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ESE 2019

Preliminary Examination

Detailed Solutions of

Electronics & Telecom Engg.

(Set-A)

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Expected Cutof of ESE 2019 Prelims					Actual Cutof of ESE 2018 Prelims				
Branch	Gen	OBC	SC	ST	Branch	Gen	OBC	SC	ST
CE	180-190	170-180	150-160	150-160	CE	207	194	169	188
ME	190-200	180-190	160-170	160-170	ME	256	255	220	223
EE	230-240	220-230	190-200	190-200	EE	230	218	190	191
E&T	210-220	200-210	170-180	170-180	E&T	213	206	173	155

E&T Paper Analysis
ESE 2019 Prelims Exam

Sl.	Subjects	Number of Questions
1	Material Science	13
2	EDC	4
3	Analog Electronics	11
4	Network Theory	15
5	Control Systems	12
6	Electromagnetic Theory	14
7	Measurement	11
8	Communication Systems	11
9	Advance Communications	14
10	Advance Electronics	5
11	Baisc Electrical Engineering	8
12	Computer Organization	10
13	Signals and Systems	4
14	Digital Electronics	10
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UPSC ESE/IES Prelims 2019

Electronics & Telecom Engg. analysis and expected cutoff by MADE EASY faculty

https://youtu.be/RlnTT4Yxh_A

1. Consider a common -emitter current gain of $\beta = 150$ and a base current of $i_B = 15\ \mu A$. If the transistor is biased in the forward active mode, the collector and emitter current will be
(a) 2.25 mA and 2.27 mA
(b) 3.25 mA and 2.27 mA
(c) 2.25 mA and 1.37 mA
(d) 3.25 mA and 1.37 mA

Ans. (a)

$$\beta = 150$$
$$I_B = 15\ \mu A$$
$$I_C = ?$$
$$I_E = ?$$
$$I_C = \beta I_B = 150[15\ \mu A] = 2250\ \mu A = 2.25\ mA$$
$$I_E = (1+\beta)I_B = 151[15\ \mu A] = 2.27\ mA$$

End of Solution

2. The input to a bridge rectifier is 230 V (rms), 50 Hz. The DC output voltage and the ripple factor with R_L of 100 Ω and capacitor filter of 1000 μF are
(a) 207 V and 0.028
(b) 325 V and 0.028
(c) 207 V and 0.020
(d) 325 V and 0.020

Ans. (b)

$$\frac{V_m}{\sqrt{2}} = 230$$
$$V_m = 230\sqrt{2} = 325\ V$$
$$V_{DC} \approx V_m = 325\ V$$
$$r = \frac{1}{4\sqrt{3} f_0 C R_L} \approx 0.028$$

Alternate Solution

$$R.F = \frac{1}{4\sqrt{3} f R_L C} = \frac{1}{4\sqrt{3}\times 50\times 100\times 1000\times 10^{-6}} = 0.028$$
$$V_{DC} = \frac{V_m \times 4 f R_L C}{1+4R_L C} = \frac{V_{RMS}\sqrt{2}\times 4 f R_L C}{1+4 f R_L C}$$
$$= \frac{230\times\sqrt{2}\times 4\times 50\times 100\times 1000\times 10^{-6}}{1+4\times 50\times 100\times 1000\times 10^{-6}}$$
$$= 309.78 \approx 310\ V$$

OR : As time constant $RC = 100 \times 1000 \times 10^{-6} = 0.1$ sec > 5 = 0.025

$$V_{DC} \geq V_m - \frac{V_r}{2} \approx V_m = V_{RMS}\sqrt{2} = 230\sqrt{2} = 325\ V$$

End of Solution

3. The effect of reduction in effective base width due to increase in reverse voltage of BJT is
(a) Hall effect
(b) Early effect
(c) Zener effect
(d) Miller effect

Ans. (b)

The process of varying the effective base width of a transistor by varying collector junction voltage is called base-width modulation or early effect.

End of Solution

4. What is the drain current for a *D*-MOSFET having the characteristic values I_{DSS} of 10 mA, $V_{GS\,(off)}$ of –4 V and V_{GS} of +2 V?
(a) 22.5 mA
(b) 17.5 mA
(c) 12.5 mA
(d) 2.5 mA

Ans. (a)

Given D-MOSFET

$$I_{DSS} = 10 \text{ mA}$$
$$V_{GS(off)} = -4 \text{ V}$$
$$V_{GS} = +2 \text{ V}$$

In a DMOSFET

$$I_D = I_{DSS}\left[1-\frac{V_{GS}}{V_{GS(off)}}\right]^2 = 10\left[1-\frac{2}{-4}\right]^2 \text{ mA}$$
$$= 10[1.5]^2 \text{ mA} = 22.5 \text{ mA}$$

End of Solution

5. In the Wien bridge oscillator, the 0° phase-shift is met by using lead-lag network and by using
(a) inverting op-amp
(b) non-inverting op-amp
(c) feedback op-amp
(d) high-gain op-amp

Ans. (b)

End of Solution

6. What is the frequency of oscillation for an *RC* phase-shift oscillator with *R* of 10 kΩ and C of 0.001 μF in each of its three RC sections?
(a) 5.0 kHz
(b) 5.5 kHz
(c) 6.0 kHz
(d) 6.5 kHz

Ans. (d)

$$f = \frac{1}{2\pi RC\sqrt{6}} = \frac{1}{2\pi\times 10^4\times 10^{-9}\times\sqrt{6}} = 6.5 \text{ kHz}$$

End of Solution

7. When there is no clock signal applied to CMOS logic circuits, they are referred to as
(a) complex CMOS logic circuits
(b) static CMOS logic circuits
(c) NMOS transmission gates
(d) random PMOS logic circuits

Ans. (b)

End of Solution

8. One form of NMOS circuit logic that minimizes power dissipation, and maximizes device density is called
(a) pass transistor logic
(b) sequential logic circuit
(c) NMOS SRAM cell
(d) NMOS transmission gate

Ans. (a)

End of Solution

9. The ideal op-amp has
(a) infinite voltage gain and zero input impedance
(b) infinite voltage gain and infinite bandwidth
(c) zero voltage gain and infinite CMRR
(d) zero output impedance and zero CMRR

Ans. (b)

End of Solution

10. A d.c. voltage supply provides 60 V when the output is unloaded. When connected to a load, the output drops to 56 V. The value of the voltage regulation is
(a) 3.7%
(b) 5.7%
(c) 7.1%
(d) 9.1%

Ans. (c)

Unloaded, $V_{NL} = 60$ V

Loaded, $V_{FL} = 56$ V

$$\% \text{ Regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 = \frac{60 - 56}{56} \times 100 = 7.1\%$$

End of Solution

11. In optical communication, the maximum angle in which external light rays may strike the air/glass interface and still propagate down the fiber is called as
(a) critical angle
(b) numerical aperture
(c) angle of refraction
(d) acceptance angle

Ans. (d)

End of Solution

12. The light intensity 3 m from a lamp that emits 25 W of light energy will be
(a) 243 mW/m^2
(b) 232 mW/m^2
(c) 221 mW/m^2
(d) 210 mW/m^2

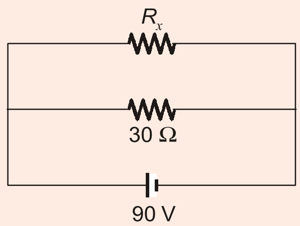
Ans. (c)

$$P_t = 25 \text{ W}$$
$$r = 3 \text{ m}$$
$$\text{Light intensity} = \frac{P_t}{4\pi r^2} = \frac{25}{4\pi(3)^2}\left(\frac{\text{W}}{\text{m}^2}\right) = 221 \text{mW/m}^2$$

End of Solution

13. Two resistances, one of 30 Ω and another of unknown value, are connected in parallel. The total power dissipated in the circuit is 450 W when the applied voltage is 90 V. The unknown resistance is
(a) 45 Ω
(b) 35 Ω
(c) 30 Ω
(d) 20 Ω

Ans. (a)



The total power dissipated in the circuit is equal to the total power delivered by the source.

$$90 \times I_{\text{total}} = 450$$
$$I_{\text{total}} = \frac{450}{90} = 5 \text{ A}$$

Current through 30 Ω resistance is

$$I_{30} = \frac{90}{30} = 3 \text{ A}$$

Current through the R_x is

$$I_x = 5 - 3 = 2 \text{ A}$$
$$R_x = \frac{V}{I_x} = \frac{90}{2} = 45 \, \Omega$$

End of Solution

14. An electric kettle contains 1.5 kg of water at 15°C. It takes 15 minutes to raise the temperature of water to 95°C. If the heat loss due to radiations and heating the kettle is 15 kcalories and the supply voltage is 100 V, the current taken will be
(a) 8.0 A
(b) 7.1 A
(c) 6.3 A
(d) 5.4 A

Ans. (c)

$$H = MC\,\Delta t$$
$$C = 4.2 \text{ J/g-k}$$
$$H = 1.5 \times 10^3 \times 4.2 \times (95 - 15)$$
$$= 504000 \text{ J} = 504 \text{ kJ}$$

Heat loss due to radiation

$$H_{loss} = 15 \times 10^3 \times 4.2$$
$$H_{loss} = 63 \text{ kJ}$$
$$\text{Total heat} = 504 + 63 = 567 \text{ kJ}$$
$$H = V \times I \times t$$
$$567 \times 10^3 = 100 \times I \times 15 \times 60$$
$$I = 6.3 \text{ A}$$

End of Solution

15. A heater element is made of nichrome wire having resistivity equal to 100×10^{-8} Ωm and diameter of 0.4 mm. The length of the wire required to get a resistance of 40 Ω will be nearly
(a) 9 m
(b) 7 m
(c) 5 m
(d) 3 m

Ans. (c)

$$R = \frac{\rho l}{A} = \frac{\rho l}{\pi d^2/4} \Rightarrow \frac{\rho l \cdot 4}{\pi d^2}$$
$$l = \frac{\pi d^2 \cdot R}{\rho\, 4} = \frac{\pi\,(0.4 \times 10^{-3})^2 \times 40}{100 \times 10^{-8} \times 4}$$
$$l = 5 \text{ m}$$

End of Solution

16. A car is travelling at 72 km/h. If the length of an axle is 2 m and the vertical component of the earth's magnetic field is 40 μWb/m^2, the e.m.f. generated in the axle of the car is
(a) 2.6 mV
(b) 2.2 mV
(c) 1.6 mV
(d) 1.2 mV

Ans. (c)

$$B = 40 \ \mu\text{Wb/m}^2,\ l = 2\text{m}$$
$$V = 72 \text{ km/hr} = 72 \times \frac{1000 \text{ m}}{3600 \text{ sec}}$$
$$E_{generated} = Blv = \left(40 \times 10^{-6} \times 2 \times 72 \times \frac{1000}{3600}\right) \text{V} = 1.6 \text{ mV}$$

End of Solution

17. In a telephone receiver, the size of each of the two poles is 1.2 cm × 0.2 cm and the flux between each pole and the diaphragm is 3×10^{-6} Wb. The force attracted to the poles will be nearly
(a) 0.15 N
(b) 0.20 N
(c) 0.30 N
(d) 0.40 N

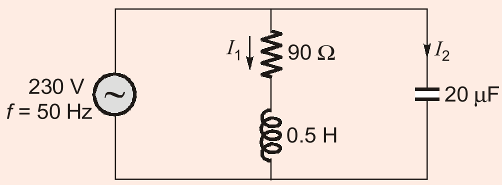
Ans. (a)

$$\text{Cross sectional area} = A = 1.2 \times 0.2 \times 10^{-4}\ \text{m}^2$$
$$= 0.24 \times 10^{-4}\ \text{m}^2$$
$$\phi = 3 \times 10^{-6}\ \text{(Weber)}$$
$$B = \frac{\phi}{A} = \frac{3\times10^{-6}}{24\times10^{-6}} = \frac{1}{8}\ \text{Wb/m}^2$$
$$\text{Force} = \frac{B^2AN}{2\mu_o} = \frac{1(24\times10^{-6})}{(8)^2\,(2\times4\pi\times10^{-7})}(1)$$
$$= \frac{6\times10}{8\times8\times2\times\pi} = 0.149\ \text{N} \simeq 0.15\ \text{N}$$

End of Solution

18. An inductor of 0.5H inductance and 90 Ω resistance is connected in parallel with a 20 μF capacitor. A voltage of 230 V at 50 Hz is maintained across the circuit. The total power taken from the source is nearly
(a) 588 W
(b) 145 W
(c) 135 W
(d) 125 W

Ans. (b)



$$X_L = 2\pi fL = 2\pi \times 50 \times 0.5 = 157\ \Omega$$
$$|Z_1| = \sqrt{90^2 + 157^2} \approx 180\ \Omega$$
$$I_1 = \frac{230}{180} = 1.27\ \text{A}$$

The total power taken from the source is equal to power absorbed by the resistance.

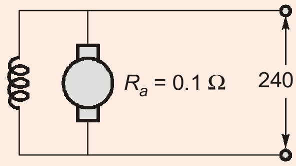
$$P = I_1^2 \times R$$
$$= (1.27)^2 \times 90 \approx 145\ \text{W}$$

End of Solution

19. A 240 V shunt motor with the armature resistance of 0.1 Ω runs at 850 r.p.m. for an armature current of 70 A. If its speed is to be reduced to 650 r.p.m. the resistance to be placed in series for an armature current of 50 A is nearly

(a) 0.82 Ω
(b) 1.14 Ω
(c) 1.24 Ω
(d) 1.34 Ω

Ans. (b)



when, $N = 850$ rpm $\Rightarrow I_a = 70$ A
If, $N = 650$ rpm $\Rightarrow I_a = 50$ A then $R_{ext} = ?$
As, $E_b \propto \phi N$, ϕ = constant
$E_b \propto N$
So, $(240 - 70 \times 0.1) \propto 850$ ...(i)
$[240 - 50\,(0.1 + R_{ext})] \propto 650$ ...(ii)
Solving equations (i) and (ii)

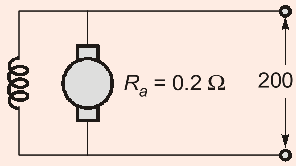
$$R_{ext} = 1.14\ \Omega$$

End of Solution

20. A 200 V d.c. shunt motor with armature resistance of 0.2 Ω and carrying a current of 50 A is running at 960 r.p.m. If the flux is reduced by 10% at constant torque and with negligible iron and friction losses, the speed will be nearly

(a) 1280 rpm
(b) 1170 rpm
(c) 1100 rpm
(d) 1060 rpm

Ans. (d)



when, $I_1 = 50$ A $\Rightarrow \phi_1$ = Flux per pole, $N = 960$ rpm and flux is reduced by 10% at constant.
Torque, $N = ?$

As we know, $N \propto \dfrac{E_b}{\phi}$ ...(i)

and, $T \propto \phi I_a$ ...(ii)
From equation (ii),

$$\phi_1 I_{a_1} = \phi_2 I_{a_2}$$

$$\Rightarrow \quad \phi_1 \times 50 = (0.9\,\phi_1) \times I_{a_2}$$

$$\Rightarrow \qquad I_{a_2} = \frac{50}{0.9} = \frac{500}{9} \qquad \text{...(iii)}$$

From equation (i), $\dfrac{N_1}{N_2} = \dfrac{E_{b_1}}{E_{b_2}} \times \dfrac{\phi_2}{\phi_1}$

$$\Rightarrow \qquad \frac{960}{N_2} = \frac{(200 - 0.2 \times 50)}{\left(200 - 0.2 \times \frac{500}{9}\right)} \times \frac{0.9\phi_1}{\phi_1}$$

$$\Rightarrow \qquad N_2 = 1060 \text{ rpm}$$

End of Solution

21. Which of the following statements are correct for d.c. shunt motor?
1. Speed of a shunt motor is sufficiently constant.
2. For the same current input, its starting torque is not as high as that of a series motor.
3. The motor can be directly coupled to a load such as a fan whose torque increases with speed.

Select the correct answer using the code given below.
(a) 2 and 3 only (b) 1 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

Ans. (c)
DC shunt motors should never be started with heavy loads such as fan.

End of Solution

22. Consider the following materials:
1. Lead peroxide
2. Sponge lead
3. Dilute sulphuric acid

Which of the above, are active materials of a lead-acid battery?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

23. Which of the following statements are correct for a fully charged lead-acid cell?
1. Gassing occurs at both electrodes.
2. The terminal voltage is 2.6 V.
3. The specific gravity of the electrolyte is 1.21.

Select the correct answer using the code given below.
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

24. Which of the following statements are correct for synchronous motors?

1. Synchronous motors are well- suited for direct connection to reciprocating compressors.
2. Over-excited synchronous motors are most commonly used for power factor improvement.
3. Synchronous motors are generally used for current regulation of long transmission lines.

Select the correct answer using the code given below.

(a) 1, 2 and 3 (b) 1 and 3 only
(c) 1 and 2 only (d) 2 and 3 only

Ans. (a)

Over excited synchronous motors takes leading current and supply lagging reactive VAR to systems.

End of Solution

25. Which crystal system requires six lattice parameters to fully specify its unit cell?

(a) Triclinic (b) Monoclinic
(c) Cubic (d) Hexagonal

Ans. (a)

For triclinic crystal system

$$\alpha \neq \beta \neq \gamma \neq 90^\circ$$
$$a \neq b \neq c$$

Therefore, all 6 lattice parameters (a, b, c, α, β, γ) are required to fully specify unit cell.

End of Solution

26. The minimum cation-to-anion radius ratio for the coordination number 3 is

(a) 0.175 (b) 0.155
(c) 0.135 (d) 0.115

Ans. (b)

Radius ratio range for CN = 3 is 0.155 to 0.225

Minimum radius ratio = 0.155

End of Solution

27. Which of the following- materials are categories of ceramic materials?

1. Oxides-Alumina, Zirconia
2. Non-oxides-Carbides, Borides, Nitrides and Silicides
3. Composites-Particulate reinforced combinations of oxides and non-oxides

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

28. Consider the following data for copper:
Energy for vacancy formation is 0.9 eV/atom
Atomic weight is 63.5 g/mol
Density is 8.4 g/cm^3 at 1000°C
The equilibrium number of vacancies per cubic meter at 1000 °C will be
(a) 3.2×10^{20} (b) 3.2×10^{25}
(c) 2.2×10^{20} (d) 2.2×10^{25}

Ans. (d)

Density of atoms (N) = $\dfrac{N_A \rho}{M_{at}} = \dfrac{6.023 \times 10^{23} \times 8.4}{63.5} \simeq 8 \times 10^{22}\ \text{cm}^{-3}$

The density of vacansies at 1000°C can be given by,

$$N_v = Ne^{-Q_V/kT}$$

Q_V = Activation energy = 0.9 eV

So, $$N_v = 8 \times 10^{22}\, e^{-\frac{(0.9\,\text{eV})}{(8.62\times 10^{-5}\,\text{eV/K})\,(1273\,\text{K})}}\ \text{cm}^{-3}$$

$= 2.2 \times 10^{19}$ vacancies/cm^3
$= 2.2 \times 10^{25}$ vacancies/m^3

End of Solution

29. Which of the following are electrical insulating materials?
1. Lucite 2. Mica 3. Bakelite
Select the correct answer using the code given below.
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

30. The magnitude of the energy gap for an insulator is
(a) less than 1 eV (b) between 2 eV to 3 eV
(c) more than 3 eV (d) between 1 eV to 2 eV

Ans. (c)
Insulators are bad conductors of current and they have larger band-gap.

End of Solution

31. In a 440 V, 50 Hz transformer, the total iron loss is 3700 W. When the applied voltage is 220 V at 25 Hz, the total iron loss is 750 W. The eddy current loss at the normal voltage and frequency will be
(a) 1000 W (b) 1200 W
(c) 1400 W (d) 1850 W

Ans. (*)

$$\frac{V_1}{f_1} = \frac{440}{50} = 8.8 \quad ; \quad \frac{V_2}{f_2} = \frac{220}{25} = 8.8$$

If $\frac{V}{f}$ ratio is constant

$$W_I = Af + Bf^2$$

$$3700 = A50 + B50^2 \quad \text{...(i)}$$

$$750 = A25 + B25^2 \quad \text{...(ii)}$$

By solving equation (i) and (ii)

$$B = \frac{2200}{1250}$$

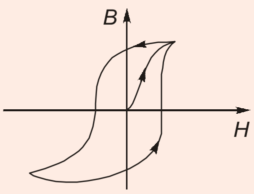
$$W_e = Bf^2 = \frac{2200}{1250} \times 50 \times 50 = 4400 \text{ W}$$

End of Solution

32. A transformer core is wound with a coil carrying an alternating current at a frequency of 50 Hz. The hysteresis loop has an area of 60000 units, when the axes are drawn in units of 10^{-4} Wb m^{-2} and 10^2 Am^{-1}. If the magnetization is uniform throughout the core volume of 0.01m^3, then the hysteresis loss will be

(a) 200 W
(b) 230 W
(c) 270 W
(d) 300 W

Ans. (d)



$$\text{Area} = 60.000 \text{ units}$$

$$f = 50 \text{ Hz}$$

y-axis, $\quad$ 1 unit = 10^{-4} Wbm^{-2}

x-axis, $\quad$ 1 unit = 10^2 Am^{-1}

Volume of material = 0.01 m^3

$$P_H = (60.000 \times 50 \times 10^{-4} \times 10^2 \times 0.01) \text{ W} = 300 \text{ W}$$

End of Solution

33. The process of evaporating a metal in an inert. atmosphere and allowing it to condense on the surface of a cold finger, which is kept at liquid nitrogen temperature of 77 K, is known as

(a) DC arc method
(b) gas-phase condensation
(c) sonohydrolysis
(d) flame pyrolysis

Ans. (b)

End of Solution

34. Which one of the following materials is having the highest electrical conductivity at room temperature?
(a) Silver (b) Copper
(c) Gold (d) Platinum

Ans. (a)

End of Solution

35. Consider the following processes
1. Sol-gel process
2. Electrodeposition
3. Plasma-enhanced vapour decomposition
4. Gas-phase condensation
5. Sputtering technique

The above processes are related to
(a) analysis of nano-powders (b) sintering of nano-powders
(c) synthesis of nano-powders (d) microwave sintering of nano-powders

Ans. (c)

End of Solution

36. In the superconducting state, the flux lines of a magnetic field are ejected out of the superconductor as per
(a) Curie effect (b) Faraday's effect
(c) Maxwell's effect (d) Meissner effect

Ans. (d)
Meissner's effect: Repulsion of magnetic flux lines from the interior of superconducting material, when material is in superconducting state, is called Meissner's effect.

End of Solution

37. A null type of instrument as compared to a deflection type of instrument
(a) has a higher accuracy (b) is less sensitive
(c) is more rugged (d) is faster in response

Ans. (a)

End of Solution

38. A Wheatstone bridge requires a change of 7 Ω in the unknown resistance arm of the bridge to produce a change in deflection of 3 mm of the galvanometer. The sensitivity and the deflection factor will be nearly
(a) 0.23 mm/Ω and 2.3 Ω/mm (b) 0.43 mm/Ω and 2.3 Ω/mm
(c) 0.23 mm/Ω and 1.3 Ω/mm (d) 0.43 mm/Ω and 1.3 Ω/mm

Ans. (b)

$$S = \frac{\Delta\theta}{\Delta R} = \frac{3\text{ mm}}{7\ \Omega} = 0.428 \approx 0.43\text{ mm}/\Omega$$

$$\text{D.F} = \frac{1}{S} = \frac{1}{0.43} = 2.33\ \Omega/\text{mm}$$

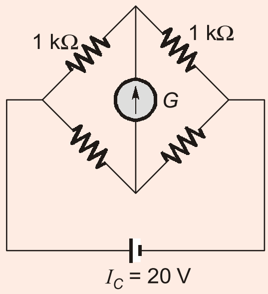
End of Solution

39. The galvanometer used in a Wheatstone bridge as a detector can detect a current as low as 0.1 nA and its resistance is negligible compared to internal resistance of the bridge. Each arm of the bridge has a resistance of 1 kΩ. The input voltage applied to the bridge is 20 V. The smallest change in the resistance that can be detected is

(a) 10 μΩ
(b) 20 μΩ
(c) 30 μΩ
(d) 40 μΩ

Ans. (b)

$$I_g = 0.1 \times 10^{-9}\text{ A} = I_g$$
$$R_{Th} = 1\text{k} \,||\, 1\text{k} = 1\text{k} \,||\, 1\text{k}$$
$$R_{Th} = 1\text{k}$$
$$i_g = \frac{V_{Th}}{R_{Th}} \Rightarrow V_{Th} = i_g \times R_{Th}$$
$$V_{Th} = 0.1 \times 10^{-9} \times 10^3 = 10^{-7}\text{ V}$$
$$V_{Th} = \frac{E}{4} \times \frac{\Delta R}{R}$$
$$\Rightarrow \quad 10^{-7} = \frac{20}{4} \times \frac{\Delta R}{10^3}$$
$$\Delta R = \frac{10^{-7} \times 10^3}{5}$$
$$\Delta R = 0.2 \times 10^{-4} = 20 \times 10^{-6}\ \Omega$$
$$\Delta R = 20\ \mu\Omega$$



End of Solution

40. The inductance of a 25 A electrodynamic ammeter changes uniformly at the rate of 0.0035 μH/degree. The spring constant is 10^{-6} N m/degree. The angle of deflection at full scale will be

(a) 135°
(b) 125°
(c) 115°
(d) 105°

Ans. (b)

$$\theta = \frac{I^2}{k_c} \times \frac{dm}{d\theta}$$

$$= \frac{(25)^2}{10^{-6}\text{N-m/degree}} \times 0.0035 \times 10^{-6} \text{ H/degree} = 2.18 \text{ rad}$$

$$\theta = 2.18 \times \frac{180°}{\pi} = 125°$$

End of Solution

41. A resistance is determined by voltmeter- ammeter method. The voltmeter reads 100 V with a probable error of ±12 V and the ammeter reads 10 A with a probable error of ± 2 A. The probable error in the computed value of the resistance will be nearly

(a) 0.6 Ω
(b) 1.3 Ω
(c) 2.3 Ω
(d) 3.6 Ω

Ans. (d)

$$R = \frac{V}{A} = \frac{100\text{ V} \pm 12}{10\text{ A} \pm 2} = \frac{100 \pm 12\%}{10 \pm 20\%}$$

$$= 10 \pm 32\% = 10 \pm 3.2\ \Omega$$

End of Solution

42. A temperature-sensing device can be modeled as a first-order system with a time constant of 6 s. It is suddenly subjected to a step input of 25°C-150°C. The indicated temperature in 10 s after the process has started will be

(a) 118.2 °C
(b) 126.4 °C
(c) 134.6 °C
(d) 142.8 °C

Ans. (b)

$\tau = 6$ sec, $t = 10$ sec

$$\theta(t) = \theta_f(1 - e^{-t/\tau}) + \theta_i \times e^{-t/\tau}$$

$$= 150(1 - e^{-10/6}) + 25 \times e^{-10/6}$$

$$= 121.66 + 4.721 = 126.38°\text{C}$$

End of Solution

43. In a parallel circuit having two branches, the current in one branch is I_1 = 100 ± 2 A and in the other is I_2 = 200 ± 5 A. Considering errors in both I_1 and I_2 as limiting errors, the total current will be

(a) 300 ± 5 A
(b) 300 ± 6 A
(c) 300 ± 7 A
(d) 300 ± 8 A

Ans. (c)

$$I = I_1 + I_2 = (100 \pm 2) + (200 \pm 5) = 300 \pm 7\text{ A}$$

End of Solution

44. A 0-150 V voltmeter has a guaranteed accuracy of 1% of full-scale reading. The voltage measured by this instrument is 75 V. The limiting error will be

(a) 5% (b) 4%

(c) 3% (d) 2%

Ans. (d)

$$\text{Limiting error} = \frac{150}{75} = 2\%$$

End of Solution

45. A quartz piezoelectric crystal having a thickness of 2 mm and voltage sensitivity of 0.055 V m/N is subjected to a pressure of 1.5 MN/m^2. The voltage output will be

(a) 165 V (b) 174 V

(c) 183 V (d) 192 V

Ans. (a)

$$V_0 = gpt$$
$$= 0.055 \text{ V-m/N} \times 1.5 \times 10^6 \text{ N/m}^2 \times 2 \times 10^{-3} \text{ m}$$
$$= 165 \text{ V}$$

End of Solution

46. A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of 100 MN/m^2. The modulus, of elasticity of steel is 200 GN/m^2. The change in the value of gauge resistance due to the applied stress will be

(a) 0.05% (b) 0.10%

(c) 0.30% (d) 0.60%

Ans. (b)

$$G_f = 2$$
$$\text{Stress} = 100 \times 10^6 \text{ N/m}^2$$
$$Y = 200 \times 10^9 \text{ N/m}^2$$

$$\text{Strain} = \varepsilon = \frac{\text{Stress}}{Y} = \frac{100 \times 10^6}{200 \times 10^9} = 0.5 \times 10^{-3}$$

$$\Delta R = G_f \varepsilon \cdot R$$

$$\Rightarrow \quad \frac{\Delta R}{R} = 2 \times 0.5 \times 10^{-3} \times 100 = 0.1\%$$

End of Solution

47. The applications of photomultipliers are seen in

(a) night vision equipment, medical equipment

(b) mechanical counters, timers

(c) translational, optical instruments

(d) ultrasonic transducer, infrared imaging

Ans. (a)

Photo-multipliers have very high sensitivity and they can be used in night vision equipment medical equilibrium for precise capture of image or object.

End of Solution

48. A capacitance of 250 pF produces resonance with a coil at a frequency of $\left(\frac{2}{\pi}\right)\times 10^6$ Hz, while at the second harmonic of this frequency, resonance is produced by a capacitance of 50 pF. The self-capacitance of the coil will be nearly

(a) 16.7 pF
(b) 20.5 pF
(c) 24.3 pF
(d) 28.1 pF

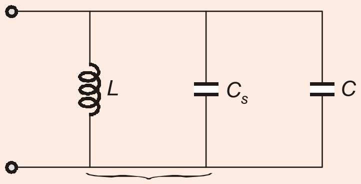
Ans. (a)

For $n = 2 \Rightarrow$ double frequency

$$C_d = \frac{C_1 - n^2C_2}{n^2 - 1} = \frac{C_1 - 4C_2}{3}$$

$$= \frac{250 - 4\times 50}{3} = \frac{50}{3} = 16.67 \text{ pF}$$

Alternate Solution:



Coil with self capacitance

$$f = \frac{1}{2\pi\sqrt{L(C_s + C)}}$$

$$\frac{2}{\pi}\times 10^6 = \frac{1}{2\pi\sqrt{L(C_s + 250\times 10^{-12})}}$$

$$(4 \times 10^6)^2 = \frac{1}{L(C_s + 250\times 10^{-12})} \quad \text{...(i)}$$

For second harmonic frequency,

$$2\times\frac{2}{\pi}\times 10^6 = \frac{1}{2\pi\sqrt{L(C_s + 50\times 10^{-12})}}$$

$$4(4 \times 10^6)^2 = \frac{1}{L(C_s + 50\times 10^{-12})} \quad \text{...(ii)}$$

From equation (i) and (ii), we get,

$$C_s = 16.67 \text{ pF}$$

End of Solution

49. Consider the following data for twigs and links :

N = Number of nodes
L = Total number of links
B = Total number of branches

The total number of links associated with a tree is

(a) $B - N + 1$
(b) $B - N - 1$
(c) $B + N + 1$
(d) $2B - N + 1$

Ans. (a)

$$I = B - N + 1$$

End of Solution

50. In *ABCD* parameters, *A* and *C* are called
(a) reverse current ratio and transfer admittance
(b) reverse voltage ratio and transfer impedance
(c) reverse current ratio and transfer impedance
(d) reverse voltage ratio and transfer admittance

Ans. (d)

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

$$A = \left.\frac{V_1}{V_2}\right|_{I_2 = 0}$$

'*A*' is reverse voltage ratio

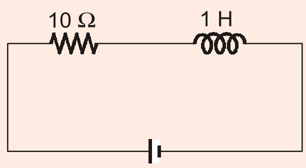
$$C = \left.\frac{I_1}{V_2}\right|_{I_2 = 0}$$

'*C*' is transfer admittance.

End of Solution

51. A coil having resistance of 10 Ω and inductance of 1 H is switched on to a direct voltage of 100 V. The steady-state value of the current will be
(a) 10 A
(b) 15 A
(c) 20 A
(d) 25 A

Ans. (a)



In steady state inductor acts as a short circuit for DC supply.

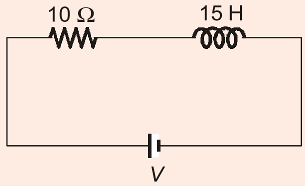
$$I = \frac{100}{10} = 10 \text{ A}$$

End of Solution

52. A coil has R = 10 Ω and L = 15 H. The voltage at the instant when the current is 10 A and increasing at the rate of 5 A/s will be
(a) 125 V
(b) 150 V
(c) 175 V
(d) 200 V

Ans. (c)

Write KVL equation,



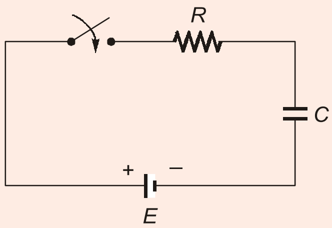
$$V = 10i(t) + 15\frac{d}{dt}i(t)$$

$$V = 10 \times 10 + 15 \times 5$$

$$V = 175 \text{ V}$$

End of Solution

53. Consider the following RC circuit. The capacitor has an initial charge q_0 such that it opposes the flow of charging current:



The response of the circuit $i(t)$ will be

(a) $\left(\frac{E}{R} - \frac{q_0}{RC}\right)e^{-t/RC}$

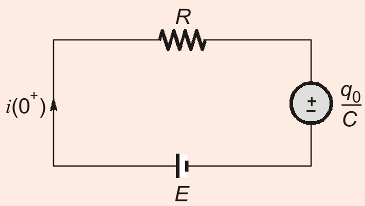
(b) $-\frac{q_0}{RC}e^{-t/RC}$

(c) $\frac{E}{R}e^{-t/RC}$

(d) $\left(\frac{E}{R} + \frac{q_0}{RC}\right)e^{-t/RC}$

Ans. (a)

The initial charge on the capacitor is q_0.



$\therefore$ Initial voltage $(V) = \frac{q_0}{C}$

Initial current i at $t = 0^+$ is

$$i(0^+) = \frac{E - \frac{q_0}{C}}{R}$$

In steady state capacitor acts as a open circuit.

For DC supply,

$\therefore$ $i(\infty) = 0$

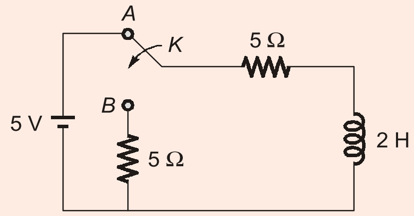
$$i(t) = i(\infty) + \left(i(0^+) - i(\infty)\right)e^{-t/\tau}$$

$$i(t) = 0 + \left(\frac{E - \frac{q_0}{C}}{R} - 0\right)e^{-t/RC}$$

$$i(t) = \left(\frac{E}{R} - \frac{q_0}{RC}\right)e^{-t/RC}$$

End of Solution

54. In the following circuit, switch K is thrown from position A to position B at time $t = 0$, the current having previously reached its steady state:



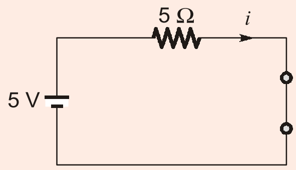
The current $i(t)$ after switching will be

(a) $5e^{-5t}$
(b) $4e^{-5t}$
(c) $3e^{-5t}$
(d) e^{-5t}

Ans. (d)

The switch was at position 'A', the inductor reached the steady-state and it acts as a short circuit.

At $t = 0^-$



$$i(0^-) = \frac{5}{5} = 1\,\text{A} = i(0^+)$$

The switch moving from position 'A' to position 'B'. The current through inductor does not change i.e. $i(0^+) = 1$ A.

After switching, the circuit is source free.

So the current through inductor is 0 A.

$$i(\infty) = 0 \text{ A}$$

$$\text{Time constant} = \frac{L}{R} = \frac{2}{10} = 0.2$$

$$i(t) = i(\infty) + \left(i(0^+) - i(\infty)\right)e^{-t/\tau} = e^{-t/0.2}$$

$$i(t) = e^{-5t}$$

End of Solution

55. What is the condition for reciprocity and symmetry in Y-parameter representation?

(a) $Y_{21} = Y_{11}$ and $Y_{22} = Y_{21}$
(b) $Y_{21} = Y_{12}$ and $Y_{11} = Y_{22}$
(c) $Y_{21} = Y_{22}$ and $Y_{11} = Y_{22}$
(d) $Y_{11} = Y_{22}$ and $Y_{21} = Y_{22}$

Ans. (b)

$$I_1 = Y_{11}V_1 + Y_{12}V_2$$
$$I_2 = Y_{21}V_1 + Y_{22}V_2$$

For Reciprocity, $Y_{21} = Y_{12}$

For Symmetry, $Y_{11} = Y_{22}$

End of Solution

56. In hybrid parameters, h_{11} and h_{21} are called as
(a) input impedance and forward current gain
(b) reverse voltage gain and output admittance
(c) input impedance and reverse voltage gain
(d) output impedance and forward current gain

Ans. (a)

$$V_1 = h_{11}I_1 + h_{12}V_2$$

If $V_2 = 0$, $$h_{11} = \frac{V_1}{I_1} = h_i = \text{Input impedance}$$

$$I_2 = h_{21}I_1 + h_{22}V_2$$

If $V_2 = 0$, $$h_{21} = \frac{I_2}{I_1} = h_f = \text{forward current gain}$$

End of Solution

57. Consider the following equations:

$$V_1 = 6V_2 - 4I_2$$
$$I_1 = 7V_2 - 2I_2$$

A, B, C and D parameters are
(a) 6, –4 Ω, 7 mho and –2
(b) 6, 4 Ω, 7 mho and 2
(c) –6, 4 Ω, –7 mho and 2
(d) 6, 4 Ω, –7 mho and –2

Ans. (b)

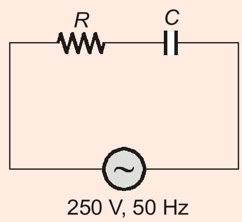
$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

Compare the equations,
$A = 6$; $B = 4$; $C = 7$; $D = 2$

End of Solution

58. A supply of 250 V, 50 Hz is applied to a series RC circuit. If the power absorbed by the resistor be 400 W at 160 V, the value of the capacitor C will be nearly
(a) 30.5 μF
(b) 41.5 μF
(c) 64.0 μF
(d) 76.8 μF

Ans. (b)



The power absorbed by the resistor is

$$P = \frac{V_R^2}{R}$$

$$400 = \frac{160^2}{R}; \qquad R = 64\ \Omega$$

Total current through the circuit is

$$I_R = I_{total} = \frac{V_R}{R} = \frac{160}{64} = 2.5\text{ A}$$

$$Z = \frac{V}{I_{total}} = \frac{250}{2.5} = 100\ \Omega$$

$$\sqrt{R^2 + X_C^2} = 100$$
$$X_C = 76.8$$
$$C = 41.5\ \mu F$$

End of Solution

59. A 50 Hz sinusoidal voltage V = 311sinωt is applied to an RL series circuit. If the magnitude of resistance is 5 Ω and that of the inductance is 0.02 H, the r.m.s. value of the steady-state current and the relative phase angle are nearly

(a) 19.6 A and 51.5°
(b) 27.4 A and –51.5°
(c) 19.6 A and –51.5°
(d) 27.4 A and 51.5°

Ans. **(b)**

The steady state current,

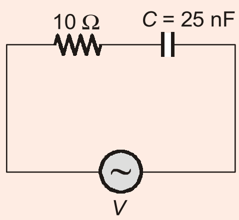
$$I = \frac{V_{rms}}{Z} = \frac{\frac{311}{\sqrt{2}}}{\sqrt{5^2 + (2\pi \times 50 \times 0.02)^2}}$$
$$I = 27.4\ A$$
$$\theta = -\tan^{-1}\left(\frac{X_L}{R}\right) = -51.5°$$

End of Solution

60. In a series RC circuit, the values of R = 10 Ω and C = 25 nF. A sinusoidal voltage of 50 MHz is applied and the maximum voltage across the capacitance is 2.5 V. The maximum voltage across the series combination will be nearly

(a) 172.7 V
(b) 184.5 V
(c) 196.3 V
(d) 208.1 V

Ans. **(c)**



Capacitance reactance,

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 10^6 \times 25 \times 10^{-9}} = 0.127\ \Omega$$
$$I_C = \frac{V_C}{X_C} = \frac{2.5}{0.127} = 19.6\ A$$
$$V_R = I \times R = 19.63 \times 10 = 196.3\ V$$
$$V = \sqrt{V_R^2 + V_C^2} = \sqrt{(196.3)^2 + (2.5)^2} = 196.3\ V$$

End of Solution

61. The peak-to-peak ripple voltage for a half-wave rectifier and filter circuit operating at 60 Hz, which has a 680 μF reservoir capacitor, an average output of 28 V and 200 Ω load resistance, will be nearly
(a) 2.5 V
(b) 3.4 V
(c) 4.3 V
(d) 5.2 V

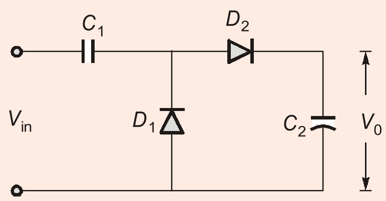
Ans. (b)

$$V_r = \frac{V_{DC}}{fR_LC} = \frac{28}{60\times 200\times 680\times 10^{-6}} = 3.4\text{ V}$$

End of Solution

62. The components of full-wave voltage doubler circuit are
(a) 2 diodes and 1 capacitor
(b) 4 diodes and 1 capacitor
(c) 2 diodes and 2 capacitor
(d) 4 diodes and 2 capacitor

Ans. (c)



End of Solution

63. An amplifier has a signal input voltage V_i of 0.25 V and draws 1 mA from the source. If the amplifier delivers 8 V to a load of 10 mA, the power gain is
(a) 340
(b) 320
(c) 250
(d) 150

Ans. (b)

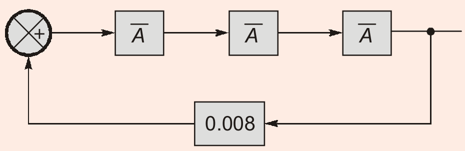
$$\text{Power gain} = \frac{P_0}{P_{in}} = \frac{V_0 i_0}{V_i i_i} = \frac{8\times 10\times 10^{-3}}{0.25\times 10^{-3}} = 320$$

End of Solution

64. Three amplifiers of gain

$$\bar{A} = \left(\frac{A_0}{2}\right)\angle -60°$$

are connected in tandem. The feedback loop is closed through a positive gain of 0.008:



The magnitude of A_0 for the system to be oscillatory will be
(a) 0.2
(b) 0.1
(c) 5.0
(d) 10.0

Ans. (d)

For an oscillator,

$$|A\beta| = 1$$

$$|A|\,|\beta| = 1$$

$$\left(\frac{A_0}{2}\right)^3 \times 0.008 = 1$$

$$\Rightarrow \quad A_0 = 10$$

End of Solution

65. The output voltage from a 5-bit ladder type DAC that has a digital input of 11010, and by assuming 0 = 0 V and 1 = +10 V, is nearly

(a) 26.0 V
(b) 16.3 V
(c) 10.3 V
(d) 8.1 V

Ans. (d)

5 bit $\quad 11010 \rightarrow (26)_{10}$

$$V_{DAC} = \frac{V_R}{2^5} \text{ (decimal equivalent)}$$

$$\Rightarrow \quad = \frac{10}{32} \times 26$$

$$= \frac{65}{8} = 8.1\,\text{V}$$

End of Solution

66. An 8-bit D/A converter has step size of 20 mV. The full-scale output and the resolution will be nearly

(a) 5.1 V and 0.3%
(b) 4.6 V and 0.4%
(c) 5.1 V and 0.4%
(d) 4.6 V and 0.3%

Ans. (c)

8-bit, $\quad$ Resolution = 20 mV

$$V_{FS} = (2^8 - 1) \times 20\text{ mV}$$

$$= 255 \times 20\text{ mV} = 5.1\text{ V}$$

$$\%\text{ Resolution} = \frac{1}{2^8 - 1} \times 100 = \frac{100}{255} = 0.4\%$$

End of Solution

67. For 555 astable multivibrator, if $C = 0.01\ \mu\text{F}$, $R_A = 10\text{ k}\Omega$, $R_B = 50\text{ k}\Omega$, the frequency and the duty cycle will be nearly

(a) 1.6 kHz and 54.5%
(b) 1.3 kHz and 54.5%
(c) 1.6 kHz and 46.5%
(d) 1.3 kHz and 46.5%

Ans. (b)

$$f = \frac{1}{0.69(R_A + 2R_B)C} = \frac{1}{0.69[10\times10^3 + 2\times50\times10^3]\times10^{-8}}$$

$$= 1.3 \text{ kHz}$$

$$\%\text{D.C} = \frac{R_A + R_B}{R_A + 2R_B}\times100 = \frac{60\text{k}}{100\text{ k}}\times100 = 54.5\%$$

End of Solution

68. Consider the following expression:

$$A\cdot B\cdot C\cdot D + A\cdot B\cdot\bar{C}\cdot\bar{D} + A\cdot B\cdot C\cdot\bar{D} + A\cdot B\cdot\bar{C}\cdot D + A\cdot B\cdot C\cdot D\cdot E + A\cdot B\cdot\bar{C}\cdot\bar{D}\cdot\bar{E} + A\cdot B\cdot\bar{C}\cdot D\cdot E$$

The simplification of this by using theorems of Boolean algebra will be

(a) $A + B$ (b) $A\oplus B$
(c) $(A + B)\,(A\cdot B)$ (d) $A\cdot B$

Ans. (d)

$$= ABCD + AB\bar{C}\bar{D} + ABC\bar{D} + AB\bar{C}D + ABCDE + AB\bar{C}\bar{D}\bar{E} + AB\bar{C}DE$$

$$= AB[\bar{C}\bar{D} + \bar{C}D + C\bar{D} + CD] + ABCDE + AB\bar{C}\bar{E} + AB\bar{C}D\bar{C}$$

$$= A\cdot B$$

End of Solution

69. An electric power generating station supplies power to three loads A, B and C. Only a single generator is required when any one load is switched on. When more than one load is on, an auxiliary generator must be started. The Boolean equation for the control of switching of the auxiliary generator will be

(a) $AA + BB + CC$ (b) $ABC + BCA + CAB$
(c) $AB + AC$ (d) $AB + AC + BC$

Ans. (d)

A	B	C	Auxiliary generator
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

$$= AB + AC + BC$$

End of Solution

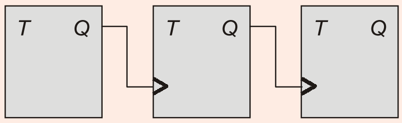
70. Which one of the following types of instructions will be used to copy from the source to the destination location?
(a) Arithmetic instruction
(b) Data transfer instructions
(c) Logical instructions
(d) Machine control instructions

Ans. (b)
Copy/data transfer instruction.

End of Solution

71. A cascaded arrangement of flip-flops, where the output of one flip-flop drives the clock input of the following flip-flop, is known as
(a) synchronous counter
(b) ripple counter
(c) ring counter
(d) up counter

Ans. (b)



Ripple counter

End of Solution

72. The number of flip-flops required to construct an 8-bit shift register will be
(a) 32
(b) 16
(c) 8
(d) 4

Ans. (c)
Number of flip-flops required to conduct 8-bit shift register is 8.

End of Solution

73. Which one of the following specifications does **not** fit for a single-mode fiber?
(a) The bandwidth of 1 GHz/km.
(b) The digital communication rate is excess of 2000 Mbytes/s.
(c) More than 100000 voice channels are available
(d) The mode field diameter (MFD; spot size) is larger than the core diameter.

Ans. (a)
For a single-mode fibre, the bandwidth ranges from 50 to 100 GHz/km.

End of Solution

74. For a binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2 kbps, the peak frequency deviation will be
(a) 0.5 kHz
(b) 1.0 kHz
(c) 2.0 kHz
(d) 4.0 kHz

Ans. (b)

$$f_L = 49 \text{ kHz}$$
$$R_b = 2 \text{ kbps}$$
$$f_H = 51 \text{ kHz}$$

Peak frequency deviation

$$\Rightarrow \quad 2\Delta f = f_H - f_L$$
$$2\Delta f = 51 \text{ k} - 49 \text{ k}$$
$$\Rightarrow \quad \Delta f = 1 \text{ kHz}$$

End of Solution

75. A random process $X(t)$ is defined as

$$X(t) = 2\cos(2\pi t + Y)$$

where Y is a discrete random variable with $P(Y = 0) = \frac{1}{2}$ and $P\left(Y = \frac{\pi}{2}\right) = \frac{1}{2}$. The mean $\mu_x(1)$ is

(a) $\frac{1}{4}$

(b) $\frac{1}{3}$

(c) $\frac{1}{2}$

(d) 1

Ans. (d)

$$X(t) = 2\cos(2\pi t + y)$$
$$= 2\cos 2\pi t \cdot \cos y - 2\sin 2\pi t \cdot \sin y$$
$$E[X(t)] = 2\cos 2\pi t \cdot E[\cos y] - 2\sin 2\pi t \cdot E[\sin y]$$
$$= 2\cos 2\pi t\left[\cos 0 \times \frac{1}{2} + \cos\frac{\pi}{2} \times \frac{1}{2}\right] - 2\cos 2\pi t\left[\sin 0 \times \frac{1}{2} + \sin\frac{\pi}{2} \times \frac{1}{2}\right]$$
$$= 2\cos 2\pi t\left[\frac{1}{2} + 0\right] - 2\sin 2\pi t\left[\frac{1}{2}\right]$$
$$= \cos 2\pi t - \sin 2\pi t$$
$$\mu_X(t) = E[X(t)] = \cos 2\pi t - \sin 2\pi t$$
$$\mu_X(1) = \cos 2\pi - \sin 2\pi = 1$$

End of Solution

76. A source produces three symbols A, B and C with probabilities $P(A) = \frac{1}{2}$, $P(B) = \frac{1}{4}$ and $P(C) = \frac{1}{4}$. The source entropy is

(a) $\frac{1}{2}$ bit/symbol

(b) 1 bit/symbol

(c) $1\frac{1}{4}$ bits/symbol

(d) $1\frac{1}{2}$ bits/symbol

Ans. (d)

$$P(A) = \frac{1}{2}$$

$$P(B) = \frac{1}{4}$$

$$P(C) = \frac{1}{4}$$

$$H = \Sigma P_i \log\frac{1}{P_i} = \frac{1}{2}\log_2 2 + \frac{1}{4}\log_2 4 + \frac{1}{4}\log_2 4$$

$$= \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = \frac{3}{2} = 1\frac{1}{2} \text{ bits/symbol}$$

End of Solution

77. An Am wave with modulation index 0.8 has total sideband power of 4.85 kW. The carrier power and the total power radiated will be nearly

(a) 12.2 kW and 20 kW
(b) 15.2 kW and 20 kW
(c) 12.2 kW and 25 kW
(d) 15.2 kW and 25 kW

Ans. (b)

$$\mu = 0.8$$

$$P_{SB} = P_C\frac{\mu^2}{2}$$

$$4.85 = P_C\frac{(0.8)^2}{2}$$

$$9.7 = P_C \times (0.8)^2$$

$$P_C = 15.15 \text{ kW}$$

$$P_t = P_C + P_{SB} = 20 \text{ kW}$$

End of Solution

78. A 360 W carrier is simultaneously modulated by two audio waves with modulation percentages of 55 and 65 respectively. The effective modulation index and the total power radiated are

(a) 0.85 and 490.5 W
(b) 0.65 and 490.5 W
(c) 0.85 and 450.5 W
(d) 0.65 and 450.5 W

Ans. (a)

$$P_C = 360 \text{ W}$$

$$\mu_1 = 0.55$$

$$\mu_2 = 0.65$$

$$\mu_t = \sqrt{\mu_1^2 + \mu_2^2} = 0.85$$

$$P_t = P_C\left[1 + \frac{\mu_t^2}{2}\right] = 360\left[1 + \frac{(0.85)^2}{2}\right] = 490.5 \text{ W}$$

End of Solution

79. An amplitude modulated amplifier has a radio frequency output of 50 W at 100% modulation. The internal loss in the modulator is 10 W. The unmodulated carrier power is

(a) 40 W
(b) 50 W
(c) 60 W
(d) 80 W

Ans. (a)

Total AM power ⇒ 50 W + 10 W

$$P_t = 60 \text{ W}$$

$$\mu = 1$$

$$P_t = P_C\left[1+\frac{\mu_t^2}{2}\right]$$

$$60 = P_C\left[1+\frac{1}{2}\right] = 40 \text{ W}$$

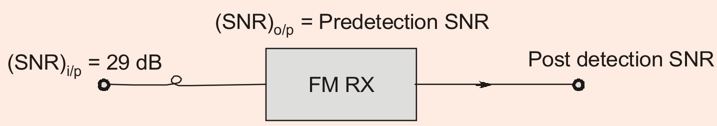
End of Solution

80. For an FM receiver with an input signal-to-noise ratio of 29 dB, a noise figure of 4 dB and an FM improvement factor of 16 dB, the pre-detection and post-detection signal-to-noise ratios are

(a) 25 dB and 41 dB
(b) 30 dB and 49 dB
(c) 25 dB and 49 dB
(d) 30 dB and 41 dB

Ans. (a)

$$\left(\frac{S}{N}\right)_{i/p} = 29 \text{ dB}$$



N.F = 4 dB

FM improvement factor = 16 dB

$$\text{Noise figure} = \frac{(\text{SNR})_{i/p}}{(\text{SNR})_{o/p}}$$

$$\Rightarrow \quad (\text{N.F})_{\text{dB}} = (\text{SNR})_{i/p \text{ dB}} - (\text{SNR})_{o/p \text{ dB}}$$

$$(\text{SNR})_{o/p \text{ dB}} = (\text{SNR})_{i/p \text{ dB}} - (\text{N.F})_{\text{dB}}$$

Pre-detection SNR = 29 dB – 4 dB = 25 dB

Post-detection SNR = Predetection SNR + FM improvement factor

= 25 dB + 16 dB = 41 dB

End of Solution

81. For Gaussian and White channel noise, the capacity of a low-pass channel with a usable bandwidth of 3000 Hz and $\frac{S}{N} = 10^3$ at the channel output will be

(a) 15000 bits/s
(b) 20000 bits/s
(c) 25000 bits/s
(d) 30000 bits/s

Ans. (d)

$$B = 3000 \text{ Hz}$$
$$\frac{S}{N} = 10^3$$
$$C = B\log_2\left(1+\frac{S}{N}\right) = 3k \cdot \log_2(1+10^3)$$
$$= 29.9 \text{ kbps} \approx 30000 \text{ bps}$$

End of Solution

82. For a PM modulator with a deviation sensitivity K = 2.5 rad/V and a modulating signal $v_m(t) = 2\cos(2\pi 2000t)$, the peak phase deviation m will be

(a) 1.25 rad
(b) 2.5 rad
(c) 5.0 rad
(d) 7.5 rad

Ans. (c)

Phase sensitivity, $K = 2.5$ rad/V

$$V_m(t) = 2\cos(2\pi \times 2000t)$$

Peak phase deviation $= K_p A_m$

$$= 2.5 \times 2 = 5 \text{ rad}$$

End of Solution

83. In a PCM system, non-uniform quantization leads to

(a) increased quantizer noise
(b) simplification of the quantization process
(c) higher average SNR
(d) increased bandwidth

Ans. (c)

End of Solution

84. The bandwidth required in DPCM is less than that of PCM because

(a) the number of bits per code is reduced resulting in a reduced bit rate
(b) the difference signal is larger in amplitude than actual signal
(c) more quantization levels are needed
(d) the successive samples of signal often differ in amplitude

Ans. (a)

End of Solution

85. For the given transfer function

$$G(s) = \frac{Y(s)}{R(s)} = \frac{1}{s^2 + 3s + 2}$$

the response $y(t)$ for a step input $r(t) = 5u(t)$ will be

(a) $\left[\frac{5}{2} - 5e^{-t} + \frac{5}{2}e^{-2t}\right]u(t)$

(b) $\left[\frac{5}{2} - 5e^{-t}\right]u(t)$

(c) $\left[\frac{5}{2} + \frac{5}{2}e^{-2t}\right]u(t)$

(d) $\left[-5e^{-t} + \frac{5}{2}e^{-2t}\right]u(t)$

where $u(t)$ is a unit step input.

Ans. (a)

$$\frac{Y(s)}{R(s)} = \frac{1}{s^2 + 3s + 2}$$

$$Y(s) = \frac{1}{(s+1)(s+2)} \times \frac{5}{s} = \frac{A}{s} + \frac{B}{s+1} + \frac{C}{s+2}$$

$$A = \frac{5}{2} \; ; \; B = -5 \; ; \; C = \frac{5}{2}$$

$$\therefore \quad y(t) = \left[\frac{5}{2} - 5e^{-t} + \frac{5}{2}e^{-2t}\right]u(t)$$

End of Solution

86. The price for improvement in sensitivity by the use of feedback is paid in terms of

(a) loss of system gain

(b) rise of system gain

(c) improvement in transient response, delayed response

(d) poor transient response

Ans. (a)

Feedback (negative) decreases both gain and sensitivity.

End of Solution

87. Consider a feedback system with the characteristic equation

$$1 + K\frac{1}{s(s+1)(s+2)} = 0$$

The asymptotes of the three branches of root locus plot of this system will form the following angles with the real axis

(a) 60°, 120° and 300°

(b) 60°, 120° and 180°

(c) 60°, 180° and 300°

(d) 40°, 120° and 200°

Ans. (c)

$$G(s)\,H(s) = \frac{K}{s(s+1)(s+2)}$$

Angle of asymptotes, $\phi_A = \frac{(2K+1)\,180°}{P-z}$

$K = 0, 1, \ldots, P - z - 1$

$\therefore \quad \phi_A = 60°, 180°, 300°$

End of Solution

88. If the characteristic equation of a feedback control system is given by,

$$s^4 + 20s^3 + 15s^2 + 2s + K = 0$$

then the range of values of K for the system to be stable will be

(a) $1 < K < 2.49$
(b) $0 < K < 1.49$
(c) $1 < K < 4.49$
(d) $0 < K < 3.49$

Ans. (b)

$$q(s) = s^4 + 20s^3 + 15s^2 + 2s + K = 0$$

Necessary condition: $K > 0$

Sufficient condition:

$$\begin{array}{c|ccc} s^4 & 1 & 15 & K \\ s^3 & 20 & 2 & \\ s^2 & \frac{300-2}{20} & K & \\ s^1 & \frac{2\left(\frac{298}{20}\right)-20K}{\left(\frac{300-2}{20}\right)} & & \\ s^0 & K & & \end{array}$$

$\therefore \quad 2\left(\frac{298}{20}\right) - 20K > 0$

$\therefore \quad 0 < K < 1.49$

End of Solution

89. For a Type-2 system, the steady-state errors for unit step and unit ramp input are

(a) 0 and ∞
(b) ∞ and 0
(c) 0 and 0
(d) ∞ and ∞

Ans. (c)

Type-2: $G(s)\,H(s) = \frac{1}{s^2}$

$$R(s) = \frac{1}{s}$$

$$\Rightarrow \quad e_{ss} = \lim_{s \to 0} \frac{s \times \frac{1}{s}}{1 + \frac{1}{s^2}} = 0$$

$$R(s) = \frac{1}{s^2}$$

$$\Rightarrow \quad e_{ss} = \lim_{s \to 0} \frac{s \times \frac{1}{s^2}}{1 + \frac{1}{s^2}} = 0$$

End of Solution

90. Consider the following statements regarding a parabolic function:

1. A parabolic function is one degree faster than the ramp function.
2. A unit parabolic function is defined as $f(t) = \begin{cases} \frac{t^2}{2}, & \text{for } t > 0 \\ 0 & \text{otherwise} \end{cases}$
3. Laplace transform of unit parabolic function is $\frac{1}{s^3}$.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (d)

$$P(t) = \frac{t^2}{2} u(t)$$

$$\frac{d}{dt} p(t) = t u(t)$$

$\therefore$ Parabolic function is one degree faster than ramp function

$$L\left[\frac{t^2}{2} u(t)\right] = \frac{1}{s^3}$$

End of Solution

91. Consider the following open-loop transfer function:

$$G = \frac{K(s+2)}{(s+1)(s+4)}$$

The characteristic equation of the unity negative feedback will be

(a) $(s + 1)(s + 4) + K(s + 2) = 0$
(b) $(s + 2)(s + 1) + K(s + 4) = 0$
(c) $(s + 1)(s - 2) + K(s + 4) = 0$
(d) $(s + 2)(s + 4) + K(s + 1) = 0$

Ans. (a)

$$q(s) = 1 + G(s)H(s) = 0$$

$$q(s) = 1 + \frac{K(s+2)}{(s+1)(s+4)} = 0$$

$$q(s) = (s + 1)(s + 4) + K(s + 2) = 0$$

End of Solution

92. The magnitude and phase relationship between the sinusoidal input and the steady-state output of a system is called as

(a) magnitude response
(b) transient response
(c) steady-state response
(d) frequency response

Ans. (d)

Magnitude and phase relation between sinusoidal input and the steady state output such that input amplitude and phase kept constant and input frequency is varied is called frequency response of LTI system.

End of Solution

93. A transfer function having all its poles and zeros only in the left-half of the *s*-plane is called

(a) a minimum-phase function
(b) a complex transfer function
(c) an all-pass transfer function
(d) a maximum-phase transfer function

Ans. (a)

A system is said to be minimum phase if it has all finite zeros and poles in left side of *s*-plane.

End of Solution

94. The frequency where magnitude *M* has a peak value in frequency response is known as

(a) normalized frequency
(b) resonant frequency
(c) peak frequency
(d) tuned frequency

Ans. (b)

Resonant frequency is that at which the magnitude of frequency response is maximum.

End of Solution

95. For a lead compensator having transfer function

$$G_c(s) = \frac{(s+z_c)}{(s+p_c)} = \frac{\left(s+\frac{1}{\tau}\right)}{\left(s+\frac{1}{\alpha\tau}\right)}$$

1. $\alpha = \frac{z_c}{p_c} < 1$
2. $\alpha = \frac{z_c}{p_c} > 1$
3. $\tau > 0$
4. $\tau < 0$

Which of the above are correct?

(a) 1 and 4 (b) 1 and 3
(c) 2 and 4 (d) 2 and 3

Ans. (b)

$$G_c(s) = \frac{s+z_c}{s+p_c} < 1$$

1. For lead compensator $\frac{Z_c}{P_c} < 1$ i.e. zero should be dominant.
2. T(time constant) is a positive value.

End of Solution

96. The attenuation (magnitude) produced by a lead compensator at the frequency of maximum phase lead $\omega_m = \sqrt{ab}$ is

(a) $\sqrt{\frac{b}{a}}$ (b) $\sqrt{a+b}$
(c) $\sqrt{b-a}$ (d) $\sqrt{\frac{a}{b}}$

Ans. (d)

$$G_c = \frac{s+a}{s+b}$$

$$M \text{ at } \omega_m = \frac{1}{\sqrt{\alpha}} \text{ (amplification)}$$

$$\text{Attenuation} = \sqrt{\alpha} = \sqrt{\frac{a}{b}}$$

$$\therefore \quad \alpha = \frac{a}{b}$$

End of Solution

97. Consider the following statements:

1. A computer will have a multiply instruction.
2. Multiply instruction will be implemented by a special multiply unit.

Which of the following is correct?

(a) Both 1 and 2 are not architectural design issues.
(b) Both 1 and 2 are not organizational issues.
(c) 1 is an architectural design issue while 2 is an organizational issue.
(d) 1 is an organizational issue while 2 is an architectural design issue.

Ans. (d)

Multiply unit implementation is a H/W issue.
i.e. Architectural issue.
Multiply instruction is a organization issue.

End of Solution

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98. Consider a disk with an average seek time of 4 ms, rotational delay of 2 ms, rotation speed of 15000 r.p.m. and 512 byte sectors with 500 sectors per track. A file occupies all of the sectors on 5 adjacent tracks. After reading the first track, if remaining tracks can be read with no seek time, then the time required in sequential organization to transfer the file will be nearly

(a) 0.01 second (b) 0.034 second
(c) 0.34 second (d) 3.4 second

Ans. (b)

1. Seek time = 4 ms
2. 15000 revolutions —— 1 min (60 sec)
   1 revolution —— ?

$$\Rightarrow \frac{60}{15000} \text{ sec} = 4 \text{ ms}$$

$\therefore$ Average rotational latency = $\frac{1}{2}$ revolution time = $\frac{1}{2} \times 4 \text{ ms} = 2 \text{ ms}$

3. Transfer time
   1 revolution time = 1 track data
   i.e., 4 ms/track
   File stored in 5 adjacent track which doesn't requires seek time for every track.
   $\therefore$ Time required to access the file is
   $\Rightarrow$ 4 ms + (2 ms + 4 ms)5 $\Rightarrow$ 34 ms
   $\Rightarrow$ 0.034 sec

End of Solution

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99. Add 8 and 9 in BCD code

(a) 00010111 (b) 00010001
(c) 01110111 (d) 10001001

Ans. (a)

$$(8)_{10} + (9)_{10} = (17)_{10}$$

In BCD, $(17)_{10} = 00010111$

End of Solution

100. Convert the binary number 11000110 to Gray code

(a) 001000101 (b) 10100100
(c) 11100110 (d) 10100101

Ans. (d)

1 1 0 0 0 1 1 0 : Binary
↓
1 0 1 0 0 1 0 1 : Gray code

End of Solution

101. The decimal value of the signed binary number 10101010 expressed in 2's complement will be

(a) –42 (b) –86
(c) –116 (d) –170

Ans. (b)

1 0 1 0 1 0 1 0 ⟶ $-N$
↓ Take 1's complementary
0 1 0 1 0 1 0 1 ⟶ $+N$
              1
0 1 0 1 0 1 1 0

$N = 86$

$10101010 \rightarrow -86$

End of Solution

102. Which of the following statements is/are correct?

1. An address generated by the CPU is commonly referred to as a physical address.
2. An address seen by the memory unit is commonly referred to as a logical address.
3. The run-time mapping from virtual to physical address is done by the memory management unit (MMU).

Select the correct answer using the code given below.

(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

103. In a cache with 64-byte cache lines, how many bits are used to determine which byte within a cache line an address points to?

(a) 16
(b) 8
(c) 6
(d) 3

Ans. (c)

Word offset = $\log_2^{64} = 6$ bit

End of Solution

104. A system has 64-bit virtual addresses and 43-bit physical addresses. If the pages are 8 kB in size, the number of bits required for VPN and PPN will be respectively

(a) 51 bits and 30 bits
(b) 30 bits and 51 bits
(c) 51 bits and 13 bits
(d) 30 bits and 13 bits

Ans. (a)

$$\#\text{pages in SM} = \frac{\text{SM size}}{\text{page size}} = \frac{2^{64}}{8\,k} = \frac{2^{64}}{2^{13}} = 2^{51}$$

64 bit virtual address

p	d
$\log_2^{2^{51}}$ ↓ 51 bit	$\log_2^{8\,k}$ ↓ 13 bit

$$\#\text{pages (frames) in MM} = \frac{\text{MM size}}{\text{page size}} = \frac{2^{43}}{8\,k} = \frac{2^{43}}{2^{13}} = 2^{30}$$

43 bit physical address

f	d
$\log_2^{2^{30}}$ ↓ 30 bit	$\log_2^{8\,k}$ ↓ 13 bit

End of Solution

105. A soft error is a

(a) regular-nondestructive event
(b) random-nondestructive event
(c) random-destructive event
(d) regular-destructive event

Ans. (b)

End of Solution

106. A main memory can hold 3 page frames and initially all of them are vacant. Consider the following stream of page requests

2, 3, 2, 4, 6, 2, 5, 6, 1, 4, 6

If the stream uses FIFO replacement policy, the hit ratio *h* will be

(a) $\frac{11}{3}$
(b) $\frac{1}{11}$
(c) $\frac{3}{11}$
(d) $\frac{2}{11}$

Ans. **(d)**

2 – M
3 – M
2 – H
4 – M
6 – M
2 – M
5 – M
6 – H
1 – M
4 – M
6 – M

MM

~~2~~	~~6~~	1
~~3~~	~~2~~	4
~~4~~	~~5~~	6

$$H = \frac{\#\text{Hits}}{\text{Total\# Accesses}}$$

$$H = \frac{2}{11}$$

End of Solution

107. Which one of the following is an advantage of assembly language over high-level language?
(a) Assembly language program runs faster.
(b) Writing of assembly language programming is easy.
(c) Assembly language program is portable
(d) Assembly language program contains less instruction.

Ans. **(a)**

Assembly language is a low-level language. Assembler can be used to convert into machine code directly so runs faster.

End of Solution

108. Which of the following statements are correct?
1. A pseudoinstruction is a machine instruction.
2. A pseudoinstruction is an instruction to the assembler.
3. The ORG (origin) is an example of pseudoinstruction.
4. It is not possible to use ORG more than once in a program.

Select the correct answer using the code given below.
(a) 1 and 3
(b) 2 and 3
(c) 1 and 4
(d) 2 and 4

Ans. **(b)**

Pseudoinstruction is a hint given to assembler by programmer. They do not require any memory space.

Example: ORG, DB, DW.

End of Solution

109. The vector R_{AB} extends from $A(1, 2, 3)$ to B. If the length of R_{AB} is 10 units and its direction is given by

$$a = 0.6\hat{a}_x + 0.64\hat{a}_y + 0.48\hat{a}_z$$

the coordinates of B will be

(a) $7\hat{a}_x + 4.8\hat{a}_y + 4.8\hat{a}_z$
(b) $6\hat{a}_x + 6.4\hat{a}_y + 4.8\hat{a}_z$
(c) $7\hat{a}_x + 8.4\hat{a}_y + 7.8\hat{a}_z$
(d) $6\hat{a}_x + 8.4\hat{a}_y + 7.8\hat{a}_z$

Ans. (c)

As R_{AB} length is 10 units

$$\vec{R}_{AB} = \left|\vec{R}_{AB}\right| \vec{a}$$

$$\vec{R}_{AB} = 10\vec{a} = 6\hat{a}_x + 6.4\hat{a}_y + 4.8\hat{a}_z$$

$$\vec{A} \text{ radial vector} = \hat{a}_x + 2\hat{a}_y + 3\hat{a}_z$$

$$\vec{R}_{AB} = \vec{B} - \vec{A}$$

$$\vec{B} = \vec{R}_{AB} + \vec{A}$$

$$\therefore \quad \vec{B} = 10a + \vec{A} = 7\hat{a}_x + 8.4\hat{a}_y + 7.8\hat{a}_z$$

End of Solution

110. What is the value for the total charge enclosed in an incremental volume of 10^{-9} m^3 located at the origin if $D = e^{-x}\sin y\hat{a}_x - e^{-x}\cos y\hat{a}_y + 2z\hat{a}_z$ C/m^2?

(a) 8 nC
(b) 4 nC
(c) 2 nC
(d) 1 nC

Ans. (c)

$$\vec{\nabla}\cdot\vec{D} = \rho_v$$

$$\Rightarrow \quad \rho_v = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{dy} + \frac{\partial D_z}{\partial z}$$

$$\vec{\nabla}\cdot\vec{D} = -e^{-x}\sin y + e^{-x}\sin y + 2$$

At origin, $\vec{\nabla}\cdot\vec{D} = 2$

$$\therefore \quad Q = \rho_v\, dV = 2 \times 10^{-9} \text{ m}^3 = 2 \text{ nC}$$

End of Solution

111. The unit vector extending from origin toward the point $G(2, -2, -1)$ is

(a) $\frac{2}{3}\hat{a}_x + \frac{2}{3}\hat{a}_y + \frac{1}{3}\hat{a}_z$
(b) $-\frac{2}{3}\hat{a}_x + \frac{2}{3}\hat{a}_y + \frac{1}{3}\hat{a}_z$
(c) $\frac{2}{3}\hat{a}_x - \frac{2}{3}\hat{a}_y - \frac{1}{3}\hat{a}_z$
(d) $-\frac{2}{3}\hat{a}_x - \frac{2}{3}\hat{a}_y - \frac{1}{3}\hat{a}_z$

Ans. (c)

$$\overrightarrow{OG} = 2\hat{a}_x - 2\hat{a}_y - \hat{a}_z$$

$$\vec{a} = \frac{\overrightarrow{OG}}{|\overrightarrow{OG}|} = \frac{2\hat{a}_x - 2\hat{a}_y - \hat{a}_z}{\sqrt{2^2 + 2^2 + 1^2}} = \frac{2}{3}\hat{a}_x - \frac{2}{3}\hat{a}_y - \frac{1}{3}\hat{a}_z$$

End of Solution

112. Ground waves progress along the surface of the earth and must be polarized
(a) horizontally
(b) circularly
(c) elliptically
(d) vertically

Ans. (d)
Ground waves are vertically polarized waves using vertical antennas with a small height.

End of Solution

113. For a lossless line terminated in a short circuit, the stationary voltage minima and maxima are separated by
(a) $\frac{\lambda}{8}$
(b) $\frac{\lambda}{2}$
(c) $\frac{\lambda}{3}$
(d) $\frac{\lambda}{4}$

Ans. (d)
Periodicity of standing wave is $\lambda/2$ and distrace between maxima to minima is $\lambda/4$.

End of Solution

114. The characteristic impedance of an 80 cm long lossless transmission line having L = 0.25 μH/m and C = 100 pF/m will be
(a) 25 Ω
(b) 40 Ω
(c) 50 Ω
(d) 80 Ω

Ans. (c)

$$Z_o = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.25 \times 10^{-6}}{100 \times 10^{-12}}} = \sqrt{0.25} \times 100 = 50$$

End of Solution

115. It is required to match a 200 Ω load to a 300 Ω transmission line to reduce the SWR along the line to 1. If it is connected directly to the load, the characteristic impedance of the quarterwave transformer used for this purpose will be
(a) 275 Ω
(b) 260 Ω
(c) 245 Ω
(d) 230 Ω

Ans. (c)

$$Z_0' = \sqrt{200 \times 300} = 245\,\Omega$$

End of Solution

116. For a standard rectangular waveguide having an aspect ratio of 2 : 1, the cutoff wavelength for $TM_{1,1}$ mode will be nearly

(a) 0.9a
(b) 0.7a
(c) 0.5a
(d) 0.3a

Ans. (a)

$$f_{c_{mn}} = \frac{c}{2}\left(\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}\right) \quad \text{for } TM_{11}$$

$$\frac{a}{b} = \frac{2}{1} \Rightarrow b = \frac{a}{2}$$

$$f_{c_{11}} \lambda_{c_{11}} = c$$

$$\Rightarrow \quad \lambda_{c_{11}} = \frac{c}{f_{c_{11}}}$$

$$\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}} = \frac{2}{\sqrt{\left(\frac{1}{a}\right)^2 + \left(\frac{2}{a}\right)^2}} = \frac{2a}{\sqrt{5}}$$

$$\therefore \quad \lambda_c = 0.9\ a$$

End of Solution

117. The irises in the rectangular metallic waveguide may be

1. inductive
2. resistive
3. capacitive

Select the correct answer using the code given below.

(a) 1, 2 and 3
(b) 1 and 2 only
(c) 1 and 3 only
(d) 2 and 3 only

Ans. (c)

Iris is effectively an obstruction within a waveguide that provides a capacitance or inductive element.

End of Solution

118. A 10 GHz signal is propagated in a waveguide whose wall separation is 6 cm. The greatest number of half-waves of electric intensity will be possible to establish between the two walls. The guide wavelength for this mode of propagation will be

(a) 6.48 cm
(b) 4.54 cm
(c) 2.48 cm
(d) 1.54 cm

Ans. **(b)**

Given a = 6 cm

$$f_{c_1} = \frac{c}{2a} = \frac{3\times10^8}{2\times6\times10^{-2}} = 2.5\times10^9 = 2.5\text{ GHz}$$

$$f_{c_2} = 2f_{c_1} = 5\text{ GHz} \;;\; f_{c_3} = 3f_{c_1} = 7.5\text{ GHz} \;;\; f_{c_4} = 10\text{ GHz does not exist}$$

Highest mode m = 3

$$\lambda_3 = \frac{\lambda}{\sqrt{1-\left(\frac{7.5}{10}\right)^2}} = \frac{3}{\sqrt{\frac{16-9}{16}}}\text{ cm} = \frac{12}{\sqrt{7}}\text{ cm} = 4.55\text{ cm}$$

End of Solution

119. In $TE_{m,\,n}$ mode m and n are integers denoting the number of

(a) $\frac{1}{2}$ the wavelengths of intensity between each pair of walls

(b) $\frac{1}{3}$ the wavelengths of intensity between each pair of walls

(c) $\frac{1}{4}$ the wavelengths of intensity between each pair of walls

(d) $\frac{1}{8}$ the wavelengths of intensity between each pair of walls

Ans. **(a)**

m and n represent number of $\frac{1}{2}$ cycles in the intensity of wave between guide walls.

End of Solution

120. Consider the following statements with reference to dipole arrays :

1. In broadside array, all the dipoles are fed in the same phase from the same source.
2. In end-fire array, the magnitude of the current in each element is same and there is no phase difference between these currents.

Which of the above statements is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Ans. **(a)**

Broadside array has θ_{max} = 90°/270° giving $\psi \to 0$

$$\psi = \alpha + \beta d\cos\theta$$

$\Rightarrow$ $\alpha = 0$

End fire array has θ_{max} = 0°/180° giving $\psi \to 0$

$\Rightarrow$ $\psi = \alpha + \beta d\cos(0°/180°) = 0$

$$\alpha = \pm\beta d$$

End of Solution

121. Which of the following are the advantages of Silicon over Insulator (SOI)?
1. Lower diffusion capacitance
2. Smaller parasitic delay and lower dynamic power consumption
3. Lower threshold voltages

Select the correct answer using the code given below.
(a) 1, 2 and 3
(b) 1 and 2 only
(c) 1 and 3 only
(d) 2 and 3 only

Ans. (b)

End of Solution

122. The finite state machine in which
1. the output is a function of the current state and inputs
2. the output is a function of only the current state

Which of the following machines are respectively correct for these styles?
(a) Mealy machine and Moore machine
(b) Moore machine and Mealy machine
(c) State machine and Mealy machine
(d) State machine and State machine

Ans. (a)

End of Solution

123. In EPROMs, applying a high voltage to the upper gate causes electrons to jump through the thin oxide onto the floating gate through the process known as
(a) mask programming
(b) one-time programming
(c) avalanche injection or Fowler-Nordheim tunneling
(d) erasing

Ans. (c)

End of Solution

124. What is the range of values of a and b for which the linear time-invariant system with impulse response

$$h(n) = \begin{cases} a^n, & n \geq 0 \\ b^n, & n < 0 \end{cases}$$

is stable?
(a) Both $|a| < 1$ and $|b| > 1$ are satisfied
(b) Both $|a| > 1$ and $|b| < 1$ are satisfied
(c) Both $|a| > 1$ and $|b| > 1$ are satisfied
(d) Both $|a| < 1$ and $|b| < 1$ are satisfied

Ans. (a)

$$h[n] = a^n u[n] + b^n u[-n-1]$$

$$H(z) = \frac{1}{1-az^{-1}} - \frac{1}{1-bz^{-1}} \quad |a|<|z|<|b|$$

For system to be stable, $|a|<1$ and $|b|>1$.

End of Solution

125. The special case of a finite-duration sequence is given as

$$x(n) = \{2, \underset{\uparrow}{4}, 0, 3\}$$

The sequence $x(n)$ into a sum of weighted impulse sequences will be

(a) $2\delta(n+1) + 4\delta(n) + 3\delta(n-2)$
(b) $2\delta(n) + 4\delta(n-1) + 3\delta(n-3)$
(c) $2\delta(n) + 4\delta(n-1) + 3\delta(n-2)$
(d) $2\delta(n+1) + 4\delta(n) + 3\delta(n-1)$

Ans. (a)

$$x[n] = \{2, \underset{\uparrow}{4}, 0, 3\}$$

So, $$x[n] = 2\delta[n+1] + 4\delta[n] + 3\delta[n-2]$$

End of Solution

126. The two advantages of FIR filters over IIR- filters are.

(a) they are guaranteed to be stable and non-linear
(b) they are marginally stable and linear.
(c) they are. guaranteed to be stable and may be constrained to have linear phase
(d) they are marginally stable and non-linear

Ans. (c)

FIR filters are always stable and can have linear phase.

End of Solution

127. The frequency response and the main lobe width for rectangular window are

(a) $\dfrac{\sin\frac{\omega N}{2}}{\sin\frac{\omega}{2}}$ and $\dfrac{4\pi}{N}$
(b) $\dfrac{\sin\frac{\omega N}{2}}{\frac{\omega}{2}}$ and $\dfrac{\pi}{N}$
(c) $\dfrac{\sin\frac{\omega}{2}}{\sin\frac{\omega N}{2}}$ and $\dfrac{2\pi}{N}$
(d) $\dfrac{\sin\frac{\omega N}{4}}{\sin\frac{\omega}{2}}$ and $\dfrac{8\pi}{N}$

Ans. (a)

For rectangular window, main lobe width is $\dfrac{4\pi}{N}$ and frequency response is $\dfrac{\sin\frac{\omega N}{2}}{\sin\frac{\omega}{2}}$.

End of Solution

128. A controller that takes control of the buses and transfers data directly between source and destination bypassing the microprocessor is known as
(a) DMA controller
(b) read-write controller
(c) high-speed controller
(d) master-slave controller

Ans. (a)
DMA in between memory and I/0 without the intervention of microprocessor.

End of Solution

129. A 2-byte instruction which accepts the data from the input port specified in the second byte and loads into the accumulator is
(a) OUT <8-bit port address>
(b) IN <8-bit port address>
(c) OUT *R* <8-bit port address>
(d) IN *R* <8-bit port address>

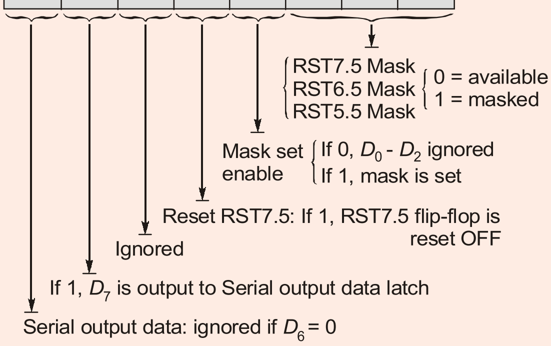
Ans. (b)
In 8-bit port to address to access data from 8-bit port address into accumulator.

End of Solution

130. Consider the following instruction :
EI
MVI A, 08H
SIM
It means
(a) disable all interrupts
(b) enable all interrupts
(c) disable RST 7.5 and 6.5
(d) enable RST 7.5 and 6.5

Ans. (b)
EI ; enable all maskable interrupts
MVI A, 08H ; Accumulator has 08H.
SIM : set interrupt mask

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
SOD	SDE	xxx	R7.5	MSE	M7.5	M6.5	M5.5



$D_7 \to 0$; $D_6 \to 0$; $D_5 \to 0$; $D_4 \to 0$; $D_3 \to 1$; $D_2 \to 0$; $D_1 \to 0$; $D_0 \to 0$
D_3 is 1 which implies D_2 to D_0 are significant.
D_2 to D_0 are 0 so all are available.
EI in also valid INTR.

End of Solution

131. The instruction BC 0 × 15 means
(a) jump 15 bytes relative to the program counter
(b) copy and load 15 words in reverse direction to the program counter
(c) move to a location by 15 bits to the program counter
(d) redirect (jump) to a location by 15 words relative to the program counter

Ans. (a)
Note: There is no instruction as BC in the instructions set of a microprocessor. It should have been JC → Jump if carry to 0 × 15.

End of Solution

132. Which of the following constraints are to be considered by the designer while designing an embedded system?
1. Selecting the microcontroller as a controlling device
2. Selecting the language to write the software
3. Partitioning the tasks between hardware and software to optimize the cost

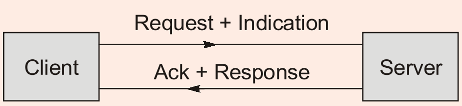
Select the correct answer using the code given below.
(a) 1, 2 and 3
(b) 1 and 2 only
(c) 1 and 3 only
(d) 2 and 3 only

Ans. (a)
All the three statements are considered by the designer while designing an embedded system.

End of Solution

133. Which one of the following is the correct combination for a layer providing a service by means of primitives in an open systems interconnection?
(a) Request, Indication, Response and Confirm
(b) Request, Inform, Response and Service
(c) Request, Command, Response and Action
(d) Request, Confirm, Indication and Action

Ans. (a)
In OSI model there is layered architecture and the service primitives are used to define client server model.



End of Solution

134. A network uses a fully interconnected mesh topology to connect 10 nodes together. The number of links required will be
(a) 35
(b) 40
(c) 45
(d) 50

Ans. (c)

For a fully connected mesh set n is number of nodes, hence number of links

$$= \frac{n(n-1)}{2} = \frac{(10)(10-1)}{2} = 45$$

End of Solution

135. Which of the following are the advantages of packet switching?

1. Greater link efficiency than circuit switching
2. Connections are not blocked when traffic congestion occurs
3. Direct channel established between transmitter and receiver
4. No time is taken to establish connection

Select the correct answer using the code given below.

(a) 1 and 3 (b) 1 and 2
(c) 2 and 3 (d) 3 and 4

Ans. (b)

The link is shared between number of users and no dedicated connection is there. It also supports first come first serve basis hence the blocking is addressed.

End of Solution

136. A message consisting of 2400 bits is to be passed over an internet. The message is passed to the transport layer which appends a 150-bit header, followed by the network layer which uses a 120-bit header. Network layer packets are transmitted via two networks, each of which uses a 26-bit header. The destination network only accepts up to 900 bits long. The number of bits, including headers delivered to the destination network, is

(a) 2706 bits (b) 2634 bits
(c) 2554 bits (d) 2476 bits

Ans. (a)

Number of message bits = 2400 bits
TL segment = Data + Header = 150 + 2400 = 2550 bits
Data supported by network = 900 − 26 bits = 874 bits
Packet 1 = 874 bits
Packet 2 = 874 bits
Packet 3 = 802 bits
Total = 2550 bits

Total number of bits including header as well as travelling through two different network. Hence, the number of bits delivered to the destination network is equal to,

(26 + 26 + 874) + (26 + 26 + 874) + (26 + 26 + 802) = 2706 bits

End of Solution

137. In a communication network, 4 $T1$ streams are multiplexed to form 1 $T2$ stream and 7 T1 streams are multiplexed to form 1 T3 stream. Further 6 T3 streams are multiplexed to form 1 T4 stream. If each T1 stream is of 1.544 Mbps, the data rate of 1 T4 stream should be

(a) 211.8 Mbps
(b) 232.6 Mbps
(c) 243.4 Mbps
(d) 274.2 Mbps

Ans. (d)

$$4T_1 = 1T_2$$
$$7T_2 = 1T_3$$
$$6T_3 = 1T_4$$
$$T_1 = 1.544 \text{ Mbps}$$
$$T_4 = ?$$
$$4T_1 = T_2 = 6.312 \text{ Mbps}$$
$$7T_2 = 28\text{T}_1 = 44.736 \text{ Mbps } (T_3)$$
$$6T_3 = 1T_4 = 274.2 \text{ Mbps}$$

Note: There is a printing error in the given question, the statement should be like: "In a communication network, 4 T1 streams are multiplexed to form 1 T2 stream and 7 T2 streams are multiplexed to form 1 T3 stream. Further 6 T3 streams are multiplexed to form 1 T4 stream."

End of Solution

138. Which of the following statements are correct regarding CDMA?

1. It is similar to GSM.
2. It allows each station to transmit over the entire frequency spectrum all the time.
3. It assumes that multiple signals add linearly.

Select the correct answer using the code given below.

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (c)

In CDMA there is no concept of frequency reuse and it is more secure by using codes. Hence, each station can transmit over entire frequency spectrum as each signal is having different codes. With the help of rake receiver multiple signals can add linearly.

End of Solution

139. Which of the following regarding cellular systems with small cells are correct?

1. Higher capacity and robustness
2. Needless transmission power and have to deal with local interference only
3. Frequency planning and infrastructure needed
4. These require both circuit switching and packet switching

Select the correct answer using the code given below

(a) 1, 2 and 4
(b) 1, 3 and 4
(c) 1, 2 and 3
(d) 2, 3 and 4

Ans. (c)

In cellular system if cell size is small than the population density is high hence number of users are more and cellular system is decentralised hence robust.

Size ↓ d ↓ hence less radiated power to coverage of cell.

Small cells requires more frequency planning and infrastructure to avoid adjacent channel interference and co-channel interference is constant because Q/R is constant so need to address local interference.

End of Solution

140. A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12 h. If the eccentricity = 0.002, $i = 0°$, $K_1 = 66063.17$ km^2, $\mu = 3.99 \times 10^{14}$ m^3/s^2 and the earth's equatorial radius = 6378.14 km, the semi-major axis will be

(a) 34232 km
(b) 30424 km
(c) 26612 km
(d) 22804 km

Ans. (c)

For an elliptical orbit according to Kepler's law

$$T^2 = \frac{4\pi^2}{GM}a^3$$

Here, a = Perigee distance hence = a_p

$T = 12h = 43200$ sec

$$\therefore \quad a_p^3 = \frac{T^2 GM}{4\pi^2} = \frac{43200 \times 43200 \times 4 \times 10^{14}}{4 \times (3.14)^2}$$

$a_p = 26525 \times 10^3$m $= 26525$ km

Also, $a_p = a(1 - e)$

Hence, $$a = \text{Semi-major axis} = \frac{a_p}{(1-e)} = \frac{26525}{0.998} \quad (\because e = 0.002)$$

$a = 26578$ km

Nearest possible answer is option (c).

End of Solution

141. A single-mode optical fiber has a beat length of 8 cm at 1300 nm. The value of birefringence B_f will be nearly

(a) 1.6×10^{-5}
(b) 2.7×10^{-5}
(c) 3.2×10^{-5}
(d) 4.9×10^{-5}

Ans. (a)

$$\text{Beat length, } L = \frac{2\pi}{\beta_x - \beta_y} \rightarrow \text{Propagation constant}$$

$$L = \frac{2\pi}{\delta B_f} = \frac{\lambda_c}{B_f}$$

$$B_f = \frac{2\pi}{L} = \frac{\lambda}{L} = \frac{1300}{8} \times 10^{-9} = 1.6 \times 10^{-5}$$

End of Solution

142. Which one of the following instruments is useful while measuring the optical power as a function of wavelength?

(a) Optical power attenuator
(b) Optical power meter
(c) Optical spectrum analyzer
(d) Optical return loss tester

Ans. (c)

Optical spectrum analyzer measures optical power as a function of wavelength.

End of Solution

143. The optical performance monitoring involves

(a) transport layer monitoring, optical signal monitoring and protocol performance monitoring
(b) physical layer, network layer and application layer monitoring
(c) data-link layer, presentation layer and session layer monitoring
(d) transport layer, session layer and application layer monitoring

Ans. (a)

End of Solution

144. An earth station at sea level communicates at an elevation angle of 35° with GEO satellite. The vertical height of the stratiform rain is 3 km. The physical path length L through the rain will be nearly

(a) 6.3 km
(b) 5.2 km
(c) 4.1 km
(d) 3.0 km

Ans. (b)

Angle of elevation = 35°

Stratiform rain height = 3 km

$$\text{Physical path length} = \frac{R_{SRH}}{\sin\theta_e} = \frac{3\text{ km}}{\sin 35°} = 5.19\text{ km} \simeq 5.2\text{ km}$$

The following six (6) items consist of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the code given below:

Code:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is .not the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

145. **Statement (I):** Sign-magnitude representation is rarely used in implementing the integer of the ALU.

Statement (II): There are two representations of zero in sign-magnitude representation.

Ans. (a)

End of Solution

146. **Statement (I):** Dynamic loading gives better memory-space utilization.
Statement (II): In dynamic loading, an unused routine is never loaded

Ans. (a)
Dynamic loading is a mechanism by which a computer program can at run time, load a library into a memory, retrieve the addresses of functions and variables contained in the library execute those function (or) access those variables and unload the library from the memory.

End of Solution

147. **Statement (I):** SRAM is used for cache memory and DRAM is used for main memory.
Statement (II): SRAM is somewhat faster than DRAM.

Ans. (a)
SRAM is faster than DRAM.

End of Solution

148. **Statement (I):** In a multiuser system, each user is assigned a section of usable memory area and is not allowed to go out of the assigned memory area.
Statement (II): In multiuser system, there is a software mechanism to prevent unauthorized access of memory by different users.

Ans. (a)

End of Solution

149. **Statement (I):** The external surface of a crystal is an imperfection in itself as the atomic bonds do not extend beyond the surface.
Statement (II): The external surfaces have surface energies that are related to the number of bonds broken at the surface.

Ans. (b)

End of Solution

150. **Statement (I):** By organizing' various ' optical functions into an 'array structure' via nano-pattern replication, 'spatial integration' is established.
Statement (II): By adding a nano-optic layer or layers to functional optical materials, the 'hybrid integration' is possible to be achieved.

Ans. (b)

End of Solution

■■■■