IES MASTER

Institute for Engineers (IES/GATE/PSUs)

ESE-2016

Detailed Exam Solutions
(Objective Paper-II)
Electrical Engineering

In case there is any kind of discrepancy in solutions please write to us at ***ies_master@yahoo.co.in*** or call us at : **Ph: 011-41013406, 09711853908** for rectification/deletion/updation of the same.

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Explanation of Electrical Engg. Objective Paper-II (ESE - 2016)

SET - A

1. Compared to the salient-pole Hydroelectric generators, the steam and the gas-turbine have cylindrical rotors for

(a) Better air-circulation in the machine

(b) Reducing the eddy-current losses in the rotor

(c) Accommodating larger number of turns in the field winding

(d) Providing higher mechanical strength against the centrifugal stress

Sol. (d)

Steam and Gas turbine generators have high speed of rotation. For high speed, cylinderical rotor provides greater mechanical strength and have more accurate dynamic balancing.

2. Consider the following losses for short circuit test on a transformer:

1. Copper loss
2. Copper and iron losses
3. Eddy current and hysteresis losses
4. Friction and windage losses

Which of the above is/are correct ?

(a) 1 only (b) 2 only

(c) 3 only (d) 2, 3 and 4

Sol. (a)

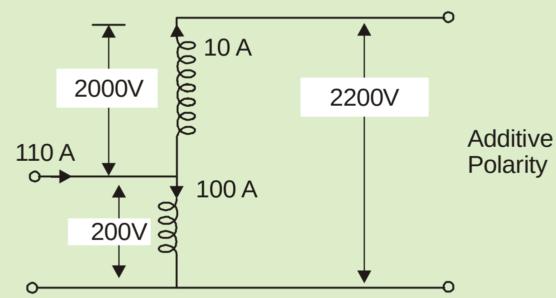
Short circuit test is used to find out copper or ohmic losses in a transformer. In short circuit test rated current flows in the winding whereas applied voltage is 2% – 12% of rated value. As core losses $\propto$ (voltage)^2. Core losses in a short circuit transformer can be neglected for all practical purpose.

3. A 2000 V/200 V, 20 kVA, two winding, single phase transformer is reconnected as a step up auto-transformer having 200 V/2200 V ratings. Then the power rating for the auto transformer will be

(a) 160 kVA (b) 180 kVA

(c) 200 kVA (d) 220 kVA

Sol. (none)



For single phase transformer

Permissible current in 2000V winding

$$= \frac{20\times10^3}{2000} = 10A$$

Permissible current in 200V winding

$$= \frac{20\times10^3}{2000} = 100A$$

So, Power rating = V.I

= (2200) (10)

= 22KVA

No option is correct.

4. The regulation of a transformer in which ohmic loss is 1% of the output and reactance drop is

5% of the voltage, when operating at 0.8 power factor lagging, is

(a) 3.8% (b) 4.8%

(c) 5.2% (d) 5.8%

Sol. (a)

% Voltage regulation = $(\epsilon_r \cos\theta + \epsilon_x \sin\theta)\times 100$

$\cos\theta$ = Power factor

ϵ_r = Per unit equivalent resistance or ohmic losses

ϵ_x = Per unit reactance drop

$\epsilon_r = 0.01$

$\epsilon_x = 0.05$

$\cos\theta = 0.8, \ \sin\theta = 0.6$

% Voltage regulation = [(0.01) (0.8) + (0.05) (0.8)] × 100 = 3.8 %

5. In a power transformer, the core loss is 50 W at 40 Hz and 100 W at 60 Hz, under the condition of same maximum flux density in both cases. The core loss at 50 Hz will be

(a) 64 W (b) 73 W

(c) 82 W (d) 91 W

Sol. (b)

$$\frac{Pc}{f} = a + bf \quad a, b \rightarrow \text{constant}$$

$$\frac{50}{40} = a + 40f$$

$$\frac{100}{60} = a + 60f$$

Solving $b = \frac{1}{48}, \ a = \frac{20}{48}$

P_c at 50 Hz.

$$\frac{P_c}{50} = \frac{20}{48} + \frac{50}{48} = \frac{70}{48}$$

$$P_c \simeq 73 \text{ W}$$

6. Consider the following advantages of a distributed winding in a rotating machine:

1. Better utilization of core as a number of evenly placed small slots are used
2. Improved waveform as harmonic emf's are reduced
3. Diminished armature reaction and efficient cooling

Which of the above advantages are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol. (d)

When conductors are placed in several slots under single pole the type of winding is called distributed winding. Although, distributed winding reduces the emf induced, still it is used because of following reasons:

(i) It reduces harmonic emf, so emf waveform is improved.

(ii) It diminishes armature reaction.

(iii) Distribution of conductors in multi-slots, helps is better cooling.

(iv) The core is fully utilized as the conductors are distributed over the slots on the armature periphery.

7. The breadth factor for 3rd harmonic emf of a 3-phase, 4-pole, synchronous machine having 36 stator slots is

(a) 0.47 (b) 0.53

(c) 0.67 (d) 0.73

Sol. (c)

K_d = distribution or breadth factor

$$K_d = \frac{\sin\frac{qn\gamma}{2}}{q\sin\frac{n\gamma}{2}}$$

Slots = 36

Phase = 3

Poles = 4

n – n^{th} harmonic

q = Number of Slots per pole per phase

$$\gamma = \frac{180}{\text{slots per pole}}$$ (electrical degrees)

$$n = 3,\ q = \frac{36}{3\times 4} = 3$$

$$\gamma = \frac{180}{\frac{36}{4}} = 20°$$

So $$K_d = \frac{\sin\frac{(3)(3)(20)}{2}}{3\cdot\sin\frac{(3)(20)}{2}} = \frac{\sin 90°}{3\sin 30°}$$

$$= \frac{2}{3} = 0.67$$

8. Consider the following factors for a dc machine:

1. Interpole
2. Armature resistance
3. Reduction in field current

Which of the above factors are responsible for decrease in terminal voltage of a shunt generator?

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

Sol. (b)

- Interpoles are used in dc machine to neutralise the armature cross flux and produce some additional flux to counter the induced rotational emf in commutating coil. It does not affect the terminal voltage.
- Since, for shunt generator,
  Terminal Voltage,
  $V_t = E_g - I_a r_a$
  It means, increase in armature resistance decreases the terminal voltage or vice-versa.
- Since, generated emf,
  $$E_g \propto \phi\, \omega_m$$
  $$\propto I_f \omega_m$$
  i.e., reduction in terminal voltage will decrease generated emf and hence decrease the terminal voltage.
  i.e., option (b).

9. A dc motor develops an electromagnetic torque of 150 N-m in a certain operating condition. From this operating condition, a 10% reduction in field flux and 50% increase in armature current is made. What will be new value of electromagnetic torque?

(a) 225 N-m (b) 202.5 N-m
(c) 22.5 N-m (d) 20.25 N-m

Sol. (b)

Torque in D.C. machine $T \propto \phi I_a$

$\phi \rightarrow$ field flux

$I_a \rightarrow$ Armature current

So $T_1 \propto \phi_1 I_{a_1}$

$\phi_2 = 0.9\ \phi_1$; $I_{a2} = 1.5\ I_{a1}$

$T_2 \propto (0.9)\ \phi_1 (1.5)\ I_{a1}$

So $$\frac{T_2}{T_1} = 1.35$$

$T_2 = 1.35\ T_1 = (1.35)\ (150)$

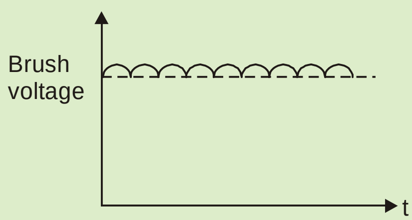
$T_2 = 202.5$ N – m

10. A dc machine, having a symmetrical closed-circuit armature winding and a sinusoidal air-gap flux-density distribution, will have a sinusoidal voltage induced in the individual coils. The resultant brush-to-brush voltage will have a waveform

(a) Sinusoidal with the negative-half reversed
(b) Unidirectional and constant without any ripples
(c) Unidirectional and constant with ripples superimposed
(d) Sinusoidal positive-half and zero negative-half, in each cycle

Sol. (c)

Brush to Brush voltage is resultant of voltage induced in all coils. So output will be a unidirectional voltage with ripples



11. A 3-phase, induction motor operating at a slip of 5% develops 20 kW rotor power output. What is the corresponding rotor copper loss in this operating condition?

(a) 750 W (b) 900 W
(c) 1050 W (d) 1200 W

Sol. (c)

Rotor power output = mechanical power developed in rotor (P_m)

$P_m = 20 \times 10^3$, Slip s = 0.05

$P_m = I_2^2 r_2 \dfrac{(1-s)}{s}$ $\quad I_2^2 r_2$ = Rotor Copper Losses

$$20 \times 10^3 = I_2^2 r_2 \frac{(1-0.5)}{0.5}$$

$$I_2^2 r_2 = \frac{(20\times 10^3)(0.5)}{0.95} = \frac{10\times 10^3}{0.95} \approx 1050\,\text{W}$$

So Rotor copper losses = 1050 W.

12. What are the signs of load angle in an alternator during generator and motor operations, respectively?

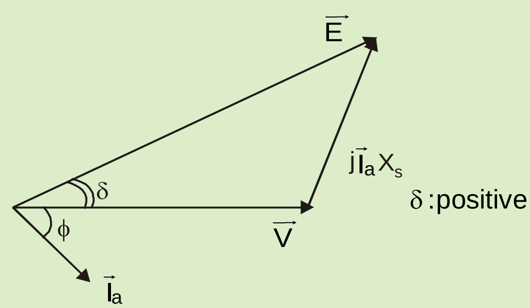
(a) Negative, negative
(b) Positive, negative
(c) Negative, positive
(d) Positive, positive

Sol. (b)

Load angle or Torque angle (δ) is the angle between the induced emf $(\vec{E})$ and terminal voltage $(\vec{V})$, or the angle between the stator and rotor magnetic fields.

For synchronous Generator:

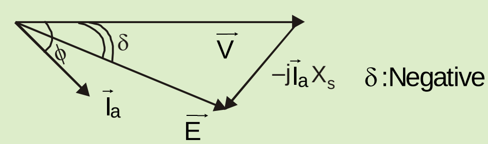
$$\vec{E} = \vec{V} + j\vec{I}_a X_s$$



For synchronous Motor:

$$\vec{V} = \vec{E} + j\vec{I}_a X_s$$

$$\Rightarrow \quad \vec{E} = \vec{V} - j\vec{I}_a X_s$$



13. In an alternator, the armature winding is kept stationary while the field winding is kept roating for the following reasons:

1. Armature handles very large current and high voltage
2. Armature fabrication, involving deep slots to accommodated large coils, is easy if armature is kept stationary
3. It is easier to cool the stator than the rotor

Which of the above reasons are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol. (d)

Advantage of stationary armature winding

- It is economical and efficient
- As armature handles large voltage, so insulation is easy for stationary winding
- Can be cooled easily
- Rotor is lighter and hence low centrifugal forces.
- Fabrication is easy from mechanical stability point of view.

14. Increasing the air-gap of a squirrel-cage induction motor would result in

(a) Increase in no-load speed

(b) Increase in full-load power-factor

(c) Increase in magnetizing current

(d) Maximum available torque

Sol. (c)

$$\text{Flux} = \frac{\text{mmf}}{\text{Reluctance}}$$

For constant flux, if reluctance is high we require large mmf which implies higher current as mmf = (N) (I)

So large air gap implies higher magnetising current.

15. A cumulative compound dc motor runs at 1500 rpm on full load. If its series field is short circuited, its speed

(a) Becomes zero (b) Remains same

(c) Increases (d) Decreases

Sol. (c)

For a cumulative compound motor

$$\omega_m = \frac{1}{K_a(\phi_{sh}+\phi_{se})} \times [V_t - I_a(r_a + r_s)]$$

$\phi_{se} \rightarrow$ flux due to series winding = 0

So ω_m will increase as clear from above equation.

16. If the capacitor of a capacitor-start single-phase motor fails to open when the motor picks up speed,

(a) The motor will stop

(b) The auxiliary winding will be damaged

(c) The capacitor will be damaged

(d) The winding will be damaged

Sol. (c)

If switch fails to open then capacitor will remain in circuit and high voltage appearing across capacitor will damage the capacitor.

17. For a 3-phase induction motor, what fraction/ multiple of supply voltage is required for a direct-on-line starting method such that starting current is limited to 5 times the full-load current and motor develops 1-5 times full-load torque at starting time?

(a) 1.632 (b) 1.226

(c) 0.816 (d) 0.456

Sol. (b)

$$\frac{T_{st}}{T_{fl}} = \left(\frac{I_{st}}{I_{fl}}\right)^2 s_{fl}$$

Let reduced terminal voltage = xV

V → Full load or Rated voltage $I \propto V$

So $I_{st} = x\, I_{sc}$

I_{sc} → Direct on line current

$I_{sc} = 5\, I_{fl}$ (Given)

Assume $s_{fl} = 0.04$

$T_{st} = 1.5\, T_{fl}$

$$\frac{T_{st}}{T_{fl}} = 1.5 = x^2 \left(\frac{I_{sc}}{I_{fl}}\right)^2 s_{fl}$$

$$= x^2 (5)^2 (0.4)$$

$$1.5 = x^2$$

$$\Rightarrow \quad x = 1.226$$

18. What is the material of slip-rings in an induction machine?

(a) Carbon (b) Nickel

(c) Phosphor bronze (d) Manganese

Sol. (c)

Slip ring are made up of phosphor Bronze. Slip rings are tapped by means of copper - carbon brushes.

19. The stator loss of a 3-phase induction motor is 2 kW. If the motor is running with a slip of 4% and power input of 90 kW, then what is the rotor mechanical power developed?

(a) 84.48 kW (b) 86.35 kW

(c) 89.72 kW (d) 90.52 kW

Sol. (a)

Air Gap Power P_g = Power Input-stator losses

$P_g = 90 \times 10^3 - 2 \times 10^3 = 88 \times 10^3$ W

$P_m = (1 - s)\, P_g \quad s = 0.04$

$P_m = (1 - 0.04)\, (88 \times 10^3)$

$P_m = 84.48$ kW

20. In a single-phase capacitor-start induction motor, the direction of rotation

(a) can be changed by reversing the main winding terminals

(b) cannot be changed

(c) is dependent on the size of the capacitor

(d) can be changed only in large capacity motors.

Sol. (a)

Direction can be chaged by interchanging the main winding terminals.

21. Air pollution due to smoke around a thermal power station can be reduced by installing

(a) Induced draft fan

(b) Super heater

(c) Economizer

(d) Electrostatic precipitator

Sol. (d)

Electrostatic precipitator is used to collect the dust particles from the flue gases.

22. The load curve is useful in deciding

1. The operating schedule of generating units
2. The total installed capacity

Which of the above statement is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

Sol. (c)

The load curve indicates average (KWh) energy consumption during a given period and hence it is useful in deciding both the operating schedule of generating units and the total installed capacity.

23. The maximum demand on a steam power station is 480 MW. If the annual load factor is 40%, then the total energy generated annually is

(a) 19819.2×10^5 kWh

(b) 18819.2×10^5 kWh

(c) 17819.2×10^5 kWh

(d) 16819.2×10^5 kWh

Sol. (d)

Maximum demand = 480 MW.

Annual load factor = 40%

$\therefore$ Total energy generated anually will be

$$480\times\frac{40}{100}\times24\times365\times10^6$$

$= 16819.2\times10^5$ kWh

24. To equalize the sending and receiving end voltages, impedance is connected at the receiving end of a transmission line having the following ABCD parameters

$A = D = 0.9\ \angle0^\circ\ \ B = 200\ \angle90^\circ\,\Omega$

The impedance so connected would be

(a) $1000\ \angle0^\circ\,\Omega$ (b) $1000\ \angle90^\circ\,\Omega$

(c) $2000\ \angle90^\circ\,\Omega$ (d) $200\ \angle0^\circ\,\Omega$

Sol. (c)

Using the equation,

$$V_s = AV_R + BI_R$$

Now, to equalize the sending and receiving end voltages $V_s = V_R$.

$$\therefore \quad V_R = AV_R + BI_R$$

$$\Rightarrow V_R(1-A) = BI_R$$

$$\Rightarrow \frac{V_R}{I_R} = \frac{B}{1-A} = \frac{200\angle90^\circ}{1-(0.9\angle0^\circ)}$$

$$\Rightarrow \frac{V_R}{I_R} = \frac{200\angle90^\circ}{0.1} = 2000\angle90^\circ$$

25. The maximum efficiency in the transmission of bulk ac power will be achieved when the power factor of the load is

(a) Slightly less than unity lagging

(b) Slightly less than unity leading

(c) Unity

(d) Considerably less than unity

Sol. (b)

A load with slightly less than Unity Power Factor leading will supply the reactive power requirement of the transmission line. Also current flow in the line will reduce which causes the reduction in losses. Therefore a slightly leading power factor will help in efficient transmission of bulk power.

26. A speed of a dc motor is

(a) Directly proportional to back emf and inversely proportional to flux

(b) Inversely proportional to back emf and directly proportional to flux

(c) Directly proportional to back emf as well as to flux

(d) Inversely proportional to back emf as well as to flux

Sol. (a)

Back Emf $E_b = K_a\phi\omega_m$

$$\omega_m = \frac{E_b}{K_a\phi}$$

$E_b \rightarrow$ Back emf

$\phi \rightarrow$ Flux.

27. When the sending end voltage and current are numerically equal to the receiving end voltage and current respectively, then the line is called

(a) A tuned line (b) A transposed line

(c) A long line (d) A short line

Sol. (a)

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} \cosh\gamma l & Z_C \sinh\gamma l \\ \frac{1}{Z_C}\sinh\gamma l & \cosh\gamma l \end{bmatrix}\begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

Now, for an overhead line, neglecting G and R.

$$\gamma = j\omega\sqrt{LC}$$

$$\therefore \quad \cosh\gamma l = \cosh j\omega l\sqrt{LC} = \cos\omega l\sqrt{LC}$$

$$\sinh\gamma l = \sinh j\omega l\sqrt{LC} = j\sin\omega l\sqrt{LC}$$

Hence,

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} \cos\omega l\sqrt{LC} & jZ_C \sin\omega l\sqrt{LC} \\ \frac{j}{Z}\sin\omega l\sqrt{LC} & \cos\omega l\sqrt{LC} \end{bmatrix}\begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

If $\omega l\sqrt{LC} = n\pi;\ n = 1, 2, 3, \ldots.$

Then $|V_S| = |V_R|$ and $|I_S| = |I_R|$

i.e. the receiving-end voltage and current are numerically equal to the corresponding sending-end waves. Such line is called a tuned line.

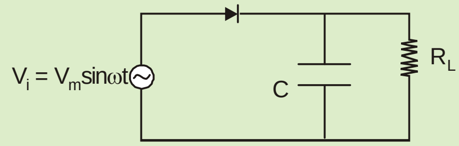
28. If V_m is the peak value of an applied voltage in a half wave rectifier with a large capacitor across the load, then the peak inverse voltage will be

(a) 0.5 V_m (b) V_m

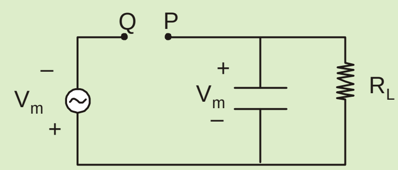
(c) 1.5 V_m (d) 2.0 V_m

Sol. (d)

Peak inverse voltage is the maximum voltage which appears across a diode when it is under reverse bias.



During the positive half cycle of V_i, the capacitor C is charged to V_m volts. During the negative half cycle of V_i, the circuit will be as below: (Diode will be reverse biased and acts as open circuit).



Voltage across diode during reverse bias V_{PQ} $= V_m + V_m = 2\,V_m$

$\therefore$ PIV = $2V_m$

29. A 100 MVA generator operates on full-load of 50 Hz frequency. The load is suddenly reduced to 50 MW. The steam valve begins to close only after 0.4s and if the value of the inertia constant H is 5s, then the frequency at 0.4s is nearly

(a) 38 Hz (b) 44 Hz

(c) 51 Hz (d) 62 Hz

Sol. (c)

$$H = \frac{\text{Stored Energy}}{\text{Capacity of machine}}$$

So, energy stored = (H) (M)

= (100) (5)

= 500 MJ

With load throw off of 50 MW, energy gain by generator in 0.4 sec. = (50) (0.4)

= 20 MJ

$$f_{new} = f_0\sqrt{\frac{H \pm \Delta H}{H}}$$

$\Delta H \rightarrow$ Change in energy before opening of steam valve

$(+) \rightarrow$ When energy is gained

$(-) \rightarrow$ When energy is lost

$f_0 \rightarrow$ Initial frequency

$$f_{new} = 50 \times \sqrt{\frac{500+20}{500}}$$

$$= 50 \times \sqrt{\frac{520}{500}}$$

$$\simeq 51 \text{ Hz}$$

30. A 25 MVA, 33 kV transformer has a pu impedance of 0.9. The pu impedance at a new base 50 MVA at 11 kV would be

(a) 10.4 (b) 12.2

(c) 14.4 (d) 16.2

Sol. (d)

$$Z_{pu2} = Z_{pu1} \cdot \frac{(MVA)_2}{(MVA)_1} \cdot \frac{(KV_1)^2}{(KV_2)^2}$$

$(MVA)_1 = 25,\ KV_1 = 33,\ Z_{PU1} = 0.9$

$(MVA)_2 = 50,\ KV_2 = 11$

$$Z_{pu2} = (0.9)\ \frac{50}{25} \cdot \left(\frac{33}{11}\right)^2$$

$$= (0.9)\ (2)\ (9)$$

$$Z_{PU2} = 16.2$$

31. Symmetrical components are used in power system for the analysis of

(a) Balanced 3-phases fault

(b) Unbalanced 3-phase fault

(c) Normal power system under steady conditons

(d) Stability of system under disturbance

Sol. (b)

Symmetrically components are used in power system for the analysis of unbalanced 3-phase fault.

32. For V-curves for a synchronous motor the graph is drawn between

(a) Terminal voltage and load factor

(b) Power factor and field current

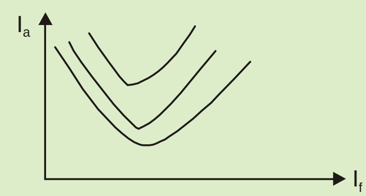
(c) Field current and armature current

(d) Armature current and power factor

Sol. (c)

X – axis $\rightarrow$ Field Current

Y – axis $\rightarrow$ Armature current



33. Critical clearing angle is related to

(a) Stability study of power system

(b) Power flow study of power system

(c) Regulation of transmission line

(d) Power factor improvement of the system

Sol. (a)

The maximum allowable value of the clearing time and angle for the system to remain stable are known respectively as critical clearing time and angle.

34. A 2-pole, 50 Hz, 11 kV, 100MW alternator has a moment of inertia of 10,000 kg.m^2. The value of inertia constant, H is

(a) 3.9 s (b) 4.3 s

(c) 4.6 s (d) 4.9 s

Sol. (d)

$$H = \frac{G}{M}$$

$$G = \frac{1}{2} I\omega^2 \qquad I \rightarrow \text{Moment of Inertia}$$

$I = 10{,}000$ kg. m^2 G $\rightarrow$ Energy stored in Machine

M = Rated Power = 100 MVA

$$H = \frac{\frac{1}{2}\cdot(10^4)(2\pi\times 50)^2}{100\times 10^6} = 4.93 \text{ s}$$

H = 4.93 sec

35. Stability of power system can be improved by

1. Using series compensators
2. Using parallel transmission lines
3. Reducing voltage of transmission

Which of the above statements are correct?

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

Sol. (d)

Stability of a power system can be improved by

(i) higher system voltage
(ii) use of parallel lines to reduce the series reactance.
(iii) Use of high speed circuit breakers and auto-reclosing breakers.
(iv) Reducing the series reactance there by increasing Pm and therefore increases the transient stability limit of a system.

36. Equal-Area Criterion is employed to determine

(a) The steady state stability
(b) The transient stability
(c) The reactive power limit
(d) The rating of a circuit breaker

Sol. (b)

Equal-area criterion is employed to analyse the transient stability.

37. Consider the following advantages with respect of HVDC transmission:

1. Long distance transmission
2. Low cost of transmission
3. Higher efficiency

Which of the above advantages are correct?

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

Sol. (b)

Advantages of HVDC systems.

(i) Economical for long distance bulk power transmission by overhead lines.
(ii) Greater power per conductor and simpler line construction.
(iii) No skin effect
(iv) No reactive compensation is required.
(v) Higher operating voltage is possible
(vi) No stability problem.

Disadvantages of HVDC systems.

(i) Installation of converters and switch gear makes it expensive.
(ii) Harmonic are generated which require filters
(iii) Voltage transformation is not easy.

38. The three sequence voltages at the point of fault in a power system are found to be equal. The nature of the fault is

(a) L–G (b) L–L–L
(c) L–L (d) L–L–G

Sol. (d)

For double line to ground fault

$$Va_0 = Va_1 = Va_2 = \frac{V_a}{3}$$

Here phase b and c are shorted to ground.

39. A distance relay with inherent directional property is known as

(a) Buchholtz relay

(b) Admittance relay

(c) Directional over current relay

(d) Directional switched relay

Sol. (b)

Its characteristic (Admittance relay) passes through origin of R–x diagram and hence directional.

40. Consider the following circuit breakers for 220 kV substations:

1. Air
2. SF_6
3. Vacuum

Which of the above circuit breakers can be used in an indoor substation?

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

(c) 2 only (d) 3 only

Sol. (c)

- SF_6 breakers are used for 220KV indoor substations due to smaller size. Other breakers i.e. Air and Vacuum are used in outdoors for 220KV sub-station.

41. A semiconductor differs from a conductor in that it has

(a) Only one path for the free electrons in the valence band

(b) Only one path for holes in the conduction band

(c) Two paths followed by free electrons and holes, one an ordinary path in the conduction band and the other one an extraordinary path in the valence band, respectively

(d) Two paths followed by free electrons and holes, one an extraordinary path in the conduction band and the other one an ordinary path in valence band, respectively

Sol. (c)

In a semiconductor, conduction band and valence band are separated by energy gap. At room temperature, some of the e^- in V.B. gains enough energy to overcome the energy gap and move into C.B. leaving behind an empty space in V.B which is called as Hole. An e^- in the V.B. may fill the hole, leaving another hole in its place. In this way, a hole appears to move.

In the presence of electric field e^- move in one direction and holes appear to move in the opposite direction and both contribute to conductivity of the material.

Hence, e^- moves in ordinary path in C.B. and holes move in extra-ordinary path in V.B.

42. Which of the following circuits is used for converting a sine wave into a square wave?

(a) Monostable multivibrator

(b) Bistable multivibrator

(c) Schmitt trigger circuit

(d) Darlington complementary pair

Sol. (c)

Schmitt Trigger is used as a wave shaping circuit. It is used to convert a sine wave into a square wave by fixing the output voltage at two distinct voltage levels.

43. What is the type of breakdown that occurs in a Zener diode having breakdown voltage (bV)?

(a) Avalanche breakdown only

(b) Zener breakdown only

(c) Avalanche breakdown where breakdown voltage is below 6V and Zener breakdown otherwise

(d) Zener breakdown where breakdown voltage is below 6V and Avalanche breakdown otherwise

Sol. (d)

Zener Breakdown occurs in heavily doped junction which produce narrow depletion region. Under a very high reverse voltage, the high electric field break some of the covalent bonds of semiconductor atoms leading to large number of minority carriers which suddenly increase the reverse current. This is zener effect.

Avalanche breakdown occurs in lightly doped junctions which has wide depletion layers. Hence, Avalanche breakdown will occur for reverse voltage greater than zener voltage. For a zener diode having breakdown of 6V, breakdown below 6V is due to zener effect and breakdown above 6V is due to Avalanche effect.

44. Consider the following statements:

A power supply uses bridge rectifier with a capacitor input filter. If one of the diodes is defective, then

1. The dc load voltage will be lower than its expected value
2. Ripple frequency will be lower than its expected value
3. The surge current will increase considerably

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

Sol. (d)

A bridge rectifer is a full wave rectifier. If the input voltage is $V_i = V_m \sin(2\pi ft)$, then for a full wave rectifier,

$$V_{d\cdot c} = \frac{2V_m}{\pi}$$

Ripple frequency = 2f

If one of the diode is defective, the bridge rectifier will now work as a half wave rectifier

and $V_{d\cdot c} = \frac{V_m}{\pi}$, Ripple frequency = f.

Hence, the d.c voltage and ripple frequency will be lower than the expected value.

Surge current is the brief and large current that exists when the power is first turned on. It is large because the filter capacitor must charge to peak voltage during the first few cycles. When one on the diode is defective in bridge rectifier, surge current increases.

Hence, 1, 2 & 3 are correct.

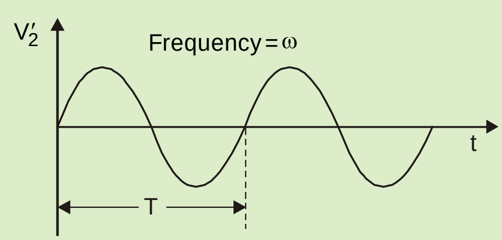
45. The lowest frequency of ac components in the outputs of half-wave and full-wave rectifiers are, respectively, (where ω is the input frequency)

(a) 0.5ω and ω (b) ω and 2ω

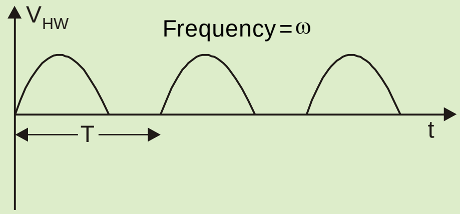
(c) 2ω and ω (d) ω and 3ω

Sol. (b)

Input signal:

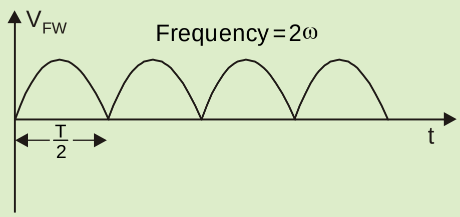


Output of Half wave Rectifier:



The time period of the output of Half wave rectifier is same as that of input signal. Hence, the lowest frequency in the output is same as input frequency i.e. ω

Output of full wave rectifier:



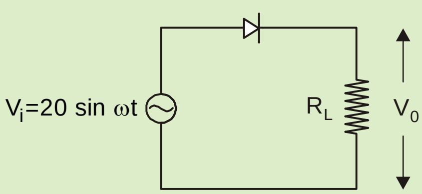
The time period of the output of full wave Rectifier is half the period of input wave. Hence, the lowest frequency in the output is twice the input frequency i.e. 2ω

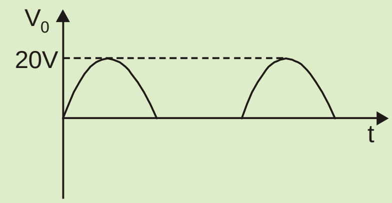
46. A half-wave rectifier circuit using ideal diode has an input voltage of 20 sin ωt Volt. Then average and rms values of output voltage respectively, are

(a) $\frac{10}{\pi}$ V and 5 V (b) $\frac{20}{\pi}$ V and 10 V

(c) $\frac{20}{\pi}$ V and 5 V (d) $\frac{10}{\pi}$ V and 10 V

Sol. (b)





For a half wave rectifier:

Average value of voltage = $\frac{V_m}{\pi} = \frac{20}{\pi}$ Volts

R.M.S value of voltage = $\frac{V_m}{2} = \frac{20}{2} = 10$ Volts

47. For a BJT, I_C = 5 mA, I_B = 50 μA and I_{CBO} = 0.5 μA, then the value of β is

(a) 99 (b) 91

(c) 79 (d) 61

Sol. (a)

The collector current in a BJT is given by:

$$I_C = \beta I_B + (1+\beta)I_{CBO}$$

$$\Rightarrow \quad I_C = \beta I_B + I_{CBO} + \beta I_{CBO}$$

$$\therefore \quad \beta = \frac{(I_C - I_{CBO})}{(I_B + I_{CBO})}$$

$$= \frac{(5\times10^{-3} - 0.5\times10^{-6})}{(50\times10^{-6} + 0.5\times10^{-6})}$$

$$= \frac{4999.5}{50.5}$$

$$\therefore \quad \beta = 99$$

48. Which of the following conditions must be satisfied for a transistor to be in saturation?

1. Its collector to base junction should be under forward bias
2. Its collector to base junction should be under reverse bias

3. Its emitter to base junction should be under reverse bias
4. Its emitter to base junction should be under forward bias

Which of the above conditons are correct?

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

Sol. (d)

A Transistor is said to be operating in saturation region if:

1. Emitter to Base Junction is forward biased

2. Collector to Base junction is forward biased

Statement 1 & 4 are correct.

49. In an amplifier with a gain of 1000 without feedback and cut-off frequencies at 2 kHz and 20 kHz, negative feedback of 1% is employed. The cut-off frequencies with feedback would be

(a) 220 Hz and 22 kHz

(b) 182 Hz and 220 kHz

(c) 220 kHz and 220 kHz

(d) 20 Hz and 22 kHz

Sol. (b)

For the given amplifier:

Gain (A) = 1000

Lower cut-off frequency f_L = 2kHz

Higher cut-off frequency f_H = 20 kHz

Feedback factor β = 0.01

In case of negative feedback, the gain of the amplifier reduces and Bandwidth increases.

The lower cut-off frequency is reduced and is given by:

$$f'_L = \frac{f_L}{1+A\beta} = \frac{2\times10^3}{1+1000\times0.01}$$

$$= 181.8 \text{ Hz}$$

$$\therefore \quad f'_L = 182 \text{ Hz}$$

The higher cut-off frequency increases and is given by:

$$f'_H = (1+A\beta)f_H$$

$$= (1 + 1000 \times 0.01) \times 20 \times 10^3$$

$$\therefore \quad f'_H = 220 \text{ kHz}$$

50. Consider the following circuits:

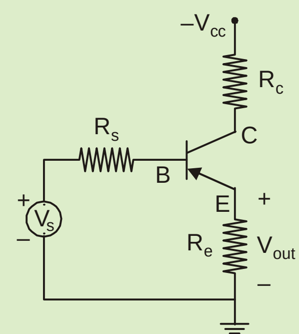
1. Oscillator
2. Emitter follower
3. Power amplifier

Which of the above circuits employ are feedback?

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

Sol. (d)

1. With the use of positive feedback or regenerative feedback in a circuit, oscillations will take place and circuit works as oscillator.
2. For the emitter follower circuit shown below, the feedback signal is the voltage V_f across emitter resistor R_e and the sampled signal V_s is the output voltage across R_e. It is a case of voltage series feedback.

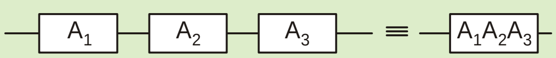


3. In a power amplifier ,AC negative feedback is used to reduce distortion and noise and widen bandwidth. Moreover, DC negative feedback is used to stabilise the DC biasing.There is also some positive feedback, 'BOOTSTRAPPING' applied to increase input impedance and improve efficiency. Other essential feature includes the use of diodes to provide thermal stability and same bias adjustments to give minimum distortion.

51. Three identical amplifiers each having a voltage gain of 50 are cascaded. The open loop voltage gain of the combined amplifier is

(a) 71 dB (b) 82 dB
(c) 91 dB (d) 102 dB

Sol. (d)



Over all voltage gain: $A_V = A_1A_2A_3$

$\Rightarrow \quad A_V = 50 \times 50 \times 50$

[∵ Amplifiers are identical]

$\Rightarrow \quad A_V = 125000$

$\therefore \quad A_V|_{dB} = 20 \log_{10} (A_V)$

$= 20 \log_{10} (125000)$

$= 102 dB$

52. A clamper circuit

1. Adds or subtracts a dc voltage to or from a waveform
2. Does not change the shape of the waveform

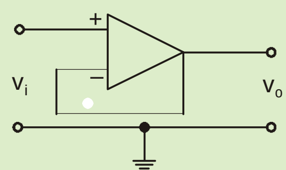
Which of the above statements are correct?

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

Sol. (c)

A clamper circuit can add or subtract the DC voltage to or from a waveform. The frequency of the waveform remains unaffected. Moreover, the shape remains unaltered with the addition of DC-voltage. Hence, shape of waveform remains same before and after clamping.

53.

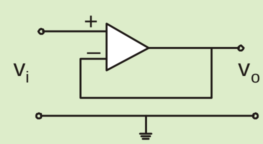


The operational amplifier circuit shown in figure having a voltage gain of unity has

(a) High input impedance and high output impedance
(b) High input impedance and low output impedance
(c) Low input impedance and low output impedance
(d) Low input impedance and high output impedance

Sol. (b)

The given circuit is a voltage follower. For a voltage follower



(i) Closed-loop gain, $A_f = 1$
(ii) Closed-loop input impedance, $R_{inf} = A R_{in}$
(iii) Closed-loop output impedance; $R_{outf} = \frac{R_{out}}{A}$
(iv) Bandwidth with feedback, $f_f = A f_0$

where R_{in}, R_{out}, A represents open loop gain.

From (ii) it is clear that R_{inf} will be high.

Form (iii) it is clear that R_{outf} will be low.

54. Consider the following statements:

1. Race-around condition occurs in a JK flip-flop when the inputs are 1, 1
2. A flip-flop is used to store one bit of information
3. A transparent latch consists of D-type flip-flops
4. Master-slave configuration is used in a flip-flop to store two bits of information

Which of the above statements are correct?

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

Sol. (a)

Master slave configuration is used to avoid race around condition. It doesnot store two bits of information. Rest statements are correct.

55. An operational amplifier has slew rate of 2V/μ sec. If the peak output is 12 V, what will be the power bandwidth?

(a) 36.5 kHz (b) 26.5 kHz
(c) 22.5 kHz (d) 12.5 kHz

Sol. (b)

Full power response of an op-amp is given as.

$$f_{max} = \frac{SR|_{max}}{2\pi V_{Pout}}$$

$$\Rightarrow \quad f_{max} = \frac{2\times10^6}{2\pi\times12} = 26.525 \text{ kHz}$$

$\Rightarrow$ Power Bandwidth; $Bw_P = f_{max}$

$\Rightarrow$ $Bw_P = 26.5$ kHz.

56. A voltage follower is used as

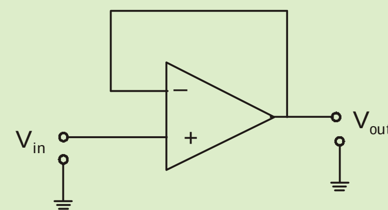
1. An isolation amplifier
2. A buffer amplifier

Which of the above statements is/are correct?

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

Sol. (c)

- An isolation amplifier is an op-amp circuit which provides isolation of one part of the circuit from another so that power is not used in a part of the circuit hence it is a voltage amplifier.
- A voltage amplifier is also a buffer amplifier since a buffer is nothing but a storing device which cannot modify input signal.



57. If a, b, c are 3-input variables, then Boolean function y = ab + bc + ca represents

1. A 3-input majority gate
2. A 3-input minority gate
3. Carry output of a full adder
4. Product circuit for a, b and c

Which of the above statements are correct?

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

Sol. (c)

A majority gate returns true if and only if more than 50% inputs are true

Y = ab + bc + ca is a 3 input majority gate

Y is also carry output of full adder

58. In a 2-input CMOS logic gate, one input is left floating i.e. connected neither ground nor to a signal. What will be the state of that input?

(a) 1

(b) 0

(c) Same as that of the other input

(d) Indeterminate (neither 1 nor 0)

Sol. (d)

A floating input for a CMOS gate may be considered as either of the logic levels.

CMOS inputs are sensitive to high voltages generated by electrostatic (static electricity) sources and may even be activated into High (1) or Low (0) states by spurious voltage sources.

59. The expression for MOD number for a ripple counter with N flip-flops is

(a) N (b) 2^N
(c) 2^{N-1} (d) 2^N-1

Sol. (b)

The expression for MOD number for a ripple counter with N Flip flop is 2^N

60. Why a ROM does not have data inputs?

(a) It does not have a WRITE operation

(b) Data inputs are integrated with data outputs

(c) Data inputs are integrated with address inputs

(d) ROM is sequentially accessed

Sol. (a)

Data cannot be written on ROM chip.

Hence it only has data output pins ROM - Read only memory.

61. Consider the following statements:

1. RAM is a non-volatile memory whereas ROM is a volatile memory
2. RAM is a volatile memory whereas ROM is a non-volatile memory
3. Both RAM and ROM are volatile memories but in ROM data is not when power is switched off

Which of the above statements are correct?

(a) 1 only (b) 2 only
(c) 3 only (d) None of the above

Sol. (b)

Non-volatile is a term used to describe any memory or storage that is saved regradless if the power to the computer is on or off. The best example of non-volatile memory and storage is a computer hard drive, flash memory and ROM. If data is stored in a hard drive, it will remain on that drive regardless if the power is interupted, which is why it is the best place to store data and documents.

62. Consider the following instructions:

1. LOCK
2. STD
3. HLT
4. CLI

Which of the above are machine control instructions?

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

Sol. (b)

Flag Manipulation instruction in 8086

CLI
CLC
CMC
STC
STD
STI
CLD

Machine control instruction in 8086

WAIT
HLT
NOP
ESC
LOCK

∴ Correct option is ‘b’

63. What is the assemble directive statement used to reserve an array of 100 words in memory and initialize all 100 words with 0000 and give it a name STORAGE?

(a) STORAGE DW 100

(b) STORAGE DW 100 DUP (0)

(c) STORAGE DW 100 DUP (?)

(d) STORAGE DB 100

Sol. (b)

STORAGE DW 100 DUP (0) $\Rightarrow$ Reserve an array of 100 words of memory and initialise all words with 0000 and gives it name as STORAGE.

DW $\rightarrow$ This directive is used to define a variable of type word or to reserve storage location of type word in memory.

DB $\rightarrow$ This directive is used to declare a byte type variable or to store a byte in memory location.

64. Consider the following statements:

1. Auxiliary carry flag is used only by the DAA and DAS instructions
2. Zero flag is set to 1 if the two operands compared are equal
3. All conditional jumps are long-type jumps

Which of the above statements are correct?

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

(c) 1 and 3 only (d) 2 and 3 only

Sol. (b)

- Auxiliary carry flag is used only by the DAA and DAS instructions.
- All conditional jumps are short-type jumps.

65. If a 3-phase slip ring induction motor is fed from the rotor side with stator winding short circuited, then frequency of currents flowing in the short circuited stator is

(a) Slip × frequency

(b) Supply frequency

(c) Frequency corresponding to rotor speed

(d) Zero

Sol. (a)

Speed of rotor field initially = Ns

Speed of stator field winding = Ns

Cause of field in stator $\rightarrow$ rotor field

Rotor should be rotated such that emf induced in stator is reduced. Rotor rotates in direction opposite to that of rotating magnetic field. Speed of rotating magnetic field w.r.t stator = $N_s - N_r$ $= sN_s$, s $\rightarrow$ slip

So induced field in stator rotates at speed $N_s - N_r = sN_s$

Frequency of stator field = sf_1

f_1 $\rightarrow$ supply frequency

Frequency of current in stator $f_2 = sf_1$

66. The reversing of a 3ϕ induction motor is achieved by

(a) Y–Δ starter

(b) DOL starter

(c) Auto transformer

(d) Interchanging any two of the supply line

Sol. (d)

By interchanging any two supply terminal, the direction of rotating magnetic field produced by induction motor is reversed. Which in turns reverses the direction of rotation.

67. Consider the following interrupts for 8085 microprocessor:

1. INTR
2. RST 5.5
3. RST 6.5
4. RST 7.5
5. TRAP

If the interrupt is to be vectored to any memeory location then which of the above interrupts is/ are correct?

(a) 1 and 2 only (b) 1, 2,3 and 4
(c) 5 only (d) 1 only

Sol. (d)

In all five hardware interrupts ie. TRAP, RST 7.5, RST 6.5, RST 5.5 and INTR, only INTR is a non-vectored interrupt. There are 8 numbers of CALL-locations for INTR interrupt ie. upto 8 number of I/o devices can be connected to INTR through an external hardware.

68. The instruction JNC 16 bit refers to Jump to 16 bit address if

(a) Sign flag is set

(b) CY flag is reset

(c) Zero flag is set

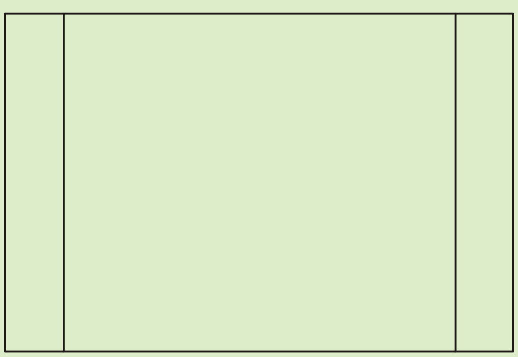
(d) Parity flag is reset

Sol. (b)

JNC (16 bit address) :

- The program jumps to the instruction which is specified by the address if there is no carry (ie. if CY = 0) or if CY flag is reset
- No flags will be affected
- Immediate addressing mode
- It takes 2 or 3 machine cycles

69. Consider the symbol shown below:



What function does the above symbol represent in a program flow chart?

(a) A process

(b) Decision making

(c) A subroutine

(d) Continuation

Sol. (c)

Given symbol is,

In a program flow chart, above symbol is used to show complex processing steps which may be detailed in a seperate flow-chart. So, it is used for predefined process or for subroutine.

70. Which one of the followng statements is correct regarding the instruction CMP A

(a) Compare accumulator with register A

(b) Compare accumulator with memory

(c) Compare accumulator with register H

(d) This instruction does not exist

Sol. (a)

CMP A : - Compare the register A with Accumulator.

In this instruction, the content of register A is subtracted from the content of the accumulator. Status flags are set/reset according to the result of subtraction. The content of accumulator remains unchanged.

71. The instruction RET executes with the following series of machine cycle

(a) Fetch, read, write

(b) Fetch, write, write

(c) Fetch, read, read

(d) Fetch, read

Sol. (c)

RET :

– Return to main program unconditionally.

– Register indirect addressing mode

– 1 Byte instruction

– No flag is affected

– Three machine cycles (Fetch + Read + Read)

When RET instruction is excuted, it takes three machine cycles. In first machine cycle, microprocessor fetches the opcode, during second and third machine cycles, it reads the contents of top of stack.

72. Consider the following circuits :

1. Full adder
2. Half adder
3. JK flip-flop
4. Counter

Which of the above circuits are classified as sequential logic circuits?

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

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

Sol. (b)

Full adder and Half adder are combination circuits, whereas JK Flip Flop and counter are sequential logic circuit.

73. When a peripheral is connected to the microprocessor in Input Output mode, the data transfer takes place between.

(a) Any register and I/O device

(b) Memory and I/O device

(c) Accumulator and I/O device

(d) HL register and I/O device

Sol. (c)

When a peripheral is connected to the microprocessor in input/output mode, the data transfer takes place between. Accumulator and I/o device. IN and OUT instructions are used for data transfer.

In port address : The data available on the port is moved to the accumulator.

Out port address : The content of the accumulator is moved to the port specified by its address.

74. While execution of IN/OUT instruction takes place, the 8-bit address of the port is placed on

(a) Lower address bus

(b) Higher address bus

(c) Data bus

(d) Lower as well as higher order address bus

Sol. (b)

While execution of IN/OUT instruction takes place, the 8-bit address of the port is placed on $A_8 - A_{15}$ lines of address bus ie. higher address bus.

75. The port C of 8255 can be configured to work in

(a) mode 0, mode 1, mode 2 and BSR

(b) mode 0, mode 1 and mode 2

(c) mode 2 and BSR

(d) BSR mode only

Sol. (a)

The intel 8255 can function brodly in two modes : The Bit Set/Reset (BSR) mode and the I/o mode. The BSR mode is used to set or reset the bits in port C. The I/o mode is further function in three modes : Mode 0, Mode 1 and Mode 2. Port C can be configured in all three modes. Port A can also configured in all three modes but Port B can configured in only Mode - 0 and Mode - 1

76. Consider the following statements :

1. Semiconductor memories are organized as linear array of memory locations
2. To address a memory location out of N memory locations, at least log N bits of address are required
3. 8086 can address 1,048,576 addresses
4. Memory for an 8086 is set up as two banks to make it possible to read or write a word with one machine cycle

Which of the above statements are correct?

(a) 1, 2 and 3 only

(b) 1, 2 and 4 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

Sol. (c)

Let there are 'n' bit of address. Total number of memory locations will be 2^n

$\therefore \quad N = 2^n$

Taking log of base 2, we have

$\log_2 N = \log_2 2^n$

$\therefore \quad n = \log_2 N$ bits

Statements (2) is wrong

Hence, correct option will be (c).

77. The sticker over the EPROM window protects the chip from

(a) Infrared light from sunlight

(b) UV light from fluorescent lights and sunlight

(c) Magnetic field

(d) Electrostatic field

Sol. (b)

The sticker over the EPROM window protects the chip from UV light from fluorescent lights and sunlight. UV light erases the content of EPROM in several minutes; sunlight would erase EPROM in weeks and indoor fluorscent lighting over several years.

78. A 2400/240 V, 200 kVA, single phase transformer has a core loss of 1.8 kW at rated voltage. Its equivalent resistance is 1.1%. Then the transfer efficiency at 0.9 power factor and on full load is

(a) 95.60% (b) 96.71%

(c) 97.82% (d) 98.93%

Sol. (c)

$$\eta = \frac{\text{output}}{\text{Input}} \times 100$$

$$= \frac{(\text{KVA})\cos\phi}{(\text{KVA})\cos\phi + P_c + P_o} \times 100$$

$P_c \rightarrow$ Core losses $= 1.8 \times 10^3$ w

$\cos\phi = 0.9$

$P_o \rightarrow$ ohmic losses $\rightarrow$ 1.1% equivalent resistance

It implies ohmic losses are 1.1% of rated VA equivalent resistance

$$= \frac{\text{Ohmic losses at rated load}}{(\text{RatedKVA})} \times 100$$

$$\text{Ohmic losses} = \frac{(1.1)(200 \times 10^3)}{100} = 2.2\text{KW}$$

Output = (KVA) cosϕ = (200 × 10^3) (0.9) = 180 KW

So $\eta = \dfrac{180\times10^3}{180\times10^3+2.2\times10^3+1.8\times10^3}\times100 = 97.82\%$

79. The 8259A Programmable Interrupt Controller in cascade mode can handle interrupts of

(a) 8 priority levels

(b) 16 priority levels

(c) 32 priority levels

(d) 64 priority levels

Sol. (d)

One 8259 A can handle 8 I/o devices to transfer data using interrupt technique. If there are more than 8 I/o devices to transfer data using interrupt, two 8259 A ICs can be connected in series or cascading. Hence, upto 64 I/o devices or priority levels can be connected employing two 8259A. ICs.

80. 8259A Programmable Interrupt Controller uses the following initialization comands :

1. ICW_1
2. ICW_2
3. ICW_3
4. ICW_4

If 8259A is to be used in cascaded and fully nested mode, the ICW_1 bits D_0 and D_1 are

(a) 0 and 0

(b) 1 and 0

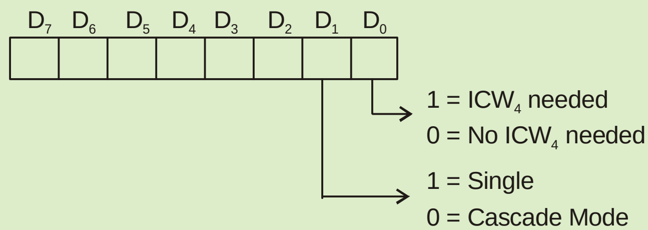
(c) 0 and 1

(d) 1 and 1

Sol. (a)

The 8259A can be initialised with four Initialisation Command Words (ICWs); the first two are essential and other two are optional based on the modes being used. These word must be issued in a given sequence.

The specific EOI Command Format for ICW_1,



Hence, $D_0 = 0$

$D_1 = 0$

81. The induced emf in the armature conductor of a D.C. machine is

(a) Sinusoidal

(b) Trapezoidal

(c) Rectangular unidirectional

(d) Triangular

Sol. (a)

Induced emf is sinusoidal but output is rectified by commutation action.

82. If a carrier of 100% modulated AM is suppressed before transmission, the power saving is nearly

(a) 50% (b) 67%

(c) 100% (d) 125%

Sol. (b)

Here, modulation index m = 1

Total Power with carrier $P_T = P_c\left(1+\dfrac{m^2}{2}\right)$

If carrier is suppressed then power will be

$$P_1 = P_c\frac{m^2}{2}$$

Power saving = $\frac{\text{Power saved}}{\text{Total Power}} = \frac{P_T - P_1}{P_T}$

$$= \frac{P_c + P_c\frac{m^2}{2} - P_c\frac{m^2}{2}}{P_c\left(1+\frac{m^2}{2}\right)} = \frac{2}{2+m^2} = \frac{2}{2+1}$$

$$= \frac{2}{3} = 0.67 = 67\%$$

83. An FM Signal is represented by v = 12 sin(6 × 10^8 t + 5 sin 1250t). The carrier frequency f_c and frequency deviation δ, respectively, are

(a) 191 MHz and 665 Hz

(b) 95.5 MHz and 995 Hz

(c) 191 MHz and 995 Hz

(d) 95.5 MHz and 665 Hz

Sol. (b)

$$V = 12\sin\left(6\times10^8 t + 5\sin 1250t\right)$$

Comparing with standard equation of FM signal,

$$s(t) = A_C \sin(\omega_c t + \beta \sin\omega_m t)$$

$$\omega_C = 6\times10^8 \quad \therefore \quad f_C = \frac{6\times10^8}{2\pi} = 95.54\,\text{MHz}$$

$\beta = 5$ (Modulation Index)

$$\omega_m = 1250 \quad \therefore \quad f_m = \frac{1250}{2\pi} = 199\,\text{Hz}$$

$$\because \quad \beta = \frac{\text{Frequency Deviation}}{\text{Message Frequency}} = \frac{\delta}{f_m}$$

$$\therefore \quad \delta = \beta \times f_m$$

$$\Rightarrow \quad \delta = 5\times199 \quad \therefore \delta = 995\,\text{Hz}$$

84. When the modulating frequency is doubled the modulation index is halved and the modulating voltage remains constant. This happens when the modulating system is

(a) AM (b) PM

(c) FM (d) Delta Modulation

Sol. (c)

Modulation Index (β) in FM is given by :

$$\beta = \frac{\text{Frequency Deviation}}{\text{Message Frequency}} = \frac{K_f.A_m}{f_m}$$

Where, K_f = Frequency sensitivity,

A_m = Modulating Voltage

When $f'_m = 2f_m$

$$\beta' = \frac{K_f.A_m}{2f_m} = \frac{\beta}{2}$$

Hence, the system is FM.

Also, modulation index of PM does not depend upon modulating frequency.

85. v = A sin (ω_ct + m sin ω_mt) is the expression for

(a) Amplitude modulated signal

(b) Frequency modulated signal

(c) Phase modulated signal

(d) Carrier signal used for modulation

Sol. (c)

For a given equation of angle modulated wave, it is not possible to determine whether it is FM or PM signal. However, if both the carrier wave and message signal are sinusoidal function, we can determine the nature of modulated signal.

Let, the carrier be $S_c(t)$ = A sin ω_ct

and message signal be m(t) = A_m sin ω_mt

The expression for FM signal will be:

$$S_{FM}(t) = A\sin\left(\omega_c t + k_f\int_0^t m(t)dt\right)$$

$$= A\sin\left(\omega_c t + K_f A_m\int_0^t \sin\omega_m t\right)$$

$$S_{FM}(t) = A\sin\left(\omega_c t - \frac{k_f A_m}{\omega_m}\cos\omega_m t\right)$$

$$= A\sin(\omega_c t - m\cos\omega_m t)$$

where m = Modulation index of FM

The expression for PM signal will be:

$$S_{PM}(t) = A\sin(\omega_c t + k_p m(t))$$

$$= A\sin(\omega_c t + k_p A_m \sin\omega_m t)$$

$$\therefore \quad S_{PM}(t) = A\sin(\omega_c t + m\sin\omega_m t)$$

Among the given options and assuming both carrier & message signal to be sine wave, the expression is of a phase modulated signal.

86. The four basic elements in a PLL are loop filter, loop amplifier, VCO and

(a) Up converter

(b) Down converter

(c) Phase detector

(d) Frequency multiplier

Sol. (c)

Basic elements in a phase locked loop are :

1. Loop filter
2. Loop Amplifier
3. Voltage controlled oscillator (VCO)
4. Phase Detector

87. In a frequency modulated (FM) system, when the audio frequency is 500 Hz and audio frequency voltage is 2.4 V, the frequency deviation δ is 4.8 kHz. If the audio frequency voltage is now increased to 7.2 V then what is the new. value of deviation?

(a) 0.6 kHz (b) 3.6 kHz

(c) 12.4 kHz (d) 14.4 kHz

Sol. (d)

f_m = 500 Hz, A_m = 2.4V, δ = 4.8 KHz

$\because$ Frequency Deviation $\delta = K_f.A_m$

Where, K_f = Frequency sensitivity of FM which is constant.

$$\therefore \quad K_f = \frac{\delta}{A_m} = \frac{4.8}{2.4}\times 10^3 \text{ Hz/V}$$

$$= 2\times 10^3 \text{ Hz/V}$$

Now, A'_m = 7.2 V

$$\therefore \quad \delta = K_f A'_m = 2\times 10^3 \times 7.2 \text{ Hz}$$

$$\delta = 14.4 \text{ KHz}$$

88. Modulation is used to

1. Separate different transmissions
2. Reduce the badwidth requirement
3. Allow the use of practicable antennas
4. Ensure that intelligence may be transmitted over long distances

Which of the above statements are correct?

(a) 1, 2 and 3 only

(b) 1, 3 and 4 only

(c) 2 and 4 only

(d) 1, 2, 3 and 4

Sol. (b)

The advantages of modulation are :

1. Multiplexing / transmission of several

message signal on a given channel. Helpful in different transmissions.

2. Bandwidth requirement is increased. If a message signal with a bandwidth of ‘f’ is amplitude modulated, the bandwidth of the modulated signal is ‘2f’.
3. It helps in reducing antenna height thereby allow the use of practical antennas.
4. It helps in transmitting message signal over long distances. Hence, statement 1, 3 & 4 are correct.

89. Carson’s rule is (with symbols having their standard meaning)

(a) B = 2 DW

(b) B = 2 (D + 1)W

(c) B = $\sqrt{2}$ (D + 1)W

(d) B = $\sqrt{2}$ DW

Sol. (b)

Carson’s Rule states the Bandiwdth requirement in wide Band FM is given by

B = 2(D + 1) W

Where :

B = Bandwidth

D = Deviation ratio / modulation index

W = Maximum Modulating Frequency

90. Consider the following features of FM vis-a-vis AM :

1. Better noise immunity is provided
2. Lower badwidth is required
3. the transmitted power is better utilized
4. Less modulating power is required

Which of the above are advantages of FM over AM?

(a) 1, 2 and 3 only

(b) 1, 3 and 4 only

(c) 2 and 4 only

(d) 1, 2, 3 and 4

Sol. (b)

1. In FM, message is stored in the form of variation in frequency whereas in AM, it is stored in the form of amplitude variation. Noise affects amplitude of a signal the most. Hence, FM provides better noise immunity.
2. B.W. required in FM is $2(\beta+1)f_m$. Maximum B.W. required in AM is = $2f_m$.
Hence, more bandwidth is required in case of FM.
3. In FM, the total power of carrier before modulation is same as the total power of frequency modulated signal. The power in the sideband frequencies appears at the expense of power originally in the carrier. Hence, transmitted power is better utilized.
4. Power transmitted in AM is given by : $P_T = P_C\left(1+\frac{m^2}{2}\right)$. As modulation index ‘m’ increases power in AM increases. In FM, power transmitted is always equal to the total power of carrier before modulation. Hence, FM requires lesspower than AM.
Statement 1, 3 and 4 are correct.

91. The ideal characteristic of a stabilizer is

(a) Constant output voltage with low internal resistance

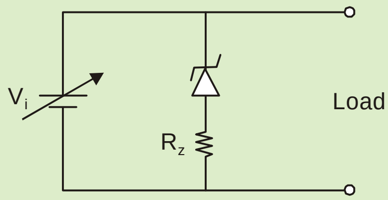
(b) Constant output current with low internal resistance

(c) Constant output voltage with high internal resistance

(d) Constant internal resistance with variable output voltage

Sol. (a)

Voltage stabilizer e.g. a zener diode or other device which suppresses variation of input d.c. voltage is always connected in parallel with load to give a constant output voltage.



Ideally the internal resistance (R_Z) must be zero for a better output voltage. Hence, internal resistance must be low.

92. For a d.c. shunt generator to self excite, the conditions to be satisfied are that there must be some residual magnetism in the field magnet, it must be in the proper direction and the shunt field resistant must be

(a) Above the critical field resistance

(b) Equal to the critical field resistance

(c) Less than the armature resistance

(d) Less than the critical field resistance

Sol. (d)

Voltage will built up when shunt field resistance is less than critical field resistance.

93. In an IGBT cell the collector and emittter are respectively

(a) n and p (b) n^+ and p^+

(c) p and n (d) p^+ and n^+

Sol. (d)

In IGBT collector is P^+ and emitter is n^+.

94. The main units in a pulse code modulator are:

1. Sampler
2. Quantiser
3. Encoder
4. Comparator

(a) 1 and 2 only (b) 2 and 3 only

(c) 1, 2 and 3 only (d) 2 and 4 only

Sol. (c)

Pulse code Modulated signal (PCM Modulation) is generated by carrying out three basic operations : sampling, quantizing and encoding.

Comparator is not used in PCM Modulation.

95. The reverse recovery time of a diode is 3 μs and rate of fall $\left(\frac{di}{dt}\right)$ is 30 A/μs.

The store charge of the diode is

(a) 45 μC (b) 135 μC

(c) 270 μC (d) 540 μC

Sol. (b)

Stored charge of diode $Q_R = \frac{1}{2} t_{rr}^2 \frac{di}{dt}$

$$Q_R = \frac{1}{2} \times (3\mu s)^2 \times \frac{30\,A}{\mu s}$$

$= 135\ \mu c$

96. NAND and NOR gates are called 'Universal' gates primarily because

(a) They are available everywhere

(b) They are widely used in I.C. packages

(c) They can be combined to produce AND, OR and NOR gate

(d) They can be manufactured easily

Sol. (c)

Universal gates are those gates which can perform the function of AND, OR and NOT gate. NAND and NOR gate can do this, hence they are called universal gates.

97. If a medium transmission line is represented by nominal T, the value of B of ABCD constant is

(a) Z (b) $Y\left(1+\frac{1}{4}YZ\right)$

(c) $Z\left(1+\frac{1}{4}YZ\right)$ (d) $\left(1+\frac{1}{2}YZ\right)$

Sol. (c)

For nominal T

$$B = z\left(1+\frac{Yz}{4}\right)$$

$$A = D = 1+\frac{Yz}{2}$$

$$C = Y.$$

98. To turn-off a GTO what is required at the gate?

(a) A high amplitude (but low energy) negative current

(b) A low amplitde negative current

(c) A high amplitude negative voltage

(d) A low amplitude negative voltage

Sol. (a)

For turn-off operation of a GTO, a high-negative current pulse is supplied to the gate using a driver circuit connected between the gate and cathode.

99. A chopper circuit is operating on TRC control mode at a frequency of 2 kHz on a 230 V dc supply. For output voltage of 170 V, the conduction and blocking periods of a thyristor in each cycle are respectively

(a) 0.386 ms and 0.114 ms

(b) 0.369 ms and 0.131 ms

(c) 0.390 ms and 0.110 ms

(d) 0.131 ms and 0.369 ms

Sol. (b)

Time-ratio control (TRC):- In TRC method the on period of the switch (T_{on}) is varied keeping the time period (T) constant.

frequency = 2 kHz

$$T = \frac{1}{f} = \frac{1}{2KHz} = 0.5 \text{ ms}$$

$$V_o = 170 \text{ V}, V_{in} = 230 \text{ v}$$

$$\frac{V_o}{V_{in}} = \frac{T_{on}}{T} = \text{Duty ratio.}$$

$$\frac{170}{230} = \frac{T_{on}}{0.5\text{ms}}$$

$$T_{on} = 0.369 \text{ ms}$$

$$T_{off} = 0.131 \text{ ms}$$

100. A switched-capacitor network is/are

1. Time variant sample data network
2. Non linear network
3. Linear time invariant network

(a) 1 only (b) 2 only

(c) 3 only (d) 1 and 2

Sol. (d)

A switched capacitor is an electronic circuit element used for discrete time signal processing. It works by moving charges into and out of capacitors when switches are opened and closed. Hence, they are time variant sampled data network. Also, they are non-linear.

Statements 1 & 2 are correct.

101. A transformer may have negative voltage regulation if the load power factor (p.f.) is

(a) Leading for some values of p.f.

(b) Unity p.f.

(c) Lagging but not zero p.f.

(d) Only zero p.f. lag

Sol. (a)

Voltage regulation negative implies voltage output is more than input. It can occur when capacitive load is connected to transformer which has leading power factor.

Mathematically also

V.R. = $\epsilon_r \cos\theta + \epsilon_x \sin\theta < 0$

$\Rightarrow \tan\theta < -\frac{\epsilon_r}{\epsilon_x}$

Negative values indicates a leading power factor.

102. Current source inverters are suitable for supplying power to

(a) R-L loads (b) Inductive loads
(c) All loads (d) Capacitive loads

Sol. (c)

Voltage source inverters are suitable for loads of high impedance while current source inverters are suitable for loads of low impedance and high power factor. Hence option is (d) is correct.

103. The main application of multilevel inverter is in

(a) Reactive power compensation

(b) D.C. motor drive

(c) Synchronous Buck-converter

(d) Voltage regulator

Sol. (a)

Multilevel converter connected parallelly will have reactive power compensation application.

104. In a 3–phase inverter with 180º conduction mode the number of switches that is on at any instant of time is

(a) 1 (b) 2

(c) 3 (d) 4

Sol. (c)

In a 3 - phase inverter with 180° conduction mode at any time 3 switches will be ON and in 120° conduction mode, 2 switches will be ON.

105. In the sinusoidal pulse–width modulation scheme, if the zero of the triangular wave coincides with the zero of the reference sinusoidal, then the number of pulses per half cycle is

(a) $\frac{f_c}{2f}$ (b) $\frac{f_c}{2f}+1$

(c) $\frac{2f_c}{f}$ (d) $\frac{f_c}{2f}-1$

Where f_c is the frequency of the carrier wave and f is the frequency of the sinusoid.

Sol. (d)

when zero of the triangle wave coincides with zero of the reference sinusoidal, then there will be $\left(\frac{f_c}{2f}-1\right)$ pulses per half cycle and when triangular carrier wave has its peak coincident with zero of the reference sinusoid, there will be $\frac{f_c}{2f}$ pulses per half cycle.

Directions:

Each of the next **Fifteen (15)** items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(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

106. Statement (I) : The armature structures of all rotating machines are laminated in order to reduce the eddy-current losses.

Statement (II): The armature windings of both the D.C. and A.C. machines have to deal with alternating currents only.

Sol. (a)

- Lamination reduces the eddy current losses
- In DC machine also alternating current flow in armature which by mechanical rectifier (commutator) is converted into direct current with ripples.

107. Statement (I) : The electro-mechanical energy conversion principles are developed with the 'field energy', being magnetic or electric, as the basis.

Statement (II): This approach can deal with only the steady-state analysis of the electro-mechanical energy conversion, but not the transient-state analysis.

Sol. (c)

Electro-mechanical energy principles are used for both steady state as well as transient state of all electromechanical converters.

108. Statement (I) : A Direct-On-Line (DOL) starter for starting dc motor is used for reasons of economy

Statement (II): DOL starter limits the starting current to a safe limit.

Sol. (c)

DOL starting causes armature current to be several times of rated values.

It is generally adopted due to

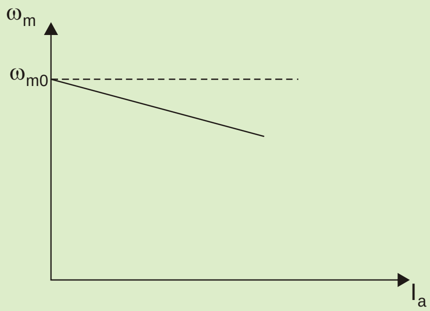
1. Economic reason
2. Motor starts quickly, Joule input per start much lesser vis-a-vis resistance start. It is helpful in repeated started saving energy.

109. Statement (I) : For constant applied voltage to its terminals, the effect of armature resistance in the operation of a dc shunt motor, is to reduce the operating speed, and cause a 'drooping' speed Vs. load characteristic.

Statement (II): The effect or armature demagnetization with the decreasing load is to reduce the drop in operating speed, and can be designed to give a 'rising' speed Vs. load characteristic which may result in a possible 'runaway'.

Sol. (c)

For a d.c. shunt motor, speed Vs load characteristics is given as



$$\omega_m = \frac{V_t - I_a r_a}{K_a \phi} = \frac{V_t}{K_a \phi} - \frac{I_a r_a}{K_a \phi}$$

$$\Rightarrow \quad \omega_m = \omega_{m0} - \frac{I_a r_a}{K_a \phi}$$

So, effect of r_a (Armature resistance) is to reduce the overall speed or produce droop.

However with reduction in I_a (load current), the factor $I_a r_a$ will reduce which will produce lesser droop. For $I_a = 0$, $\omega_m = \omega_{m0}$. So at no value of I_a, $\omega_m \not> \omega_{m0}$. It implies that speed will not be more than no load speed at any time.

Statement (II) is false

Statement (I) is correct

110. Statement (I) : Synchronous motor is a constant speed motor.

Statement (II): Synchronous motor is not a self-startint motor.

Sol. (b)

Synchronous motor is not self starting as average torque over a complete cycle is zero.

111. Statement (I) : A synchronous motor can be used as an active device to improve the power factor of a power system.

Statement (II): By over-excitation the synchronous machine would operate as a capacitor.

Sol. (a)

Power factor can be improved by suppling reactive power to load. An over-excited synchronous machine acts as capacitor which provides reactive power.

112. Statement (I) : Stability of a power system can be improved by using parallel transmission lines.

Statement (II): Two transmission lines in parallel will increase the impedance between sending end and receiving end compred to single line.

Sol. (c)

Parallel transmission line are used to enhance stability as it reduces the series reactance and increase stability margin

$$P = \frac{V_1 V_2}{x} \sin \delta$$

As x (Reactance) is decreases power increases and so is the stability margin.

113. Statement (I) : When all inputs of a NAND gate are shorted to get a single input, single output gate, it becomes an inverter.

Statement (II): When all inputs of a NAND gate are at logic '0' level, the output is at logic '0' level.

Sol. (c)

Let us take two input NAND gate

$Y = \overline{A \cdot B}$

if B = A

$Y = \overline{A \cdot A}$

$Y = \overline{A}$ $\Rightarrow$ NOT operation

Hence statement 'I' is correct and as result statement 'II' is false.

114. Statement (I) : XOR gate is not a universal gate

Statement (II): It is not possible to realize all Boolean functions using XOR gates only.

Sol. (a)

A universal gate which can implement any Boolean function without need to use any other gate type. XOR gate cannot be used to realise all Boolean functions and hence it is not a universal gate.

115. Statement (I) : READY is an output signal used to synchronize slower peripheral.

Statement (II): HOLD is activated by an external signal

Sol. (d)

Ready is an input signal sent by an input or output device to the microprocessor. This signal indicates that the input or output device is ready to send or receive data. A slow input or output device is connected to the microprocessor through READY line. The microprocessor examines READY signal before it performs data transfer operation. When READY = 1, it indicates that Input or Output device is ready to send or receive data, when READY = 0, the microprocessor waits till READY becomes high.

Hold is an input signal used when another device of the computer system requires address and data buses for data transfer. For this, device send HOLD signal to the microprocessor. After receiving the HOLD request, the microprocessor sends out HLDA signal to the device.

Hence, statement (I) is wrong but statement (II) is correct.

116. Statement (I) : The direct memory access or DMA mode of data transfer is the fastest among all the modes of data transfer.

Statement (II): In DMA mode the device directly transfers data to/form memory without interference from CPU.

Sol. (a)

The direct memory access (DMA) mode of data transfer is the fastest among all the modes of data transfer. Because in this mode of data transfer, data to/from I/o device or memory is directly occurs between them only without inference of CPU.

Hence, statement (I) and statement (II) both are correct and statement (II) is correct reason for statement (I)

117. Statement (I) : Modulation index of AM is always kept less than 1.

Statement (II): Modulation index for FM may be greater than 1.

Sol. (b)

Modulation index in AM is always kept less than 1 to avoid distortion or clipping of message signal. When m > 1, the carrier has 180° phase reversal and the envelope of modulated signal does not contain actual message signal.

In FM, modulation index for wide Band FM is greater than 1 and for Narrow Band FM, it is less than 1. Both statements are individually correct but statement II is not the correct explanation for statement I.

118. Statement (I) : The main function of a freewheeling diode in Rectifier circuits is to prevent the reversal of load voltage.

Statement (II): The freewheeling diode is never connected across the load.

Sol. (c)

Statement (II) is wrong. A freewheeling diode is connected across the load. The main function of a freewheeling diode are

(1) It prevents the output voltage from becoming negative

(2) The load current is transferred from the main thyristors to freewheeling diode, thereby allowing all of its thyristers to regain their blocking states.

119. Statement (I) : In sinusoidal pulse width modulation, width of each pulse is varied in proportion to amplitude of a sine-wave evaluated at the centre of the same pulse.

Statement (II): The rms value of output voltage can be varied by varying the modulation index.

Sol. (b)

Both statements are true, but statement (II) is not the explanation for statement (I). The width of output pulse in sinusoidal pulse width modulation is proportional to the magnitude of sine wave. The output voltage is varied by varying modulation index (MI) which is the ratio of V_r/V_c.

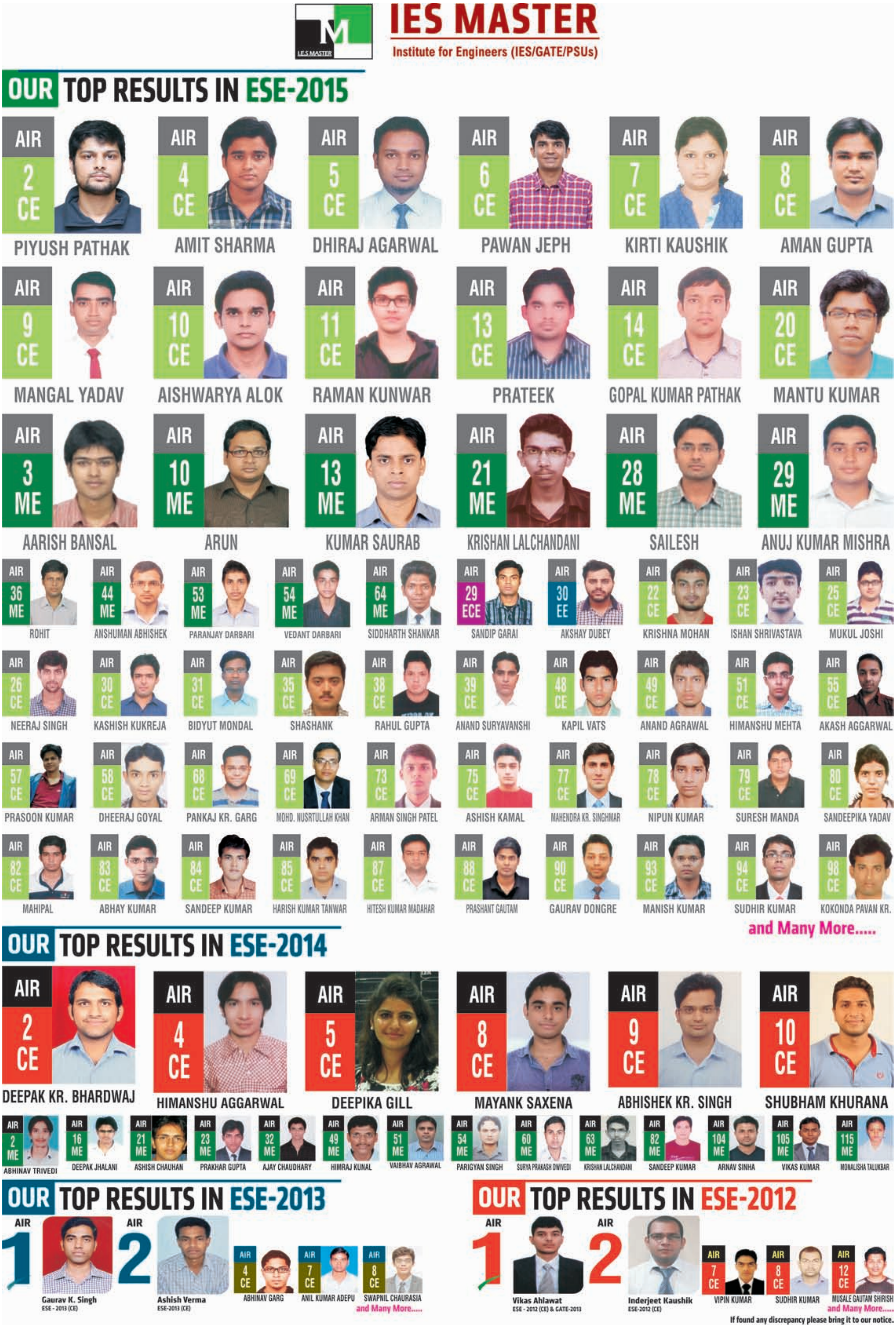
120. Statement (I) : Equal-area criterion can be used to determine the stability of single machine infinite bus system.

Statement (II): An infinite bus system has infinite inertia and constant voltage.

Sol. (a)

Equal area criteria is used to find out stability of single machine or two machine system also. There is no need to solve non-linear differential swing equation to determine stability.

The property of infinite bus are the very basis of determining stability using equal area criteria. So, statement (II) explains statement (I)



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AIR 29 ECE SANDIP GARAI
AIR 30 EE AKSHAY DUBEY
AIR 22 CE KRISHNA MOHAN
AIR 23 CE ISHAN SHRIVASTAVA
AIR 25 CE MUKUL JOSHI
AIR 26 CE NEERAJ SINGH
AIR 30 CE KASHISH KUKREJA
AIR 31 CE BIDYUT MONDAL
AIR 35 CE SHASHANK
AIR 38 CE RAHUL GUPTA
AIR 39 CE ANAND SURYAVANSHI
AIR 48 CE KAPIL VATS
AIR 49 CE ANAND AGRAWAL
AIR 51 CE HIMANSHU MEHTA
AIR 55 CE AKASH AGGARWAL
AIR 57 CE PRASOON KUMAR
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AIR 77 CE MAHENDRA KR. SINGHMAR
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AIR 79 CE SURESH MANDA
AIR 80 CE SANDEEPIKA YADAV
AIR 82 CE MAHIPAL
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AIR 60 ME SURYA PRAKASH DWIVEDI
AIR 63 ME KRISHAN LALCHANDANI
AIR 82 ME SANDEEP KUMAR
AIR 104 ME ARNAV SINHA
AIR 105 ME VIKAS KUMAR
AIR 115 ME MONALISHA TALUKDAR
OUR TOP RESULTS IN ESE-2013
AIR 1 Gaurav K. Singh ESE - 2013 (CE)
AIR 2 Ashish Verma ESE-2013 (CE)
AIR 4 CE ABHINAV GARG
AIR 7 CE ANIL KUMAR ADEPU
AIR 8 CE SWAPNIL CHAURASIA
and Many More.....
OUR TOP RESULTS IN ESE-2012
AIR 1 Vikas Ahlawat ESE - 2012 (CE) & GATE-2013
AIR 2 Inderjeet Kaushik ESE-2012 (CE)
AIR 7 CE VIPIN KUMAR
AIR 8 CE SUDHIR KUMAR
AIR 12 CE MUSALE GAUTAM SHIRISH
and Many More.....
If found any discrepancy please bring it to our notice.