 1 and 3 above

2-29. A magnetic tape recorder's flutter specification is usually expressed as a percent of peak or as a peak-to-peak value for what type of recorder?
1. Audio
2. Instrumentation
3. Video
4. All of the above

2-30. The time-base error (TBE) magnetic tape recorder specification is closely related to flutter. Which of the following statements best reflects this relationship?

1. TBE is an inverse measure of the effects of flutter on the stability of recorded data
2. TBE is a direct measure of the effects of flutter on the frequency response of recorded data
3. TBE is a direct measure of the effects of flutter on the stability of recorded data.
4. TBE is a direct measure of the effects of flutter on the bias level of recorded data.

2-31. The simplest way to measure a recorder's TBE is with what test equipment?
1. VTVM
2. Sweep analyzer
3. Oscilloscope
4. Ohmeter

2-32. There are two types of skew. What type does not show up when magnetic tapes are recorded and reproduced on the same magnetic tape recorder?
1. Positive
2. Dynamic
3. Negative
4. Fixed

2-33. Which of the following is NOT a cause of dynamic skew?
1. Gap scatter in the magnetic head stack
2. Sticking tape transport guides
3. Warped magnetic tape
4. Worn tape transport guides

2-34. Which of the following is NOT a format for digital magnetic tape recording?
1. Serial-parallel
2. Bi-phase
3. Serial
4. Parallel

2-35. Which of the following digital magnetic tape recording formats is normally used for instrumentation recording when the input data rate is high?
1. Serial-Parallel
2. Serial
3. Both 1 and 2 above
4. Bi-phase

2-36. The return-to-bias digital magnetic tape recording encoding method uses magnetic tape that is normally in a "neutral" condition.
1. True
2. False

2-37. Which of the following digital magnetic tape encoding methods is the most widely used?
1. RB
2. NRZ
3. E-RZ
4. RZ

2-38. Which of the four variations of NRZ encoding works best in high density magnetic tape recording and offers a biterror rate of one error per 1 million bits?
1. E-NRZ-L
2. NRZ-L
3. NRZ-M
4. NRZ-S

2-39. Digital magnetic tape recorders are used to store and retrieve which of the following types of data?
1. Computer programs
2. Radar and other pulsed type signals
3. Special signals with a bandwidth of less than 500 kHz
4. Each of the above

2-40. Telemetry digital magnetic tape recorders are frequently called wideband recorders.
1. True
2. False

2-41. Floppy disks are made of round plastic disks coated with magnetic oxide particles and enclosed in a plastic jacket.
1. True

Prepared by: Harlem A. Agnote

2. False

2-42. When discussing floppy disks, what is meant by the "density" of a floppy disk?
1. The thickness of the plastic disk
2. How much the disk can store
3. The thickness of floppy disk jacket
4. The number of sectors on the disk

IN ANSWERING QUESTIONS 2-43 THROUGH 2-46, SELECT THE STORAGE CAPACITY IN COLUMN B THAT BEST DESCRIBES THE TYPE OF FLOPPY DISK IN COLUMN A.

2-43. 5-1/4" double Density **ANSWER :3**

2-44. 5-1/4" high density **ANSWER: 1**

2-45. 3-1/2" double Density **ANSWER: 2**

2-46. 3-1/2" high density **ANSWER: 4**

1. 1,200,000 bytes
2. 720,000 bytes
3. 360,000 bytes
4. 1,400,000 bytes

2-47. Data is stored on floppy disks in circular "tracks." Each track is then broken up into arcs called "cylinders."
1. True
2. False

2-48. When a floppy disk is sectored using the soft sectoring method, the computer software determines the sector size and placement. What is this process called?
1. Centering
2. Addressing
3. Formatting
4. Rastering

2-49. When you handle, store, or ship floppy disks, which of the following statements is NOT a precaution you should take?
1. Always store 8" and 5 1/4" floppy disks in their envelopes when not in use
2. Always write on a floppy disk label first, and then place it on the disk
3. Always lay floppy disks on their side when storing them
4. Always ship floppy disks in their appropriate shipping containers

2-50. Which of the following items can generate magnetic fields that can destroy data on a floppy disk?
1. Paper clip
2. Telephone
3. Printer
4. Both 2 and 3 above

2-51. How can you erase a floppy disk?
1. Record over it
2. Degauss it
3. Reformat it
4. Both 2 and 3 above

2-52. A computer places data on a hard disk by using one of what two methods?
1. Cylinder or sector
2. Cylinder or circular
3. Sector or quadrant
4. Sector or record

2-53. Using the sector method, a hard disk drive locates a place on a hard disk with only one platter by using three location numbers. Which of the following is NOT one of those location numbers?
1. Surface number
2. Track number
3. Cylinder number
4. Sector number

2-54. When you handle, store, or ship removable hard disks, which of the following statements is NOT a precaution you should take?
1. Don’t touch any exposed recording surfaces
2. Keep them away from food, liquids,

and cigarette smoke
3. Store them in an environment that stays between 32 to 95 degrees Fahrenheit and 40 to 85% relative humidity
4. Keep dirt, dust, etc., off of the recording surface by storing them in their case when not in use

2-55. How can you declassify a removable hard disk which contains classified information?
1. Reformat it
2. Degauss it
3. Both 1 and 2 above
4. Destroy it using the procedures in OPNAVINST 5510.1

2-56. Which of the following encoding methods is NOT used for encoding digital data onto magnetic disks?
1. Sector encoding
2. Run length limited
3. Modified frequency modulation
4. Frequency modulation

IN ANSWERING QUESTIONS 2-57 THROUGH 2-60, SELECT THE DESCRIPTION IN COLUMN B THAT DESCRIBES THE FLOPPY DISK DRIVE PART LISTED IN COLUMN A.

2-57. Head arm Assembly **ANSWER: 2**

2-58. Drive electronics circuit board **ANSWER: 3**

2-59. Drive motor/spindle assembly **ANSWER: 1**

2-60. Actuator arm Assembly **ANSWER: 4**

1. Holds and spins the floppy disk
2. Holds the magnetic read/write heads
3. Controls the electromechanicalhigh density parts
4. Positions the heads over the disks

2-61. What part of a hard disk drive transport uses either a dc stepper motor or a voice coil to position the heads for writing data to the correct track of the disk pack?
1. Drive motor/spindle assembly
2. Head arm assembly
3. Actuator arm assembly
4. Drive electronics circuit board

2-62. What part of a hard disk drive transport holds the four magnetic heads, and is attached to the transport's actuator arm assembly?
1. Cylinder assembly
2. Head arm assembly
3. Sectoring assembly
4. Drive motor/spindle assembly

2-63. Why do floppy disk drives require more preventive maintenance than hard disk drives?
1. They are not sealed units
2. Oxide coating from disks sticks to transport parts
3. Both 1 and 2 above
4. The drive circuit board is less protected

2-64. Which of the following is a main function of the control electronics part of a disk drive's electronics component?
1. Take incoming data from the interface electronics
2. Spin the disk at the proper speed
3. Move the heads across the recording surface
4. Both 2 and 3 above

2-65. Which of the following is a function of the interface electronics part of a disk

drive's electronics component?
1. Convert data from the host computer from serial to parallel, and vice versa, as needed
2. Receive write/read control signals from the host computer
3. Receive control signals to format a disk from the host computer
4. All of the above

2-66. Which of the following is NOT one of the five most common disk drive interfaces in use today?
1. Drive motor/spindle interface
2. Naval tactical data system interface
3. ST-506/412 interface
4. Enhanced small device interface

2-67. What type of disk drive interface is often used in the hard disk drives installed in older IBM-compatible desktop computers that have a maximum capacity of 125MB?
1. Drive motor/spindle interface
2. Enhanced small device interface
3. ST-506/412 interface
4. Integrated drive electronics

2-68. What type of disk drive interface uses a high-level interface which requires only a logical sector number to locate the desired data on a disk?
1. Enhanced small device interface
2. Integrated drive electronics
3. Drive motor/spindle interface
4. Small computer systems interface

2-69. What type of disk drive interface includes all of the controller card electronics in the hard disk drive and offers a transfer rate of up to 1 MB?
1. Small computer systems interface
2. Integrated drive electronics
3. Naval tactical data system
4. Enhanced small device interface

2-70. Which of the following is NOT a benefit of the SCSI disk drive interface over previous interfaces?
1. Can handle disk drives of almost any size
2. Disconnects itself from the host computer's bus while it processes requests
3. Can transfer data up to 24 Mbits/sec
4. Can daisy-chain up to eight units off of one controller

IN ANSWERING QUESTIONS 2-71 THROUGH 2-74, SELECT THE MAGNETIC DISK RECORDING SPECIFICATION IN COLUMN B THAT MATCHES THE DEFINITION IN COLUMN A.

2-71. Indicates number of physical sectors that are between logical sectors on a hard disk **ANSWER: 4**

2-72. Total time it takes a disk drive to retrieve a sector of data **ANSWER: 3**

2-73. Time it takes for a magnetic head to position itself over a specific track **ANSWER: 1**

2-74. Time it takes a specific sector of a specific track to position itself under the magnetic head **ANSWER: 2**
1. Seek time
2. Latency period
3. Access time
4. Interleave factor

2-75. The speed at which a disk drive and a disk drive controller working together can transfer data to the host computer is what disk recording specification?
1. Seek time
2. Transfer rate
3. Access time
4. Interleave factor

MODULE 24

INTRODUCTION TO FIBER OPTICS

PREPARED BY:

Jermaine Ivy Dichoso

ASSIGNMENT 1

Textbook assignment: Chapter 1, "Background on Fiber Optics," pages 1-1 through 1-7. Chapter 2, "Fiber Optic Concepts," pages 2-1 through 2-35.

1-1. Fiber optics uses what medium to send information?
1. Electrons
2. Phonons
3. Link 11
4. Light

1-2. What are the three parts of a fiber optic data link?
1. Transmitter, optical fiber, receiver
2. Transmitter, optical fiber, optical connectors
3. Optical fiber, optical connectors, receiver
4. Optical fiber, optical connectors, optical splices

1-3. The fiber optic transmitter has which of the following functions?
1. Amplifies the optical signal
2. Converts the electrical input signal to an optical signal
3. Converts the input optical signal to an electrical signal
4. Amplifies the output electrical signal

1-4. Fiber optic systems use what two types of optical sources?
1. LEDs and APDs
2. PIN diodes and LEDs
3. LEDs and laser diodes
4. Laser diodes and APDs

1-5. The optical source performs which of the following functions?
1. Amplifies the optical signal
2. Amplifies the electrical signal
3. Launches the optical signal into the fiber
4. Converts the optical signal to an electrical signal

1-6. What fiber mechanisms weaken and distort the optical signal launched into the fiber?
1. Scattering, absorption, and dispersion
2. Scattering, radiation, and absorption
3. Dispersion, radiation, and absorption
4. Scattering, reflection, and refraction

1-7. The fiber optic receiver performs which of the following functions?
1. Amplifies the optical signal
2. Amplifies the electrical signal
3. Converts the electrical signal back into an optical signal
4. Converts the optical signal back into an electrical signal

1-8. What are the two parts of a fiber optic receiver?
1. Fiber and case
2. Fiber and optical detector
3. Optical detector and PIN diode
4. Optical detector and signalconditioning circuits

1-9. Noise has what effect, if any, on the quality of a signal?
1. Increases
2. Reduces
3. None; noise has no effect

1-10. What are the two types of optical detectors?
1. LEDs and APDs
2. PIN diodes and APDs
3. APDs and laser diodes
4. Laser diodes and PIN diodes

1-11. Besides the transmitter, the optical fiber, and the receiver, which of the following components may be found in a fiber optic link?
1. Splices only
2. Couplers only
3. Connectors only

Prepared by: Harlem A. Agnote

4. Splices, couplers, and connectors

1-12. Extremely high losses occurred in early fibers because of which of the following conditions?
1. Cracks in the fibers
2. Holes in the fiber sides
3. Core areas too small in the fibers
4. Impurities in the fiber material

1-13. What was the first light source developed that could be easily coupled into a fiber?
1. LED
2. Lamp
3. YAG laser
4. PIN diode

1-14. Compared to multimode fibers, single mode fibers tend to have lower loss and produce less signal distortion.
1. True
2. False

1-15. What multimode fiber properties help reduce connection losses?
1. Larger core size and lower NA
2. Larger core size and higher NA
3. Smaller core size and lower NA
4. Smaller core size and higher NA

1-16. Fiber optics is being used in which of the following types of applications?
1. Long-haul communications
2. Subscriber-loop applications
3. Military applications
4. All of the above

1-17. Of the following advantages, which one does NOT apply to fiber optics?
1. Established standards
2. Increased bandwidth
3. Improved environmental
4. Improved signal security

1-18. Of the following factors, which ones are advantages of fiber optic systems?
1. Electrical isolation and low bandwidth
2. Immunity to noise and low bandwidth
3. Electrical isolation and immunity to noise
4. Signal security and high price

1-19. To describe the nature of light, which of the following ways can be used?
1. Electromagnetic wave only
2. Particles of energy only
3. Electromagnetic wave and particles of energy
4. Element

1-20. Light exhibits what kind of wave motion?
1. Longitudinal
2. Transverse
3. Turbulent
4. Aperiodic

1-21. Which of the following factors is a description of transverse wave motion?
1. The wave motion is not predictable
2. The wave magnitude varies parallel to the direction of propagation
3. The wave magnitude varies perpendicular to the direction of wave motion

1-22. What does a transparent substance do to light rays that fall on it?
1. Absorbs them
2. Reflects them
3. Refracts them
4. Transmits them

1-23. What does a translucent substance do to light rays that fall on it?
1. Reflects and absorbs them
2. Refracts and absorbs them
3. Transmits and diffuses them
4. Transmits and reflects them

1-24. Which of the following substances is a good example of a translucent substance?
1. Cardboard
2. Clear glass

Prepared by: Harlem A. Agnote

3. Frosted glass
4. Aluminum foil

1-25. Which of the following substances is a good example of a transparent substance?
1. Cardboard
2. Clear glass
3. Frosted glass
4. Aluminum foil

1-26. What does an opaque substance do when light rays fall on it?
1. Refracts them
2. Reflects or absorbs them
3. Transmits them only
4. Transmits and diffuses them

1-27. Which of the following substances is an example of an opaque substance?
1. Cardboard
2. Clear glass
3. Oiled paper
4. Frosted glass

1-28. Which of the following objects is NOT an example of a luminous source?
1. Sun
2. Gas flame
3. Mirror
4. Flashlight

1-29. What are light waves called that strike a surface but are neither transmitted nor absorbed?
1. Diffused
2. Refracted
3. Reflected
4. Diffracted

1-30. What is the name of the law that states "The angle of incidence is equal to the angle of reflection"?
1. Snell's Law
2. Murphy's Law
3. Law of Entropy
4. Law of Reflection

1-31. A light wave is incident on a surface. The reflected power is the greatest in which of the following incidences?
1. 30º
2. 45º
3. Perpendicular
4. Almost parallel

1-32. A light wave passes from one medium into another medium with a different velocity. As the wave enters the second medium, the change of direction is known by which of the following terms?
1. Reflection
2. Refraction
3. Absorption
4. Diffusion

1-33. If a light wave passes from a less dense medium to a more dense medium, how does the angle of refraction compare to the angle of incidence?
1. Greater than the angle of incidence only
2. Equal to the angle of incidence only
3. Greater than or equal to the angle of incidence
4. Less than the angle of incidence

1-34. What is another word for diffused?
1. Absorbed
2. Refracted
3. Scattered
4. Attenuated

1-35. When light falls on a piece of black paper, what happens to most of the light?
1. It is absorbed
2. It is reflected
3. It is scattered
4. It is refracted

1-36. Light is transmitted along an optical fiber by what two methods?
1. Ray theory and mode theory
2. Ray theory and photon theory
3. Ray theory and quantum theory
4. Mode theory and photon theory

Prepared by: Harlem A. Agnote

1-37. How does the speed of light in the fiber compare to the speed of light in the air?
1. It is slower in the fiber
2. It is faster in the fiber
3. It is the same in both the fiber and the air

1-38. The relationship between the incident rays and the refracted rays at a boundary between mediums with different indexes of refraction describes what law?
1. Bragg's Law
2. Snell's Law
3. Murphy's Law
4. Law of Reflection

1-39. Total internal reflection occurs at which of the following angles?
1. Obtuse angle
2. Fresnel angle
3. Right angle
4. Critical angle of incidence

1-40. What are the three basic parts of an optical fiber?
1. Core, cladding, and coating
2. Inside, middle, and outside
3. Fiber, kevlar, and jacket
4. Hole, shell, and coating

1-41. The cladding performs all except which of the following functions?
1. Reduces the loss of light from the core
2. Reduces the scattering loss at the surface of the core
3. Protects the fiber core from absorbing surface contaminants
4. Reduces mechanical strength

1-42. What is the definition of a bound ray?
1. A ray that cannot move
2. A ray that travels in the air
3. A ray that is refracted out of the fiber
4. A ray that propagates through the fiber by total internal reflection

1-43. The fiber NA relates to which of the following characteristics?
1. Physical size of the fiber
2. Tensile strength of the fiber
3. Maximum angle within the fiber acceptance cone
4. Speed of light within the fiber

1-44. A skew ray is which of the following types of rays?
1. An unbound ray
2. A meridional ray
3. An unbalanced ray
4. A ray that propagates without passing through the center axis of the fiber

1-45. Electromagnetic wave behavior is used to describe the propagation of light along the fiber in what theory?
1. Mode theory
2. Particle theory
3. Darwin's theory
4. Rayleigh's theory

1-46. High-order modes cross the axis of the fiber at steeper angles than low-order modes.
1. True
2. False

1-47. Compared to a low-order mode, the electrical and magnetic fields of a highorder mode are distributed more toward the center of a fiber.
1. True
2. False

1-48. What are the two basic types of fibers?
1. Small and large
2. Glass and plastic
3. Opaque and diffuse
4. Single mode and multimode

1-49. Compared to multimode fibers, single mode fibers have a larger core size.
1. True
2. False

Prepared by: Harlem A. Agnote

1-50. The lowest signal loss and the highest bandwidth are characteristic of which of the following types of fibers?
1. Air core
2. Multimode
3. Single mode
4. Plastic core

1-51. Compared to single mode fibers, multimode fibers have which of the following advantages?
1. Ease of making connections only
2. Ease of launching light into them only
3. Ease of both making connections and launching light into them
4. Lower dispersion

1-52. System performance is affected most by which of the following fiber properties?
1. NA and delta
2. Core diameter and NA
3. Attenuation and dispersion
4. Core diameter and cladding

1-53. The loss of optical power as light travels along a fiber is called
1. attenuation
2. scattering
3. absorption
4. dispersion

1-54. Attenuation is specified in what units?
1. dB
2. dB/km
3. µm
4. µm/km

1-55. Glass optical fibers have low loss between the infrared and ultra- violet absorptive regions. The approximate wavelength of operation for glass optical fibers is in which of the following ranges?
1. 1 nm to 700 nm
2. 700 nm to 1600 nm
3. 1600 nm to 9000 nm
4. 9 µm to 20 µm

1-56. Increased extrinsic absorption at 950 nm, 1,250 nm, and 1,383 nm is caused by what impurity in glass optical fibers?
1. Phosphorus
2. Germanium
3. Titanium
4. Water

1-57. Which type of scattering loss is proportional to the reciprocal of the fourth power of the wavelength of the light?
1. Mie
2. Raman
3. Rayleigh
4. Brillouin

1-58. A radius of curvature is larger than the fiber diameter in which of the following types of fiber bends?
1. Macrobends
2. Microbends
3. Gentle bends
4. Serpentine bends

1-59. Only in multimode fibers does which of the following types of dispersion occur?
1. Modal
2. Material
3. Waveguide
4. Chromatic

1-60. When different colors of light travel through the fiber at different speeds, which of the following types of dispersion occurs?
1. Modal
2. Intramodal (chromatic)
3. Intermodal
4. Atmospheric

Prepared by: Harlem A. Agnote

ASSIGNMENT 2

Textbook assignment: Chapter 3, "Optical Fibers and Cables," pages 3-1 through 3-26. Chapter 4, "Optical Splices, Connectors, and Couplers," pages 4-1 through 4-34.

2-1. In a step-index fiber, the refractive index profile of the fiber core has which of the following characteristics?
1. It is uniform over the fiber core
2. It linearly decreases from a maximum at the fiber center to a minimum at the core-cladding boundary
3. It is parabolic with a maximum index of refraction at the center and a minimum index of refraction at the core-cladding boundary
4. It linearly increases from a minimum at the fiber center to a maximum at the core cladding boundary

2-2. In a graded-index fiber, the refractive index profile of the fiber core is best described by which of the following statements?
1. It is uniform over the fiber core
2. It linearly decreases from a maximum at the fiber center to a minimum at the core-cladding boundary
3. It is parabolic with a maximum index of refraction at the center and a minimum index of refraction at the core-cladding boundary
4. It linearly increases from a minimum at the fiber center to a maximum at the core cladding boundary

2-3. Which of the following multimode fiber core sizes is NOT a standard commercial fiber size?
1. 50 mm
2. 5 mm
3. 76 mm
4. 100 mm

2-4. Elements other than silicon and oxygen are added to glass material by the fiber manufacturer to change its index of refraction. What are these elements called?
1. Spices
2. Dopants
3. Additives
4. Impurities

2-5. Compared to multimode step-index fibers, do multimode graded-index fibers have lower, higher, or approximately equal bandwidths?
1. Lower
2. Higher
3. Approximately equal

2-6. In multimode graded-index fibers, is the index of refraction of the glass at the center of the fiber core lower, higher, or approximately equal to the index of refraction of the cladding glass?
1. Lower
2. Higher
3. Approximately equal

2-7. For a multimode graded-index fiber, the numerical aperture is at its maximum value at which of the following locations?
1. At the fiber axis
2. At the core-cladding interface
3. Half way between the fiber center and the core-cladding interface
4. One-fourth of the way between the fiber center and the core- cladding interface

2-8. In multimode fiber, all light rays have to propagate all of the way to the corecladding interface before they are reflected back toward the fiber axis.
1. True
2. False
2-9. A step-index multimode fiber and a

graded-index multimode fiber have the same core and cladding sizes and the same refractive index difference. Which fiber type, if either, will accept light more easily and have more propagating modes?
1. Step-index fiber
2. Graded-index fiber
3. Neither; they will behave approximately the same

2-10. The multimode graded-index fiber that has the best bend performance and will show the least amount of optical degradation if mishandled is what size?
1. 50/125 mm
2. 5/125 mm
3. 85/125 mm
4. 100/140 mm

2-11. The attributes of the 62.5/125- mm fiber do NOT include which of the following factors?
1. Low loss
2. High bandwidth
3. Low bending sensitivity
4. Low source to fiber coupling efficiency

2-12. What are the two basic types of single mode step-index fibers?
1. Low NA and high NA
2. Solid core and air core
3. Enriched clad and depressed
4. Matched clad and depressed clad

2-13. For wavelengths greater than its cutoff wavelength, a typical single mode fiber is allowed to propagate a total of how many modes, if any?
1. 1 only
2. 10 only
3. 100
4. None

2-14. Fibers are single mode at a particular wavelength only when V < 2.405. Under what condition, if any, will the fiber cease to be single mode?
1. When the wavelength of the light is greater than the cutoff wavelength
2. When the wavelength of the light is less than the cutoff wavelength
3. None

2-15. The use of plastic-clad silica and all plastic fibers has what primary drawback?
1. Higher NA
2. Higher cost
3. Higher bandwidth
4. Limited optical performance

2-16. In the fabrication of silica optical fibers, which of the following processes may be used?
1. Outside vapor phase oxidation (OVPO)
2. Inside vapor phase oxidation (IVPO)
3. Vapor phase axial deposition (VAD)
4. All of the above

2-17. In making a preform, layers of glass powder are deposited on the inside or outside of a glass rod or tube. What is this glass powder called?
1. Soot
2. Smoke
3. Preform
4. Afterburn

2-18. The process used in drawing the fiber is best described by which of the following statements?
1. The preform is melted and the molten glass is molded, using special fiber molds
2. The preform is softened and the glass is pulled into a thin glass filament
3. The preform is softened and the glass is rolled into a thin glass filament
4. The preform is melted and the fiber is formed by blowing the molten glass through a small hole

2-19. To protect the fiber from contaminants in the drawing process, what substance is added over the fiber?
1. Water
2. Coating
3. Preform
4. Cladding

2-20. Most fiber optic cable structures contain which of the following items?
1. Buffers only
2. Jackets only
3. Buffers and jackets only
4. Buffers, jackets, and strength members

2-21. Properly designed optical cable structures perform which of the following functions?
1. Protect the optical fibers from mechanical stresses, damage, and breakage
2. Increase the tensile stress on the fiber
3. Decrease the attenuation of the fiber
4. All of the above

2-22. The fiber buffer performs which of the following functions?
1. Protects the fiber from micro-bends
2. Provides additional mechanical protection
3. Helps preserve the fiber's inherent strength
4. All of the above

2-23. Navy shipboard fiber optic cables should NOT contain which of the following materials as a strength member?
1. Steel wire
2. Arimid yarns
3. Carbon fibers
4. Glass-reinforced plastics

2-24. In the materials of a Navy shipboard fiber optic cable jacket, which of the following properties is NOT desirable?
1. High abrasion resistance
2. High flame retardance
3. High halogen content
4. Low toxicity

2-25. Most commercial fiber optic cable jacket materials are suitable for use in Navy shipboard applications.
1. True
2. False

2-26. For low-density fiber Navy ship- board applications, which cable designs, if any, are preferred?
1. Stranded cable
2. Ribbon cable
3. OFCC cable
4. None; they are all equally effective

2-27. When compared with other cable designs, the OFCC fiber optic cable has which of the following advantages?
1. Ruggedness only
2. Ease of handling only
3. Ruggedness and ease of handling
4. Relative small size

2-28. The only advantage of the stranded cable design over the OFCC cable design is
1. greater ruggedness
2. better fiber protection
3. smaller size for the same fiber count
4. better water-blocking performance

2-29. A particular fiber optic cable design has the highest fiber count possible in the smallest size. But it is difficult to use, shows susceptibility to fiber damage during fiber breakout, and has poor bending and water-blocking performance. Which of the following designs fits this description?
1. OFCC cable
2. Stranded cable
3. Ribbon cable

2-30. A fiber optic connection that is typically intended to be permanent is what type, if any?
1. Mechanical splice

Prepared by: Harlem A. Agnote

2. Connector
3. Coupler
4. None; they are all intended to be removable

2-31. Easy coupling and uncoupling of optical fibers are allowed by what type of fiber optic connection, if any?
1. Splice
2. Coupler
3. Connector
4. None; all are equally difficult

2-32. The distribution or combination of optical signals among fibers uses which type of fiber optic connection, if any?
1. Splice
2. Coupler
3. Connector
4. None; it is not possible to distribute or combine optical signals

2-33. Coupling loss in a fiber optic connection may be caused by which of the following conditions?
1. Poor fiber alignment
2. Poor fiber end preparation
3. Differences in optical properties between connected fibers
4. All of the above

2-34. The loss in optical power through a connection is described by what relationship, if any?
1. Log relationship
2. Linear relationship
3. Exponential relationship
4. None; there is no way to describe the relationship

2-35. An intrinsic coupling loss may be caused by which of the following conditions?
1. Fiber separation
2. Angular misalignment
3. Fiber geometry mismatches
4. Poor fiber end preparation

2-36. In connections that have an air gap, the reflective losses can be minimized by taking which of the following actions?
1. Polishing the fiber ends more finely
2. Cleaning the fiber ends carefully with alcohol
3. Filling the air gap with an index matching gel
4. Heating the connection to an elevated temperature

2-37. A main source of extrinsic coupling loss in fiber to fiber connections is caused by which of the following conditions?
1. Fiber mismatches
2. Poor fiber alignment
3. Poor fiber end preparation

2-38. Which of the following conditions is NOT a form of poor fiber alignment?
1. NA mismatch
2. Fiber separation
3. Lateral misalignment
4. Angular misalignment

2-39. For mating fibers to touch when a connector is assembled, which of the following polishing techniques was developed?
1. Fresnel polish
2. Rayleigh polish
3. Circular polish
4. Physical contact polish

2-40. Single mode fibers are less sensitive to alignment errors than multimode fibers because of their small core size.
1. True
2. False

2-41. The fiber cleaving process includes which of the following actions?
1. Cutting the fiber with a cleaver
2. Bending the fiber until it breaks
3. Lightly nicking the fiber and applying tension until it breaks
4. Sawing the fiber with a special fiber saw

2-42. To remove most of the surface imperfections introduced in the fiber cleaving process in most fiber optic connections, what action should be taken?
1. Polish the fiber end
2. Cover the fiber end face with epoxy
3. Clean the fiber end face with alcohol
4. Cover the fiber end face with index matching gel

2-43. The connector end face should be inspected for scratches and shattered fiber ends by which of the following methods?
1. The naked eye
2. A 10x eye loupe
3. An electron microscope
4. A 200x-400x microscope

2-44. In Navy fiber optic applications, losses from fiber mismatches are minimized by which of the following actions?
1. Polishing the fiber ends
2. Using index matching gels
3. Using index matching epoxies
4. Using Navy specification fibers with tightly specified parameters

2-45. Fiber optic splices are typically used in which of the following conditions?
1. When repeated connections or disconnections are desired only
2. When repeated connections or disconnections are unnecessary only
3. When low loss connections are required only
4. When repeated connections or disconnections are unnecessary and when low loss connections are required

2-46. What are the two basic categories of fiber splices?
1. Glass and plastic
2. Metal and ceramic
3. V-groove and rotary
4. Mechanical and fusion

2-47. For shipboard applications, which of the following types of splices is recommended?
1. Fusion
2. Rotary
3. V-groove
4. Ceramic alignment tube

2-48. The assembly of a rotary splice is which of the following actions?
1. Cleave fiber ends, insert into each end of a glass tube filled with adhesive, and cure with ultraviolet light
2. Cleave fiber ends, insert into each end of a glass tube filled with index matching gel, and twist on splice end caps
3. Break glass tube at center, fill each half with epoxy, insert fibers into each half, cure adhesive with ultraviolet light, and polish and place polished ends together with alignment sleeve
4. Cleave fiber ends, insert fibers into splice, and crimp in place

2-49. The basic process used in making fusion splices is which of the following methods?
1. Gluing the fiber ends together
2. Melting the fiber ends together
3. Polishing the fiber ends and placing them together
4. Cleaving the fiber ends and placing them together

2-50. Fusion splicing is not recommended for Navy use for all of the following reasons except which one?
1. Low splice yields
2. Low splice losses
3. Long splicing times
4. High level of expertise required for splicer operator

2-51. The total loss of a fiber optic connector

should always remain below which of the following values?
1. 1 dB
2. 2 dB
3. 5 dB
4. 10 dB

2-52. What are the two basic types of fiber optic connectors?
1. V-groove and ribbon
2. Three rod and biconical
3. Ceramic and stainless steel
4. Butt-jointed and expanded-beam

2-53. Single fiber butt-jointed connections generally consist of which of the following parts?
1. Plug and receptacle
2. Ferrule and alignment clip
3. Two plugs and an adapter
4. One plug and two adapters

2-54. In ceramic ferrules, the center hole is created by which of the following processes?
1. With a microdrill
2. With a laser drill
3. By forming the ferrule around a precision wire
4. With a small water jet

2-55. The standard connector for Navy lightduty applications is of which of the following styles?
1. ST_
2. SMA
3. Array
4. Biconical
(NOTE: ST_; is a registered trademark of AT&T)

2-56. Light-duty connectors are intended for use in all but which of the following locations?
1. Junction boxes
2. Equipment enclosures
3. Environmentally protected locations
4. Exposed equipment interface connectors

2-57. A standard connector for Navy heavyduty applications is of which of the following styles?
1. MIL-C-83526 connector
2. MIL-C-28876 connector
3. Biconical connector
4. Array connector

2-58. In a heavy-duty connector, what are the two types of terminals called?
1. Plugs and adapters
2. Type A and type B
3. Pins and sockets
4. Nuts and bolts

2-59. Fiber optic couplers attenuate the optical signal much more than a connector or a splice.
1. True
2. False

2-60. Active fiber optic couplers are called active fiber optic couplers for which of the following reasons?
1. Because they contain moving parts
2. Because they switch the optical signal between different parts
3. Because they contain active devices, including sources and detectors
4. Because they move through the system

2-61. An optical coupler has one input port and two output ports. Which of the following types of couplers is it?
1. **Optical splitter**
2. Optical combiner
3. Star coupler
4. Tree coupler

2-62. An optical coupler has two input ports and one output port. Which of the following types of couplers is it?
1. Optical splitter
2. **Optical combiner**
3. Star coupler

Prepared by: Harlem A. Agnote

4. Tree coupler

2-63. An optical coupler has one input port and several output ports. Which of the following types of couplers is it?
1. T-coupler
2. Star coupler
3**. Tree coupler**
4. Optical splitter

2-64. An optical coupler has several input ports and several output ports. Which of the following types of couplers is it?
1. X-coupler
2. T-coupler
3. **Star coupler**
4. Tree coupler

ASSIGNMENT 3

Textbook assignment: Chapter 5, "Fiber Optic Measurement Techniques," pages 5-1 through 5-32.
Chapter 6, "Optical Sources and Fiber Optic Transmitters," pages 6-1 through 6-16.

3-1. Manufacturers should measure some component parameters during and after component manufacture for which of the following reasons?
1. To characterize the component design
2. To verify the quality of the manufactured parts
3. To determine if the component has been damaged in the shipping process
4. To determine if the installation process has degraded the component performance beyond allowable limits

3-2. End users should measure some component parameters upon receipt before installing a component into a fiber optic system for which of the following reasons?
1. To characterize the component design
2. To verify the quality of the manufactured parts
3. To determine if the component has been damaged in the shipping process

3-3. End users should measure some component parameters after installation of the component in the fiber optic system for which of the following reasons?
1. To characterize the component design
2. To verify the quality of the manufactured parts
3. To determine if the component has been damaged in the shipping process
4. To determine if the installation process has degraded the component performance beyond allowable limits

3-4. Standard test methods used for testing fiber optic components or systems can be found in which of the following test documents?
1. EIA/TIA-455 only
2. EIA/TIA-526 only
3. EIA/TIA-455 and EIA/TIA 526
4. MIL-STD 2196

3-5. In laboratory fiber attenuation measurements, the output optical power of a long fiber is compared with the optical power launched into that same fiber two meters from the optical source. This method of measuring the optical attenuation is called the
1. OTDR method
2. fiber method
3**. cutback method**
4. two-point method

3-6. Which of the following are considered launch conditions?
1. The temperature at the time of measurement
2. The humidity at the time of measurement
3. The way power is launched into the optical fiber
4. The type of connector or splice used on the fiber

3-7. Launch conditions in an attenuation measurement are important to measurement personnel for which of the following reasons?
1. The attenuation measured for each different launch condition will be different
2. The use of the wrong launch condition will damage the optical power meter

Prepared by: Harlem A. Agnote

3. The fibers will only transmit light launched in one particular manner
4. The use of the wrong launch condition will damage the fiber

3-8. For single mode fiber, what method is typically used to assure that power is launched into only the fundamental mode?
1. Only LEDs are used as test optical sources
2. Only lasers are used as test optical sources
3. The fiber is always placed at a 45º angle with respect to the plane of the source
4. A 30-mm diameter mandrel or freeform loop is applied at the launch end of the fiber

3-9. What does the term overfilled launch mean?
1. When too much power is launched into the fiber
2. When not enough power is launched into the fiber
3. When light is launched only into the low order mode
4. When the launch spot size and the angular distribution are larger than that of fiber core

3-10. In what part of the fiber does an underfilled launch concentrate most of the optical power?
1. In the center of the fiber
2. At the edge of the fiber
3. Over all of the fiber
4. In the cladding

3-11. What is a mode filter?
1. A device that converts cladding power to core power
2. A device that removes any cladding power from the fiber
3. A device that attenuates specific modes propagating in the core of the fiber
4. A device that attenuates specific wavelengths of light in the core of the fiber

3-12. To remove high-order modes in multimode fibers, which of the following mode filters is normally used?
1. Bessel filter
2. Bandpass filter
3. Mandrel wrap filter
4. Neutral density filter

3-13. What is the wavelength called over which the fiber will propagate only one mode?
1. Cutoff wavelength
2. Fresnel wavelength
3. Cutback wavelength
4. Rayleigh wavelength

3-14. Determining the cutoff wavelength of a single mode fiber involves finding the wavelength above which the power transmitted through the fiber decreases abruptly.
1. True
2. False

3-15. When the cutoff wavelength is reached, why does the transmitted power in a single mode fiber abruptly decrease?
1. The fiber absorption increases at the cutoff wavelength
2. The fiber scattering increases at the cutoff wavelength
3. The fiber diffusion increases at the cutoff wavelength
4. The second-order mode ceases to propagate at the cutoff wave- length

3-16. The spreading of a light pulse as it travels along the fiber is caused by what mechanism?
1. Diffraction
2. Attenuation
3. Absorption
4. Dispersion

Prepared by: Harlem A. Agnote

3-17. In a fiber, the intermodal (modal) dispersion is greatest under what condition?
1. When the input pulse has a long rise time
2. When all fiber modes are excited
3. When the input pulse has an extremely high amount of power
4. When the source spectrum contains many different wave- lengths

3-18. The fiber bandwidth (-3 dB) is defined as the lowest frequency at which the magnitude of the fiber frequency response has decreased to what portion of its zero-frequency value?
1. One-tenth
2. One-fifth
3. One-half
4. Three-fourths

3-19. Modal bandwidth is normally given in what units?
1. GHz
2. MHz
3. MHz/km
4. MHz-km

3-20. Why does chromatic dispersion occur?
1. Because different fiber modes have different propagation speeds
2. Because different colors of light travel through the fiber at different speeds
3. Because different colors of light are attenuated differently in the fiber
4. Because different fiber modes are attenuated differently in the fiber

3-21. End users perform fiber geometry measurements for which of the following reasons?
1. To reduce system bandwidth limitations
2. To separate bigger fibers from smaller fibers
3. To reduce system attenuation and coupling losses from fiber mismatches
4. To determine which connector to use

3-22. Cladding diameter, cladding noncircularity, core-cladding concentricity error, and core noncircularity are measured by which of the following techniques?
1. Micrometer calipers
2. Electron microscopes
3. Video cameras attached to a computer for digital analysis
4. Ruler

3-23. The core diameter of a multimode fiber is defined by which of the following measurements?
1. The distance between the 50% points of the measured near-field distribution
2. The distance between the 50% points of the measured far-field distribution
3. The distance between the 2.5% points of the measured near-field distribution
4. The distance between the 2.5% points of the measured far-field distribution

3-24. The fiber near-field is which of the following regions?
1. The region close to the fiber-end face, within a few cm of the end face
2. The region within 3 to 5 cm of the fiber-end face
3. The region about one foot of the fiber-end face
4. The region far from the fiber- end face

3-25. The fiber far-field is which of the following regions?
1. The region close to the fiber-end face, within a few cm of the end face
2. The region far from the fiber-end face, greater than a few cm for multimode and mm for single mode
3. The region exactly next to the fiberend

Prepared by: Harlem A. Agnote

face
4. Anywhere inside the acceptance cone of the fiber

3-26. The far-field power distribution describes the emitted power per unit as a function of the angle ÿ from the fiber axis some distance from the fiber-end face.
1. True
2. False

3-27. The numerical aperture of a multi- mode fiber is best described by which of the following definitions?
1. Half the difference between the 50% angles of the far-field distribution
2. Half the difference between the 50% angles of the near-field distribution
3. Half the difference between the 5% angles of the near-field distribution
4. Half the difference between the 5% angles of the far-field distribution

3-28. The mode field diameter of a single mode fiber relates to which of the following factors?
1. The cladding diameter of a multimode fiber
2. The cladding diameter of a single mode fiber
3. The spot size of the fundamental mode of a single mode fiber
4. The coating diameter of the single mode fiber

3-29. Insertion loss is determined by which of the following techniques?
1. The power transmitted through a component is compared to the power transmitted through the fiber or the cable before the component was inserted
2. The power transmitted through a component with a mandrel wrap on the fiber is compared to the power transmitted through the component without a mandrel wrap inserted
3. The power transmitted through a cable is compared to the power transmitted through a similar piece of cable
4. The power transmitted through a connector is compared to the power transmitted through a similar connector

3-30. The return loss of a fiber optic component is which of the following measurements?
1. The difference in the power loss when a component is measured in reverse directions
2. The amount of loss of the reflected light compared with the power of the incident beam at the interface
3. The amount of loss of the reflected light compared with the transmitted light at a component

3-31. Some properties may change during installation; therefore, they are typically measured in the field. All of the following measurements should be made in the field except which one?
1. Fiber loss
2. Connector/splice return loss
3. Connector/splice insertion loss
4. NA

3-32. Field loss measurements are made by using which of the following test equipments?
1. Low power calorimeters
2. Optical sources and power meters only
3. Optical time domain reflectometers only
4. Optical sources and power meters; and optical time domain reflectometers

3-33. Measurements made with an optical time domain reflectometer are more accurate than those made with an optical source and an optical power meter.
1. True

2. False

3-34. An OTDR should not be used to measure optical fibers or links that are less than a specific minimum length. What is that length?
1. 5 m
2. 50 m
3. 100 m
4. 250 m

3-35. The initial pulse (or spike) at the beginning and at most connections in a link on the OTDR trace is caused by which of the following processes?
1. Reflected power at each air gap in the link
2. Extremely high losses at the beginning of each piece of fiber
3. Amplification of the OTDR pulse at the beginning of each piece of fiber
4. Second harmonic generation at the beginning of each piece of fiber

3-36. When OTDR measurements are made, a dead zone fiber is used for what reason?
1. To compensate for the inaccuracy of the OTDR
2. To match the fiber types at the first connection
3. To maximize the reflectance at the first connection
4. To reduce the effect of the initial reflection at the OTDR on the measurement

3-37. When fiber attenuation is measured with an OTDR, the initial cursor, Z1, should be placed at what point along the OTDR trace?
1. Just before the connector or the splice at the beginning of the fiber
2. On the gradual downward part of the trace just before the ending connector or splice
3. On the steep downward part of the trace just after the beginning connector or the splice
4. On the gradual downward part of the trace just after the reflective spike from the beginning connector or splice

3-38. When fiber attenuation is measured with an OTDR, the end cursor, Z2, should be placed at what point along the OTDR trace?
1. Just before the connector or the splice at the beginning of the fiber
2. On the gradual downward part of the trace just before the ending connector or splice
3. On the steep downward part of the trace just after the beginning connector or splice
4. On the gradual downward part of the trace just after the reflective spike from the beginning connector or splice

3-39. When the distance between the ends of a fiber is measured with an OTDR, the initial cursor should be placed at what point along the OTDR trace?
1. Just before the connector or the splice at the beginning of the fiber
2. On the steep downward part of the trace just after the beginning connector or splice
3. On the gradual downward part of the trace just after the reflective spike from the beginning connector or splice
4. On the gradual downward part of the trace just before the ending connector or splice

3-40. OTDR measurements should be performed in each direction and averaged for which of the following reasons?
1. OTDRs are not consistent measurement tools; therefore, multiple measurements must be made
2. Variations in fiber properties (backscattering) change the OTDR

measurement, depending on the direction of the measurement; bidirectional averaging eliminates these effects
3. Fibers transmit preferentially in one direction; therefore, measurements must be made to determine the preferential direction

3-41. When a point defect (a connector or a splice) exhibits an apparent gain in power in one direction, it exhibits which of the following properties in the other direction?
1. The same apparent gain in power
2. An exaggerated loss in power
3. A slight loss in power
4. No gain or loss in power

3-42. When using a light source and a power meter to make link loss measurements, which of the following steps should you perform first?
1. Connect the reference jumper between the source and the power meter
2. Connect the reference jumper and one test jumper between the source and the power meter
3. Connect the link directly between the source and the power meter
4. Connect the link directly between two power meters

3-43. During the measurement of the link's output optical power, the test setup is described by which of the following orders?
1. Source, test jumper, link, test jumper, power meter
2. Source, test jumper, link, power meter
3. Source, link, test jumper, power meter
4. Source, link, power meter

3-44. What is the function of a fiber optic transmitter?
1. To amplify optical signals and launch the amplified optical signals into an optical fiber
2. To convert electrical signals into optical signals and launch the optical signals into an optical fiber
3. To convert optical signals into electrical signals only
4. To convert electrical signals into optical signals and transmit the optical signals through the air

3-45. Which of the following items is/are part of a fiber optic transmitter?
1. An optical source only
2. A source drive circuit only
3. An optical source and a source drive circuit only
4. An optical source, a source drive circuit, and an interface circuit

3-46. An optical source has which of the following functions?
1. To convert light to electrical energy (current)
2. To amplify the electrical signal
3. To convert electrical energy into light
4. To convert light into sound

3-47. Which of the following properties are NOT desired properties of an optical source?
1. Be compatible in size to low-loss optical fibers
2. Emit light at wavelengths that maximize fiber loss and dispersion
3. Maintain stable operation in changing environmental conditions
4. Cost less and be more reliable than electrical devices

3-48. Fiber optic communication systems typically operate in what three wavelength windows?
1. 400 nm, 850 nm, and 1550 nm

2. 400 nm, 900 nm, and 1400 nm
3. 850 nm, 1300 nm, and 1550 nm
4. 1300 nm, 2000 nm, and 4000 nm

3-49. Incoherent light has what type of lightwaves?
1. Lightwaves that are produced by lasers
2. Lightwaves that lack a fixed-phase relationship
3. Lightwaves that have a fixed-phase relationship
4. Lightwaves that contain only one wavelength of light

3-50. Semiconductor LEDs emit which of the following kinds of light?
1. Incoherent
2. Coherent only
3. Monochromatic only
4. Coherent and monochromatic

3-51. Semiconductor lasers emit which of the following kinds of light?
1. Spontaneous
2. Incoherent
3. Coherent
4. All of the above

3-52. All of the light emitted by a semiconductor laser or LED is coupled into an optical fiber.
1. True
2. False

3-53. Relevant optical power does NOT depend on which of the following factors?
1. The angles over which the source emits light
2. The size of the source's lightemitting area relative to the fiber core size
3. The alignment of the source and the fiber
4. The dopants in the semiconductor material

3-54. What is it called when the fiber end face is directly placed over the source emitting region?
1. Butt coupling
2. Lensed coupling
3. Evanescent coupling
4. Fresnel coupling

3-55. What are the two most common semiconductor materials used in electronic and electro-optic devices?
1. Germanium and aluminum
2. Silicon and gallium arsenide
3. Indium and zirconium
4. Zinc and platinum

3-56. LEDs produce light by what process?
1. Combustion
2. Stimulated emission
3. Spontaneous emission
4. Photosynthesis

3-57. Lasers produce light by what process?
1. Combustion
2. Stimulated emission
3. Spontaneous emission
4. Photosynthesis

3-58. Stimulated emission is the random generation of photons within the active area of an LED.
1. True
2. False

3-59. In an optical source, the input electrical energy is converted to light and which of the following other forms of energy?
1. Gravitational
2. Sound
3. Heat
4. All of the above

Prepared by: Harlem A. Agnote

ASSIGNMENT 4

Textbook assignment: Chapter 6, "Optical Sources and Fiber Optic Transmitters," pages 6-4 through 6-16. Chapter 7, "Optical Detectors and Fiber Optic Receivers," pages 7-1 through 7-14. Chapter 8, "Fiber Optic Links," pages 8-1 through 8-11.

4-1. Which of the following components is NOT one of the basic types of LEDs used for fiber optic communication systems?
1. Surface-emitting LED
2. Edge-emitting LED
3. Superluminescent diode
4. Avalanche photodiode

4-2. In low and moderate data rate applications, which of the following source types are typically used?
1. SLEDs only
2. ELEDs only
3. SLEDs and ELEDs
4. Lasers

4-3. Compared to SLEDs, ELEDs have all except which of the following properties?
1. Emit light in a narrower emission angle than SLEDs
2. Couple more power into small NA fibers than SLEDs
3. Emit power over a wider spectral range than SLEDs
4. Are more temperature sensitive than SLED

4-4. Which of the following definitions best describes the term laser mode?
1. The condition of the laser, either lasing or not lasing
2. The selected wavelengths that the laser emits
3. The maximum modulation frequency possible for the laser
4. The maximum angle of the emitted beam from the laser

4-5. What does the term lasing threshold mean?
1. The lowest drive current level at which the output of the laser results primarily from stimulated emission
2. The polished or cut surfaces at each end of the active stripe in the laser
3. The shortest wavelength that the laser emits
4. The front step of the laser chip

4-6. Transmitters containing what source type, if any, will typically require the most complex circuitry?
1. SLED
2. ELED
3. LD
4. None; all are roughly the same

4-7. Which of the following types of sources is typically the most temperature sensitive?
1. SLEDs
2. ELEDs
3. SLDs
4. LDs

4-8. Which of the following types of sources have very similar semi-conductor designs?
1. SLEDs, ELEDs, SLDs
2. SLEDs, ELEDs, lasers
3. SLEDs, SLDs, lasers
4. ELEDs, SLDs, lasers

4-9. What kind of circuitry do most lasers have that compensates for the sensitivity of the laser to its environment?
1. Linearization circuitry
2. Automatic overload protection circuitry
3. Power control circuitry
4. Low-pass filter circuitry

4-10. For lasers that are to be operated under widely changing thermal conditions,

what device is normally included in the laser package?
1. Automatic overload protection circuitry
2. Thermo electric cooler
3. Variable attenuator
4. Low-pass filter

4-11. For fiber optic transmitters, which of the following are typical output interfaces?
1. Optical fiber pigtails
2. Single fiber cable pigtails
3. Optical connectors
4. All of the above

4-12. Which of the following types of transmitters are typically the most expensive?
1. SLEDs
2. ELEDs
3. SLDs
4. LDs

4-13. Which of the following are possible transmitter package types used in Navy shipboard applications?
1. Hybrid microcircuit dual inline packages (DIPs) only
2. Circuit cards only
3. Stand-alone fiber optic converters only
4. Hybrid microcircuit dual inline packages, circuit cards, and standalone fiber optic converters

4-14. In shipboard applications with moderate data rates (50 to 200 Mbps), which of the following source types will typically be used?
1. 850-nm LEDs only
2. 1300-nm LEDs only
3. 850-nm and 1300-nm LEDs
4. Lasers

4-15. In shipboard applications with low data rates (0 to 50 Mbps), which of the following source types will typically be used?
1. 850-nm LEDs only
2. 1300-nm LEDs only
3. Either 850-nm LEDs or 1300 nm LEDs depending on design
4. Lasers

4-16. Which of the following fiber optic components is responsible for converting the weakened and distorted optical signal back to an electrical signal?
1. Fiber optic transmitter
2. Fiber optic amplifier
3. Fiber optic receiver
4. Fiber optic coupler

4-17. Which of the following is NOT a typical part of a fiber optic receiver?
1. Optical detector
2. Thermo electric cooler
3. Low-noise amplifier
4. Output signal conditioning circuity

4-18. The term receiver sensitivity has which of the following meanings?
1. The minimum amount of optical power required to achieve a specific receiver performance
2. The range of optical power levels over which the receiver operates within specified values
3. The ratio of the output photocurrent to the incident optical power
4. The wavelengths over which the receiver will properly operate

4-19. The term dynamic range has which of the following meanings?
1. The minimum amount of optical power required to achieve a specific receiver performance
2. The range of optical power levels over which the receiver operates within specified values
3. The ratio of the output photocurrent to the incident optical power
4. The wavelengths over which the receiver will properly operate

4-20. An optical detector has which of the following purposes?
1. To convert an optical signal into an electrical signal
2. To convert an electrical signal to an optical signal
3. To amplify the optical output signal
4. To generate an optical pulse proportional to the input current

4-21. Which of the following attributes is NOT a desirable attribute of an optical detector?
1. Be compatible in size to low-loss optical fibers
2. Contribute high amounts of noise to the system
3. Have a high sensitivity at the operating wavelength of the optical source
4. Maintain stable operation in changing environmental conditions

4-22. In fiber optic systems, what are the principal types of detectors used?
1. Integrating spheres
2. Photon counters
3. Photomultiplier tubes
4. PIN photodiodes and APDs

4-23. Which of the following factors does NOT affect the amount of current generated by a photodiode?
1. The responsivity of the photodiode at the wavelength of the incident light
2. The data rate of the incoming optical signal
3. The size of the photodiode active area relative to the fiber core size
4. The alignment of the fiber and the photodiode

4-24. Which of the following terms is defined as the current produced by an optical detector because of the optical energy incident on its active area?
1. Photocurrent
2. Active current
3. Incident current
4. Threshold current

4-25. The term detector responsivity has which of the following meanings?
1. The minimum amount of optical power required to achieve a specific receiver performance
2. The range of optical power levels over which the receiver operates within specified values
3. The ratio of the output photocurrent to the incident optical power
4. The wavelengths over which the detector will convert light to electric current

4-26. The responsivity of an optical detector is constant over wavelength; that is, an optical detector does not absorb some wavelengths better than others.
1. True
2. False

4-27. A PIN photodiode usually operates in what way?
1. Reverse-bias voltage applied
2. Forward-bias voltage applied
3. No bias voltage applied

4-28. What is the name of the current produced by a photodiode when no light is incident on the device?
1. Threshold current
2. Spill current
3. Photocurrent
4. Dark current

4-29. Reverse-biased photodetectors are highly linear devices with respect to output photocurrent and input optical power.
1. True
2. False

4-30. When compared to the reverse-bias voltage of a PIN photodiode, the reversebias of an APD is which of the following sizes?

1. Much less than the PIN's
2. About the same as the PIN's
3. A little greater than the PIN's
4. Much greater than the PIN's

4-31. The gain of an APD can be changed in what way?
1. By changing the data rate of the incoming optical signal
2. By changing the reverse-bias voltage
3. By changing the modulation format of the incoming signal
4. By changing the input power of the optical signal

4-32. In a fiber optic receiver, what is the dominant contributor of electrical noise?
1. Optical detector
2. Preamplifier
3. Postamplifier
4. Output circuitry

4-33. What action, if any, will maximize the sensitivity of a fiber optic receiver?
1. Minimizing the receiver noise
2. Maximizing the receiver bandwidth
3. Maximizing the receiver dynamic range
4. None; no action will maximize sensitivity

4-34. In a fiber optic system, which of the following is NOT a typical source of noise?
1. Noise from the light source
2. Noise from the interaction of light with the optical fiber
3. Noise coupled in from adjacent optical fibers in a multifiber cable
4. Noise from the receiver itself

4-35. Which of the following types of noise are introduced by the fiber optic receiver?
1. Thermal noise only
2. Shot noise only
3. Quantum noise only
4. Thermal noise, shot noise, and quantum noise

4-36. Which of the following are basic types of preamplifiers used in typical fiber optic receivers?
1. High-impedance and high- fidelity amplifiers
2. High-impedance and transimpedance amplifiers
3. High-fidelity and trans- impedance amplifiers
4. High-impedance, high-fidelity, and transimpedance amplifiers

4-37. Compared to a high-impedance amplifier, a transimpedance amplifier provides all but which of the following improvements?
1. Sensitivity
2. Dynamic range
3. Bandwidth

4-38. For which of the following applications would a transimpedance amplifier typically be used instead of a highimpedance amplifier?
1. Low-data-rate applications only
2. Moderate-data-rate applications only
3. Low- and moderate-data-rate applications
4. High-data-rate applications

4-39. For which of the following applications would an APD rarely be used?
1. Low- and moderate-data-rate applications
2. Low- and high-data-rate applications
3. Moderate- and high-data-rate applications

4-40. What type of fiber optic link consists of two simple point- to-point links transmitting in opposite directions?
1. Simplex link
2. Full duplex link
3. Composite link
4. Total link

4-41. What type of fiber optic link is the basic building block of all fiber optic systems?

1. Point-to-point
2. Point-to-central
3. Branch
4. Loop

4-42. What topology consists of a single transmission line that is shared by a number of equipments?
1. Linear bus topology
2. Ring topology
3. Star topology
4. Tree topology

4-43. What topology consists of a transmission line that branches or splits?
1. Linear bus topology
2. Ring topology
3. Star topology
4. Tree topology

4-44. What topology consists of equipments attached to one another in a closed loop?
1. Linear bus topology
2. Ring topology
3. Star topology
4. Tree topology

4-45. In what topology is each equipment connected to a common center hub?
1. Linear bus topology
2. Ring topology
3. Star topology
4. Tree topology

4-46. What are the two basic classifications of fiber optic links?
1. High power and low power
2. Return-to-zero and non-return- tozero line coded
3. Digital and analog
4. Amplitude modulated and frequency modulated

4-47. A digital signal can be defined as which of the following signals?
1. A continuous signal whose amplitude or some other property varies in direct proportion to some physical variable
2. A discontinuous signal that changes from one state to another in discrete steps
3. A signal generated by an electrical circuit
4. A signal generated by a laser

4-48. Which of the following items is NOT an example of a digital line code?
1. Frequency modulation
2. Non-return-to-zero
3. Return-to-zero
4. Manchester

4-49. What line code, if any, makes the most efficient use of system bandwidth?
1. Non-return-to-zero
2. Return-to-zero
3. Manchester
4. None; all have the same efficiency

4-50. When compared to analog transmission, digital systems can tolerate which of the following conditions without affecting system performance?
1. Large amounts of signal loss and dispersion
2. Source nonlinearities
3. Effects of temperature on system components
4. All of the above

4-51. An analog signal is defined as which of the following signals?
1. A continuous signal whose amplitude or some other property varies in direct proportion to some physical variable
2. A discontinuous signal that changes from one state to another in discrete steps
3. A signal generated by an electrical control circuit
4. A signal generated by an LED

4-52. The typical method of source modulation for most analog fiber optic systems is

what type of modulation?
1. Phase modulation
2. Wavelength modulation
3**. Intensity modulation**
4. Pulse position

4-53. Analog transmission would most likely be used in which of the following shipboard applications?
1. Video links
2. Local area networks
3. Computer interconnections
4. Long-haul communications

4-54. A fiber optic cable plant consists of which of the following parts?
1. The fiber optic cables associated with the combat system only
2. The fiber optic cables associated with noncombat systems only
3. The fiber optic interconnection equipment only
4. All of the fiber optic cables and the fiber optic interconnection equipment within the ship

4-55. When installing fiber optic cables aboard Navy ships, which of the following precautions should you take?
1. Never bend an optical cable in a bend smaller than the cable's minimum bend radius
2. Always clean fiber optic connectors before mating them
3. Never pull a fiber optic cable over or through sharp corners or cutting edges
4. All of the above