DETAILED
SOLUTIONS

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ESE 2020 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 26

Full Syllabus Test 10 : Paper-II

1. (d)
2. (b)
3. (b)
4. (a)
5. (a)
6. (a)
7. (b)
8. (c)
9. (c)
10. (a)
11. (a)
12. (a)
13. (b)
14. (a)
15. (c)
16. (d)
17. (b)
18. (a)
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22. (a)
23. (c)
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30. (a)
31. (a)
32. (d)
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34. (d)
35. (a)
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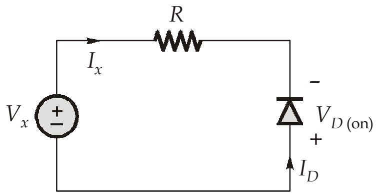
145. (a)
146. (a)
147. (a)
148. (a)
149. (a)
150. (d)

DETAILED EXPLANATIONS

1. (d)

$$V_{D(\text{on})} = 0.8\ \text{V}$$

Diode will be on for $V_x < -0.8$ V.



When diode is conducting (i.e., $I_D > 0$ or $I_x < 0$),

$$I_D = \frac{-V_x - V_{D(\text{on})}}{R} = \frac{-V_x - 0.8}{R}$$

$$I_x = -I_D = \frac{V_x + 0.8}{R};\ \text{for } V_x < -0.8\ \text{V}$$

This equation will be satisfied by the plot given in option (d).

2. (b)

$$\frac{12 - V_Z}{R} \geq I_{Z(\text{min})} + I_L$$

$$\Rightarrow \quad R \leq \frac{12 - V_Z}{I_L + I_{Z(\text{min})}}$$

For $R_L = 12.5\ \Omega$,
$$I_L = \frac{V_Z}{R_L} = \frac{5}{12.5}\ \text{A} = 400\ \text{mA}$$

$$R \leq \frac{12-5}{I_{Z(\text{min})} + I_L} = \frac{7}{0+400}\ \text{k}\Omega = 17.5\ \Omega \quad \text{...(i)}$$

For $R_L = 50\ \Omega$,
$$I_L = \frac{V_Z}{R_L} = \frac{5}{50}\ \text{A} = 100\ \text{mA}$$

$$R \leq \frac{12-5}{I_{Z(\text{min})} + I_L} = \frac{7}{0+100}\ \text{k}\Omega = 70\ \Omega \quad \text{...(ii)}$$

From equations (i) and (ii), $R \leq 17.5\ \Omega$

$$R_{(\text{max})} = 17.5\ \Omega$$

3. (b)

$$R_{DS(\text{on})} = \frac{dV_{DS}}{dI_{DS}} = \frac{1}{2K_n(V_{GS} - V_T)}$$

$$K_n = \frac{\mu_n C_{ox}}{2}\left(\frac{W}{L}\right)$$

So, $R_{DS(\text{on})} \propto$ Channel length (L)

$$\frac{dI_D}{dV_{DS}} \propto \frac{1}{L}$$

$$R_{DS(\text{on})} \propto \frac{1}{C_{ox}} \propto t_{ox} \Rightarrow \text{ Statement-3 is incorrect.}$$

4. (a)

Given that, $g_m = \frac{1}{13}\,℧$

$$\frac{I_C}{V_T} = \frac{I_C}{26} = \frac{1}{13}$$

$$I_C = 2\text{ mA}$$

Applying KVL in collector-base loop,

$$5 - I_C R_C - \frac{I_C}{\beta} R_B - 0.7 = 0$$

$$5 - 2 - \frac{2}{100} R_B - 0.7 = 0 \text{ (taking } R_B \text{ in k}\Omega)$$

$$\frac{2}{100} R_B = 2.3$$

$$R_B = \frac{2.3 \times 100}{2} = 115\text{ k}\Omega$$

5. (a)

$$\frac{V_{in}}{R} = K_n(V_{GS} - V_{th})^2$$

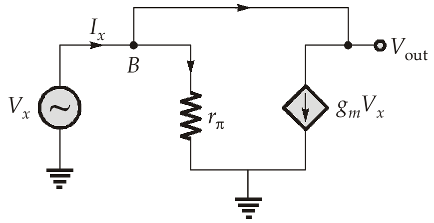
where, $V_{GS} = -V_{\text{out}}$

$$V_{\text{out}} = -\sqrt{\frac{V_{in}}{RK_n}} - V_{th}$$

$$V_{\text{out}} = -A\sqrt{V_{in}} - V_{th} \quad (A \text{ is a constant})$$

6. (a)

Drawing small signal equivalent,

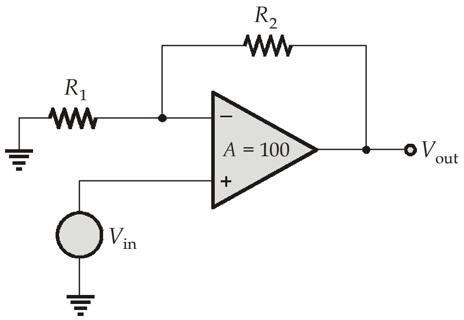


Using KCL at node B,

$$\frac{V_x}{r_\pi} + g_mV_x = I_x$$

$$\Rightarrow \qquad \frac{V_x}{I_x} = \frac{1}{g_m + r_\pi^{-1}} = \frac{r_\pi}{1 + g_m r_\pi}$$

7. (b)



When a negative feedback is created using R_1 and R_2, bandwidth of op-amp will increase by a factor $(1 + A_{OL}\beta)$.

So, $$\omega' = (1 + A_{OL}\beta)\omega_0$$

where β = feedback factor and $\beta = \dfrac{R_1}{R_1 + R_2}$

Given that ideal case closed-loop gain is 16.

So, $$1 + \frac{R_2}{R_1} = 16 \Rightarrow \frac{R_1}{R_1 + R_2} = \frac{1}{16}$$

so, $$\omega' = \left(1 + \frac{100}{16}\right) \times 1 = 7.25 \text{ MHz}$$

8. (c)

9. (c)

- Bistable multivibrator is known as flip-flop.
- An astable multivibrator can be synchronized or used as a frequency divider by applying either positive or negative pulses to either transistor or to both the transistors simultaneously.

10. (a)

Since DC no load voltage (V_{DCNL}) = 8 V

$$V_{DCNL} = \frac{2V_m}{\pi}$$

$$\Rightarrow \quad V_m = \frac{\pi V_{DCNL}}{2}$$

$$\Rightarrow \quad I_m = \frac{V_m}{r_s + 2r_d + R_L}$$

$$\Rightarrow \quad I_{DC} = \frac{2I_m}{\pi} = \frac{2 \times \pi V_{DCNL}}{2 \times \pi(r_s + 2r_d + R_L)} = \frac{8}{3 + 2(1) + 100} = \frac{8}{105}\text{A}$$

$$\Rightarrow \quad V_L = R_L \times I_{DC} = \frac{8}{105} \times 100 \simeq 7.62 \text{ V}$$

11. (a)

Since $$\mu_n = \frac{e\tau}{m_e^*}$$

$$\tau = \frac{0.5 \times 6.4 \times 10^{-32}}{1.6 \times 10^{-19}} = 2 \times 10^{-13}\text{ sec}$$

According to Mathieson’s Rule,

$$\frac{1}{\tau} = \frac{1}{\tau_{\text{lattice}}} + \frac{1}{\tau_{\text{impurity}}}$$

$$\Rightarrow \quad \frac{1}{2 \times 10^{-13}} = \frac{1}{3 \times 10^{-13}} + \frac{1}{\tau_{\text{impurity}}}$$

$$\tau_{\text{impurity}} = 6 \times 10^{-13}\text{ sec}$$

12. (a)

Diffusion constant D_n can be calculated using Einstein Relation.

$$D_n = \mu_n \cdot \frac{k_B T}{q} = \mu_n V_T = 0.4 \times 0.025 = 0.01\text{ m}^2/\text{sec}$$

The diffusion length, $$L_n = \sqrt{D_n \tau_n} = \sqrt{0.01 \times 0.6 \times 10^{-9}}$$

$$L_n = \sqrt{6} \times 10^{-6} \simeq 2.45\ \mu\text{m}$$

13. (b)

Density of states is a material property which gives the number of available electronic states per unit energy per volume.

14. (a)

In the given connection, V_G is negative. So, the MOS capacitor is in accumulation mode.
The energy band diagram given in option (a) is in accumulation mode.

15. (c)

The maximum power delivered by one solar cell,

$$P_{\max} = V_{OC} \times I_{SC} \times (\text{FF}) = 0.6 \times 25 \times 0.8 = 12 \text{ mW}$$

To drive a load of 100 mW, the number of solar cells required is,

$$N = \left\lceil \frac{100}{12} \right\rceil = \lceil 8.33 \rceil = 9$$

16. (d)

17. (b)

Since number of carriers in metal >> number of carriers in semiconductor (at room temp.)

So $$R_{H\,(\text{metal})} < R_{H\,(\text{semiconductor})} \quad \left(\because R_H = \frac{1}{ne}\right)$$

and $$V_H \propto R_H$$

so, $$V_{H\,(\text{metal})} < V_{H\,(\text{semiconductor})}$$

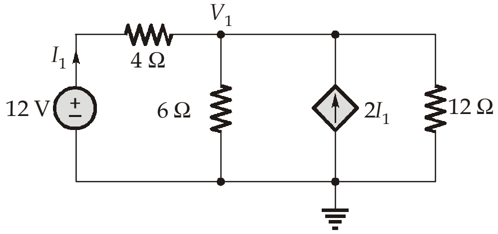
18. (a)

By forming supernode and applying KCL, we get,

$$\begin{aligned} \frac{V_1}{4} + 8 &= 4 + \frac{15 - (V_1 + 10)}{2} \\ V_1 + 32 &= 16 + 10 - 2V_1 \\ 3V_1 &= -6 \\ V_1 &= -2 \text{ V} \end{aligned}$$

19. (a)

By redrawing the circuit and applying KCL, we get,



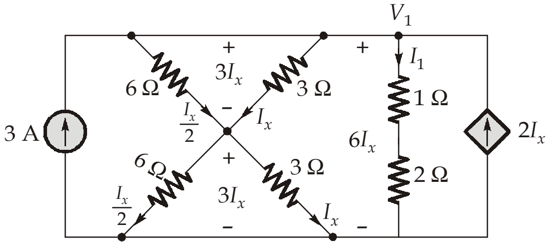
$$\begin{aligned} 3I_1 &= \frac{V_1}{12} + \frac{V_1}{6} \\ 3\left(\frac{12 - V_1}{4}\right) &= \frac{V_1}{4} \\ 4V_1 &= 36 \\ V_1 &= 9 \text{ V} \end{aligned}$$

Power dissipated by 6 Ω resistor,

$$P_{6\Omega} = \frac{V_1^2}{6\,\Omega} = \frac{9 \times 9}{6} = 13.5 \text{ W}$$

20. **(b)**

For the given circuit,



$$V_1 = 6I_x$$

$$I_1 = \frac{V_1}{3\,\Omega} = 2I_x$$

By applying KCL at top node, we get,

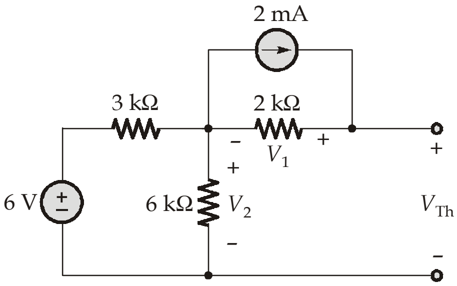
$$3\text{ A} + 2I_x = I_x + \frac{I_x}{2} + I_1 = \frac{3I_x}{2} + 2I_x$$

$$\frac{3I_x}{2} = 3\text{ A}$$

$$I_x = 2\text{ A}$$

21. **(c)**

Finding Thevenin's equivalent, we get,



$$V_{\text{Th}} = V_1 + V_2$$

$$= (2\text{ k}\Omega \times 2\text{ mA}) + \left(\frac{6}{6+3} \times 6\text{ V}\right) = 8\text{ V}$$

$$R_{\text{Th}} = (3\text{ k}\Omega \parallel 6\text{ k}\Omega) + 2\text{ k}\Omega = 4\text{ k}\Omega$$

The maximum power that can be delivered to R_L is,

$$P_{L(\max)} = \frac{V_{\text{Th}}^2}{4R_{\text{Th}}} = \frac{8 \times 8}{4 \times 4}\text{mW} = 4\text{ mW}$$

22. (a)

$$I_1 = \frac{V}{Z_1} = \frac{V}{10+j5} = |I_1|\angle\phi_1$$

$$I_2 = \frac{V}{Z_2} = \frac{V}{8+j6} = |I_2|\angle\phi_2$$

$$I = I_1 + I_2 = |I|\angle\phi$$

$$\phi_1 = \phi_V - \tan^{-1}\left(\frac{5}{10}\right) = \phi_V - \tan^{-1}(0.5)$$

$$\phi_2 = \phi_V - \tan^{-1}\left(\frac{6}{8}\right) = \phi_V - \tan^{-1}(0.75)$$

- $\phi_1 > \phi_2 \Rightarrow I_1$ leads I_2
- Resultant phase ϕ lies between ϕ_1 and ϕ_2. So, $\phi_2 < \phi < \phi_1$.
- Hence, I leads I_2 and lags behind I_1.

23. (c)

Overall circuit impedance, $Z = (Z_2 \parallel Z_3) + Z_1$

$$(Z_2 \parallel Z_3) = \frac{(2+j4)(6-j8)}{(8-j4)} = \frac{(1+j2)(3-j4)}{(2-j1)} \times \frac{(2+j1)}{(2+j1)}$$

$$= \frac{(11+j2)(2+j1)}{5} = \frac{20+j15}{5} = (4+j3)\Omega$$

$$Z = Z_1 + (Z_2 \parallel Z_3) = (6 - j8) + (4 + j3) = (10 - j5)\Omega$$

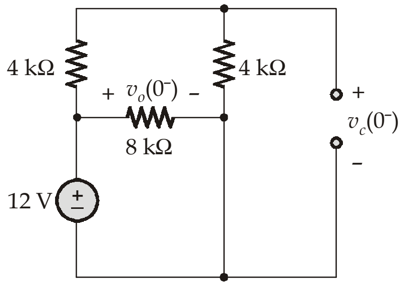
$$|I| = \frac{|V|}{|Z|} = \frac{100}{5|2-j1|} = \frac{100}{5\sqrt{5}} = \frac{20}{\sqrt{5}}\text{ A (Peak)}$$

Average power delivered by the source,

$$P = \frac{I_m^2}{2} \times R = \frac{(20)^2 \times 10}{5 \times 2} = 400\text{ W}$$

24. (b)

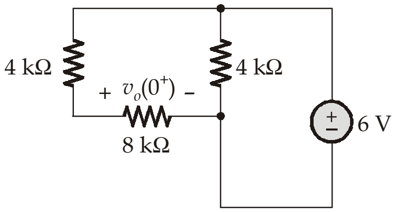
At $t = 0^-$:



$$v_o(0^-) = 12\text{ V}$$

$$v_c(0^-) = 12 \times \frac{4\text{ k}\Omega}{4\text{ k}\Omega + 4\text{ k}\Omega} = 6\text{ V}$$

At $t = 0^+$:



$$v_o(0^+) = 6\text{ V} \times \frac{8\text{ k}\Omega}{4\text{ k}\Omega + 8\text{ k}\Omega} = \frac{6\times 8}{12} = 4\text{ V}$$

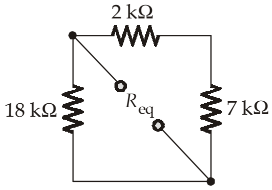
25. (c)

For $t > 0$,

time constant, $\tau = R_{eq} C = 120\ \mu s$

$$R_{eq} = (18\text{ k}\Omega) \parallel (2\text{ k}\Omega + 7\text{ k}\Omega)$$
$$= (18\text{ k}\Omega) \parallel (9\text{ k}\Omega) = 6\text{ k}\Omega$$

$$C = \frac{\tau}{R_{eq}} = \frac{120\times 10^{-6}}{6\times 10^{3}}\text{ F} = 20\text{ nF}$$



26. (b)

Tree branches or twigs = $n - 1 = 6 - 1 = 5$

Co-tree branches or links = $b - n + 1 = 8 - 6 + 1 = 3$

27. (c)

In an ionic crystal, when a host ion is displaced into an interstitial position, leaving behind a vacancy at its original site, the interstitial ion and the vacancy pair constitute the Frenkel defect.

28. (b)

Burgers vector is parallel to the screw dislocation line and perpendicular to edge dislocation line.

29. (a)

Since Electronic polarisation $(P) = Zex$ ...(1)

where x is displacement of electron cloud with respect to nucleus.

Also, $P = \alpha_e E$ ...(2)

equating (1) and (2), $\alpha_e E = Zex$

$$\Rightarrow \quad x = \frac{1.8\times 10^{-40} \times 2\times 10^{5}}{18\times 1.6\times 10^{-19}} = 12.5 \times 10^{-18}\text{ m}$$

30. (a)

According to free electron theory, electrons in a metal are subjected to constant potential.

31. (a)

For diamagnetic material χ_m is negative and is less than 1.

32. **(d)**

33. **(a)**

$$\text{Relaxation time } (\tau) = \frac{m\sigma}{ne^2} = \frac{9.1\times10^{-31}\times6\times10^{7}}{8.5\times10^{28}\times(1.6\times10^{-19})^2} \simeq 2.5\times10^{-14}\text{ sec}$$

34. **(d)**

- Chirality - twist of the nanotube
  $\phi = 0^\circ$, armchair nanotube
  $0^\circ < \phi < 30^\circ$, chiral nanotube
  $\phi > 30^\circ$, zigzag nanotube

35. **(a)**

$$\nabla\cdot\vec{D} = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho D_\rho)+\frac{1}{\rho}\frac{\partial}{\partial\phi}(D_\phi)+\frac{\partial}{\partial z}(D_z)$$

$$= \frac{10e^{-2z}}{\rho}\frac{\partial}{\partial\rho}(\rho^2)+10\frac{\partial}{\partial z}(e^{-2z}) = 20e^{-2z} - 20e^{-2z} = 0$$

At $\{\rho = 1, 0\le z\le 1\}$, $\nabla\cdot\vec{D} = 0$

So, net flux coming out from the given surface is,

$$\psi = \oint_S \vec{D}\cdot\vec{ds} = \int_V(\nabla\cdot\vec{D})dv = 0$$

36. **(a)**

$$\nabla\times\vec{A} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \dfrac{\partial}{\partial x} & \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial z} \\ (y+z\cos xz) & x & (x\cos xz) \end{vmatrix}$$

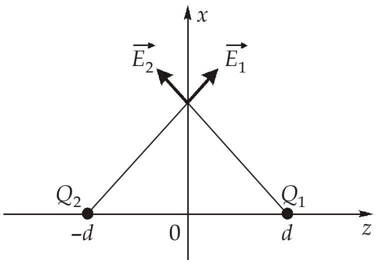
$$= (0)\hat{a}_x - (\cos xz - xz\sin xz - \cos xz + xz\sin xz)\hat{a}_y + (1-1)\hat{a}_z$$

$$\nabla\times\vec{A} = 0 \Rightarrow \text{Irrotational (or) conservative}$$

$$\nabla\cdot\vec{A} = -z^2\sin(xz) - x^2\sin(xz) \neq 0$$

Hence, $\vec{A}$ is only a conservative field but not solenoidal.

37. **(d)**



If $Q_1 = Q_2$, then the vector sum $\vec{E_1} + \vec{E_2}$ gives components purely in $\hat{a}_x$ direction.

If $Q_1 = -Q_2$, then the vector sum $\vec{E_1} + \vec{E_2}$ gives components purely in $\hat{a}_z$ direction.

Hence, both the given statements are wrong.

38. **(b)**

For a valid electrostatic field, $\nabla \times \vec{E} = 0$

$$\nabla \times \vec{E_1} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & 2yz & 3xz \end{vmatrix} = -2y\hat{a}_x - 3z\hat{a}_y - x\hat{a}_z \neq 0$$

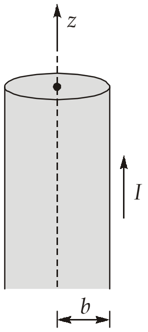
$$\nabla \times \vec{E_2} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y^2 & (2xy + z^2) & 2yz \end{vmatrix} = 0$$

So, only $\vec{E_2}$ is a valid representation of electrostatic field.

39. **(b)**

- Since the charge is moving, $\vec{E}$ is not given by Coulomb's law.
- Since a moving point charge does not constitute a steady current, its magnetic field is not given by Biot-Savart law.
- Statements 3 and 4 are true.

40. **(a)**



Current density, $\vec{J} = \frac{I}{\pi b^2}\hat{a}_z$

Electric field intensity, $\vec{E} = \frac{\vec{J}}{\sigma} = \frac{I}{\sigma \pi b^2}\hat{a}_z$

Magnetic field intensity on the surface of the wire,

$$\vec{H} = \frac{I}{2\pi b}\hat{a}_\phi$$

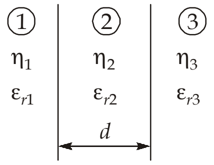
Poynting vector, $\vec{P} = \vec{E} \times \vec{H} = \frac{I^2}{2\pi^2 b^3 \sigma}(\hat{a}_z \times \hat{a}_\phi) = \frac{I^2}{2\pi^2 b^3 \sigma}(-\hat{a}_\rho)$

$$\vec{P} \propto I^2, \propto \frac{1}{\sigma}, \propto \frac{1}{b^3}$$

The direction of $\vec{P}$ is radially inward from the surface towards the axis of the wire.

Common explanation for Q. 41 and Q.42:

A dielectric medium is used for matching two different media, as shown below.



Case (I) (When $\eta_1 = \eta_3$):

To get zero reflection or perfect transmission,

- η_2 can be any real value (i.e., ε_{r2} can be any real value).
- $d = \frac{n\lambda_2}{2}; n = 0, 1, 2, 3, ...$

$$\lambda_2 = \frac{c}{\sqrt{\varepsilon_{r2}}\, f}$$

Non-zero $d_{\min} = \frac{\lambda_2}{2}$

Case (II) (When $\eta_1 \neq \eta_3$):

To get zero reflection or perfect transmission,

- $\eta_2 = \sqrt{\eta_1\eta_3}$
- $d = \frac{(2n+1)\lambda_2}{4}; n = 0, 1, 2, 3, ...$

$$\lambda_2 = \frac{c}{\sqrt{\varepsilon_{r2}}\, f}$$

$$d_{\min} = \frac{\lambda_2}{4}$$

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41. (b)

The required condition is same as case (II) in the above explanation, i.e. the dielectric slab must act as a quarter-wave transformer.

$$\eta_2 = \sqrt{\eta_1\eta_3} \Rightarrow \varepsilon_{r2} = \sqrt{\varepsilon_{r1}\varepsilon_{r3}}$$

$$d = (2n+1)\frac{\lambda_2}{4}; n = 0, 1, 2, 3, ...$$

For properly chosen medium 2,

$$\varepsilon_{r2} = \sqrt{\varepsilon_{r1}\varepsilon_{r3}} = \sqrt{16 \times 81} = 4 \times 9 = 36$$

$$d_{\min} = \frac{\lambda_2}{4} = \frac{c}{\sqrt{\varepsilon_{r2}} \times 4 \times f}$$

$$= \frac{3 \times 10^8}{\sqrt{36} \times 4 \times 500 \times 10^6} = \frac{3}{6 \times 20}\text{m} = 25\text{ mm}$$

42. (d)

The required condition is same as case (I) in the above explanation.

$$d = \left(\frac{\lambda_2}{2}\right)n; \ n = 1, 2, 3, \ldots$$

$$\lambda_2 = \frac{c}{\sqrt{\varepsilon_{r2}}\, f} = \frac{3\times10^8}{\sqrt{4}\times15\times10^9}\,\text{m} = 10\text{ mm}$$

The minimum non-zero thickness of the shielding will be,

$$d_{\min} = \frac{\lambda_2}{2} = 5\text{ mm}$$

43. (d)

44. (b)

- Radiation resistance of a quarter-wave monopole is equal to the half that of half-wave dipole.
- Directivity of a quarter-wave monopole is same as that of half-wave dipole.

45. (c)

Parallel response behaviour can be observed in,

- Short-circuited line having length equal to odd multiples of $\lambda/4$.
- Open-circuited line having length equal to even multiples of $\lambda/4$.

Series resonance behaviour can be observed in,

- Short-circuited line having length equal to even multiples of $\lambda/4$.
- Open-circuited line having length equal to odd multiples of $\lambda/4$.

46. (c)

$$\text{Return-loss} = -20\log_{10}|\Gamma| = 6\text{ dB}$$

So, $$|\Gamma| \simeq 0.5 \quad [\because 10\log_{10}(2) \simeq 3\text{ dB}]$$

$$\text{VSWR} = \frac{1+|\Gamma|}{1-|\Gamma|} = \frac{1+0.5}{1-0.5} = \frac{1.5}{0.5} = 3$$

47. (c)

Given that, $$G(s) = \frac{25}{s(s+1)(s+5)}$$

Let the compensator, $$G_c(s) = \frac{(s+\omega_z)}{(s+\omega_p)}$$

The open loop transfer function of the compensated system can be given as,

$$L(s) = G(s)\,G_c(s) = \frac{25(s+\omega_z)}{s(s+1)(s+5)(s+\omega_p)}$$

The velocity error constant of the compensated system will be,

$$K_v = \lim_{s\to0} sL(s) = \frac{25}{5}\left(\frac{\omega_z}{\omega_p}\right) = 5\left(\frac{\omega_z}{\omega_p}\right)$$

Given that, $$e_{ss} = \frac{1}{K_v} < 0.05$$

So, $$K_v > \frac{1}{0.05} = 20$$

$$5\left(\frac{\omega_z}{\omega_p}\right) > 20$$

$$\frac{\omega_z}{\omega_p} > 4$$

Only option (c) satisfies this.

48. **(b)**

Now, the phase cross-over frequency is calculated as

$$\angle G(j\omega)\,H(j\omega) = -180°$$

Here, $$\angle G(j\omega) = -90° - 3\tan^{-1}\frac{\omega}{\sqrt{6}}$$

or $$\tan^{-1}\frac{\omega}{\sqrt{6}} = 30°$$

or $$\frac{\omega}{\sqrt{6}} = \tan 30° = \frac{1}{\sqrt{3}}$$

or $$\omega_{pc} = \sqrt{2}\text{ rad/sec}$$

$$\omega_{gc} = \omega_{pc} = \sqrt{2}\text{ rad/sec}$$

The given system represents a marginally stable system having GM = 1 and PM = 0°.

49. **(b)**

Using the Routh's tabular form

s^6	1	8	20	16
s^5	2	12	16	0
s^4	$2(s^4)$	$12(s^2)$	$16(s^0)$	
s^3	8	24	0	
s^2	6	16	0	
s^1	$\frac{16}{6}$	0	0	
s^0	16			

Since there is no sign change in the first column of the Routh array, the system does not have any pole in the RHS of s-plane. However the row of zeros occur which gives the auxiliary equation

$$A(s) \Rightarrow 2s^4 + 12s^2 + 16 = 0$$

$$\Rightarrow s^4 + 6s^2 + 8 = 0 \Rightarrow s^2 = -2, -4 \Rightarrow s = \pm j\sqrt{2}, \pm j2$$

Hence, the system is said to be marginally stable.

50. (b)

The number of encirclements to the critical point $(-1 + j0) = 2$.

$$N = P - Z$$

P = Number of open-loop poles in RHS of s-plane = 0 (∵ open loop system is stable)

Z = Number of closed-loop poles in RHS of s-plane.

$$2 = 0 - Z$$

or $$Z = 2$$

The system is unstable with two RHS closed-loop poles.

51. (d)

The characteristic equation from the state model can be given by,

$$|sI - A| = 0$$

$$\begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} = \begin{bmatrix} s+1 & 0 \\ 0 & s+2 \end{bmatrix}$$

∴ $$\begin{vmatrix} s+1 & 0 \\ 0 & s+2 \end{vmatrix} = 0$$

or $$(s+1)(s+2) = 0$$

or $$s^2 + 3s + 2 = 0$$

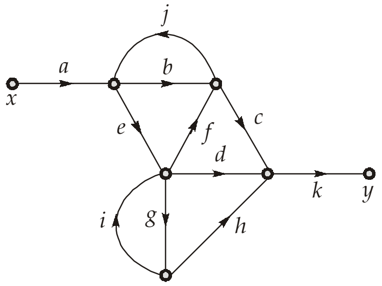
By comparing the above equation with standard second order equation, we get,

$$\omega_n^2 = 2 \Rightarrow \omega_n = \sqrt{2} \text{ rad/sec}$$

and $$2\xi\omega_n = 3 \Rightarrow \xi = \frac{3}{2\sqrt{2}} = 1.061$$

∵ $\xi > 1$, the system response is overdamped.

52. (b)



The forward paths are,

$$P_1 = abck$$
$$P_2 = aedk$$
$$P_3 = aeghk$$
$$P_4 = aefck$$

The individual loops are,

$$F_1 = bj$$
$$F_2 = gi$$
$$F_3 = efj$$

53. **(b)**

Given one is a phase lead compensator, the maximum phase lead is given by,

$$\phi_m = \sin^{-1}\left(\frac{1-\alpha}{1+\alpha}\right)$$

For high pass filter/lead compensator,

$$\tau = R_1C$$

and $$\alpha = \frac{R_2}{R_1+R_2} \; ; \; \alpha < 1$$

By putting the value of α in the above relation, we get,

$$\phi_m = \sin^{-1}\left(\frac{1-\dfrac{R_2}{R_1+R_2}}{1+\dfrac{R_2}{R_1+R_2}}\right)$$

$$= \sin^{-1}\left(\frac{R_1+R_2-R_2}{R_1+R_2+R_2}\right) = \sin^{-1}\left(\frac{R_1}{R_1+2R_2}\right)$$

54. **(b)**

The closed loop transfer function of the given system is

$$T(s) = \frac{C(s)}{R(s)} = \frac{A}{s(1+Ts)+A}$$

Comparing the above function with standard second order transfer function, we get,

$$\omega_n^2 = \frac{A}{T} \quad \Rightarrow \quad \omega_n = \sqrt{\frac{A}{T}}$$

and $$2\xi\,\omega_n = \frac{1}{T}$$

or $$\xi = \frac{1}{T}\times\frac{1}{2\omega_n} = \frac{1}{2T}\times\sqrt{\frac{T}{A}}$$

$$\xi = \frac{1}{2\sqrt{AT}}$$

∴ $$\xi \propto \frac{1}{\sqrt{AT}}$$

⇒ $$\frac{\xi_1}{\xi_2} = \sqrt{\frac{A_2T}{A_1T}}$$

$$\frac{0.2}{0.6} = \sqrt{\frac{A_2}{A_1}}$$

Therefore, the factor by which 'A' must be multiplied will be,

∴ $$\frac{A_2}{A_1} = \frac{1}{9} = 0.11$$

55. (a)

The closed loop transfer function,

$$T(s) = \frac{C(s)}{R(s)} = \frac{G(s)\cdot K_A}{1+G(s)\,K_B}$$

The sensitivity of $T(s)$ with respect to K_A can be calculated as,

$$S_{K_A}^{T} = \frac{\partial T(s)/T(s)}{\partial K_A/K_A} = \frac{\partial T(s)}{\partial K_A}\cdot\frac{K_A}{T(s)}$$

or,

$$= \frac{\partial}{\partial K_A}\left[\frac{G(s)\,K_A}{1+K_B\,G(s)}\right]\cdot\frac{K_A(1+G(s)K_B)}{G(s)\,(K_A)}$$

$$= \frac{G(s)}{1+K_BG(s)}\cdot\frac{K_A}{G(s)\cdot K_A}(1+G(s)K_B)$$

$$= 1$$

56. (c)

From the given bode plot,

$$G(s)H(s) = \frac{k\left(1+\frac{s}{\omega_1}\right)}{s^2\left(1+\frac{s}{\omega_2}\right)}$$

Since initial slope is –40 dB/dec, hence there are two poles at origin.

For corner frequency ω_1:

$$-20 = \frac{0-20}{\log 1-\log\omega_1}$$

$$-\log\omega_1 = \frac{-20}{-20} = 1 \quad\Rightarrow\quad \omega_1 = 10^{-1} = 0.1 \text{ rad/sec}$$

For corner frequency ω_2:

$$-20 = \frac{-20-0}{\log\omega_2-\log 1} \quad\Rightarrow\quad \omega_2 = 10 \text{ rad/sec}$$

For gain k:

$$20 = 20\log k - 40\log 0.1$$

$$-20 = 20\log k \quad\Rightarrow\quad k = 10^{-1} = 0.1$$

$\therefore$

$$G(s)H(s) = \frac{0.1\left(1+\frac{s}{0.1}\right)}{s^2\left(1+\frac{s}{10}\right)} = \frac{10(s+0.1)}{s^2(s+10)}$$

57. (a)

58 (a)

Maxwell's bridge is used for medium Q coils (1 to 10)

59. **(b)**

We know that, power $P = VI$

limiting error of Voltmeter, $\%\in_V = \frac{2}{70} \times 100 = 2.85\%$

limiting error of Ammeter, $\%\in_A = \frac{2}{80} \times 150 = 3.75\%$

Total limiting error in power measurement, $P = VI$

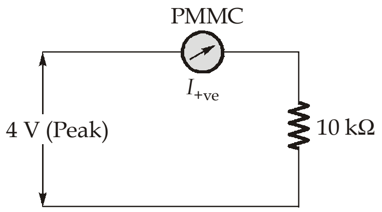
$$\in_P = 2.85\% + 3.75\%$$

$$\in_P = 6.6\%$$

60. **(c)**

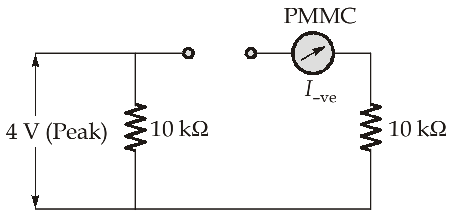
61. **(b)**

For positive half cycle, the diode D_2 is Forward bias, and diode D_1 is in Reverse bias condition during positive half cycle,



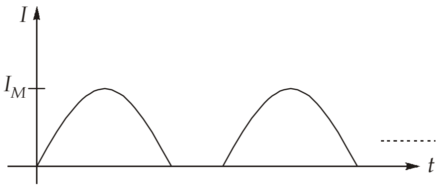
$\Rightarrow I_{+ve} = \frac{4}{10}\text{mA}$ (Peak)

during negative half cycle, D_1 is Forward bias and D_2 is Reverse bias.



$\therefore I_{-ve} = 0$ A

$\therefore$



Total current, $I_M = I_{+ve} + I_{-ve} = 0.4$ mA (Peak)

$\therefore$ PMMC reads, $I_{dc} = \frac{I_M}{\pi} = \frac{0.4}{\pi}$ mA

62. **(d)**

63. **(d)**

64. (c)

We know that, gauge factor, $$G_f = \frac{\Delta R/R}{\Delta L/L}$$

$$\text{strain, } \in = \frac{\Delta L}{L} = \frac{\Delta R/R}{G_f}$$

$$\in = \frac{0.012}{240 \times 2}$$

$$\text{applied force, } F = SA$$

where, $$\text{stress, } S = \text{Young's modulus} \times \text{Strain}$$

$$F = 200 \times 10^9 \times \frac{0.012}{240 \times 2} \times 4 \times 10^{-4}$$

$$F = 2 \times 10^3 \text{ N}$$

65. (d)

66. (b)

$$\% \text{ linearity} = \pm\frac{0.004}{2} \times 100 = \pm 0.2\%$$

67. (d)

68. (c)

69. (b)

70. (d)

71. (d)

For stop and wait protocol,

$$\text{Link utilisation efficiency} = \frac{1}{1+2a}$$

where, $$a = \frac{\text{Propagation Delay (PD)}}{\text{Transmission time}}$$

$$\Rightarrow \quad 0.5 = \frac{1}{1+2a}$$

$$\Rightarrow \quad 1 + 2a = 2 \quad \Rightarrow \quad a = 0.5$$

So, $$\text{transmission time} = \frac{PD}{0.5} = 2PD = 40 \text{ ms}$$

So, $$\text{minimum frame size} = 40 \times 10^{-3} \times 4 \times 10^3 = 160 \text{ bits}$$

72. (a)

The delay difference is given as,

$$\delta T_s = \frac{L n_1 \Delta}{c}$$

and rms pulse broadening due to intermodal dispersion can be obtained using

$$\sigma_s = \frac{L n_1 \Delta}{2\sqrt{3}c} = \frac{\delta T_s}{2\sqrt{3}} = \frac{300}{2\sqrt{3}}\text{ns}$$

maximum data rate possible is

$$B_T(\max) = \frac{0.2}{\sigma_s} = \frac{0.2 \times 2\sqrt{3} \times 1000}{300}\text{ Mbps}$$

$$= \frac{4}{\sqrt{3}} \simeq 2.3\text{ Mbps}$$

73. (c)

Blind speeds, $v_b = (\text{PRF})\frac{n\lambda}{2}; n = 1, 2, 3, \ldots$

$$\text{PRF} = 800/\text{sec}$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{5 \times 10^9} = \frac{3}{50}\text{m}$$

Lowest blind speed, $v_{b1} = (\text{PRF})\frac{\lambda}{2} = 800 \times \frac{3}{50 \times 2} = 24\text{ m/sec}$

Converting the speed from (m/sec) to (km/hour), we get,

$$v_{b1} = 24 \times \frac{60 \times 60}{1000} = 24 \times 3.6 = 86.4\text{ kmph}$$

74. (d)

To avoid the effect of plasma, f must be greater than f_P.

Where, $f_P = 9\sqrt{N}$

$$N = 4 \times 10^8\text{ cm}^{-3} = 4 \times 10^{14}\text{ m}^{-3}$$

$$f_P = 9\sqrt{4 \times 10^{14}} = 18 \times 10^7\text{ Hz} = 180\text{ MHz}$$

Only the frequency given in option (d) is greater than 180 MHz.

75. (a)

76. (c)

Frequency diversity is the best solution for ship-to-ship communication, since ships have space constraints.

77. (b)

Channel assignment is faster in fixed channel assignment compared to dynamic channel assignment.

78. **(d)**

79. **(a)**

$$\eta_{ep} = \eta_T \left(\frac{E_{g(eV)}}{V} \right)$$

$$\%\eta_{ep} = 0.18 \times \frac{1.43}{2.5} \times 100\%$$

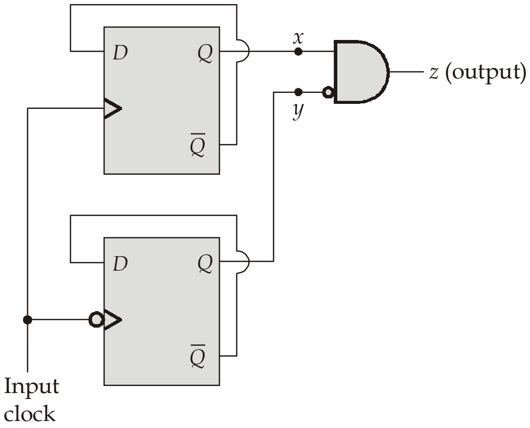
$$= 40 \times 0.18 \times 1.43\% = 7.2 \times 1.43 \simeq 10.3\%$$

80. **(b)**

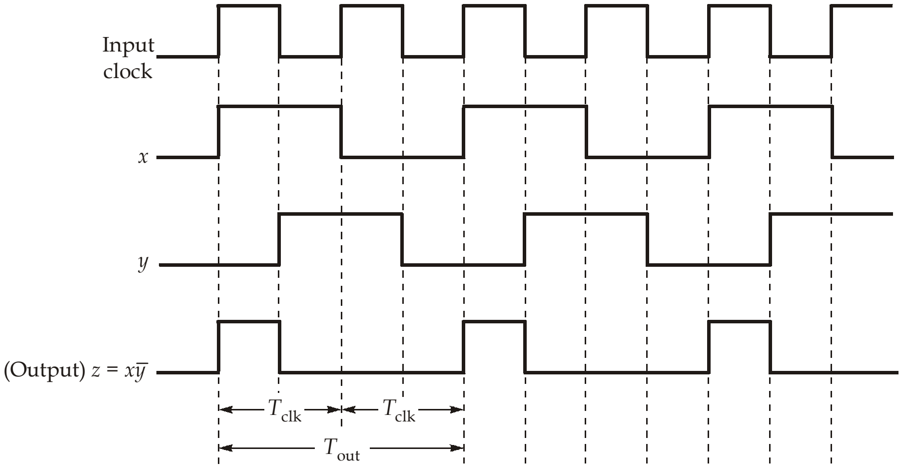
Circuit-1 does not have any feedback. Hence, it cannot be called as a sequential circuit.

81. **(b)**

In the given circuit, both the flip-flops are working in toggle mode, but one is positive-edge triggered and another is negative-edge triggered.



Output, $z = x\bar{y}$

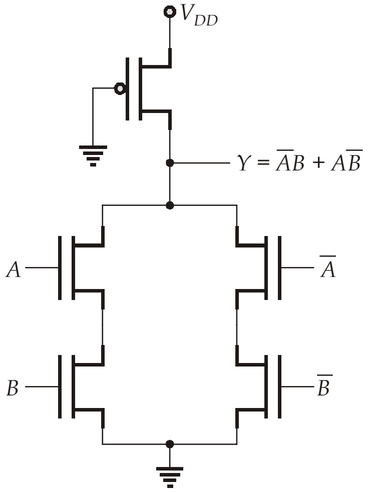


$$T_{out} = 2\,T_{clk}$$

$$f_{out} = \frac{f_{clk}}{2} = \frac{10}{2}\,\text{kHz} = 5\,\text{kHz}$$

82. **(b)**

Pseudo NMOS logic based EXOR gate,



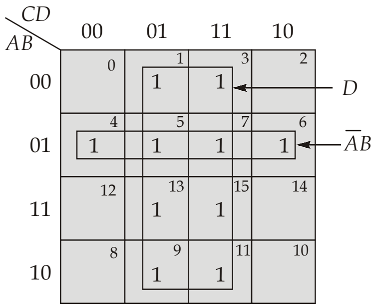
One PMOS required for pull-up network.

One PMOS required for generating $\bar{A}$ from A.

One PMOS required for generating $\bar{B}$ from B.

So minimum 3 PMOS transistors are required.

83. **(b)**



AB \ CD	00	01	11	10
00	0	1 1	3 1	2
01	4 1	5 1	7 1	6 1
11	12	13 1	15 1	14
10	8	9 1	11 1	10

$$F = \bar{A}B + D$$

84. **(c)**

$$\frac{54}{4} = 13$$

$$(54)_x = (13)_x(4)_x$$

$$5x + 4 = (x + 3)(4) = 4x + 12$$

$$x = 12 - 4 = 8$$

85. **(d)**

Full adder circuit using 2-input NAND gates is a 6 level circuit.

So, $t_{\text{pd(FA)}} = 6t_{\text{pd(NAND)}} = 6 \times 5 = 30 \text{ ns}$

86. **(c)**

The output of the first MUX circuit can be expressed as,

$$F_0 = \bar{A}$$

The output of second MUX circuit can be expressed as,

$$F = \bar{B}F_0 + BA = \bar{A}\bar{B} + AB \Rightarrow \text{EX-NOR gate}$$

87. **(b)**

$$(01100100)_2 = (100)_{10}$$
$$(10110011)_2 = (179)_{10}$$
$$\text{output voltage} \propto (\text{decimal equivalent of input binary code})$$

so,
$$\frac{x}{2} = \frac{179}{100}$$
$$x = 3.58 \text{ V}$$

88. **(b)**

$$\frac{1\ \mu\text{m}}{r} + \frac{0.01\ \mu\text{m}}{0.1r} = 5.5 \text{ minutes}$$
$$\frac{1\ \mu\text{m}}{r} + \frac{0.1\ \mu\text{m}}{r} = 5.5 \text{ minutes}$$
$$\frac{1.1\ \mu\text{m}}{r} = 5.5 \text{ minutes}$$
$$r = \frac{1.1}{5.5} = \frac{1}{5} = 0.2\ \mu\text{m/minute}$$

89. **(d)**

All the given three statements are true in connection with testing of combinational circuits.

90. **(b)**

When a number is divided by 5, there will be 5 possibilities for remainder: 0, 1, 2, 3, 4.
So, minimum 5 states are needed by the FSM.

91. **(d)**

The folded output can be expressed as,

$$F_0 = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C = \Sigma m(1,3,5)$$

The output F can be expressed as,

$$F = F_0 + \bar{A}\bar{B}\bar{C} + ABC = \Sigma m(0,1,3,5,7)$$

92. **(d)**

The source of interrupt is in phase to the system clock is called synchronous interrupt.

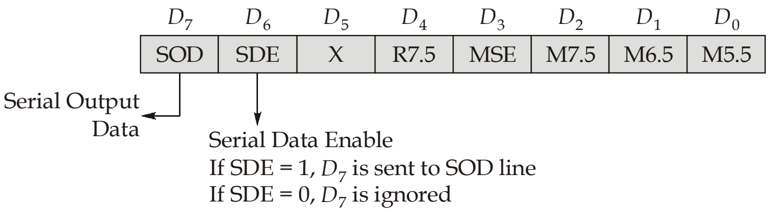
93. **(d)**

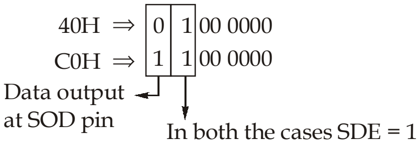
In 8051 microcontroller,

- With each PUSH operation, the contents of stack pointer (SP) is incremented by 1.
- On power-up, the RAM location 08H will be the first location of the stack.

94. (b)

When SIM instruction is being executed, the contents of the accumulator (A) is interpreted by the microprocessor as follows:

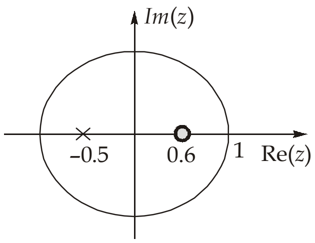




So, the outcome at SOD pin is 0 followed by 1.

95. (a)

Given,
$$H(z) = b_0 \frac{1+bz^{-1}}{1+az^{-1}}$$
$$= b_0 \frac{1-0.6z^{-1}}{1+0.5z^{-1}}$$
$$= b_0 \frac{z-0.6}{z+0.5}$$



Since the pole is inside the unit circle, the system will be stable if and only if the sytem is causal.

96. (a)

Statement 1:

For a system to be stable

$$\int_{-\infty}^{\infty} |h(t)|\,dt = M;\ M \ge 0$$

If $h(t)$ is periodic with period P(say) and also $h(t)$ is non-zero, then

$$\int_{-\infty}^{\infty} |h(t)|\,dt = N \int_{-P/2}^{P/2} |h(t)|\,dt \quad \text{(where } N \to \infty)$$

$$\int_{-\infty}^{+\infty} |h(t)|\,dt \to \infty$$

Hence unstable.

Statement 2:

Let an LTI system

$$y(t) = x(t - t_0) \quad \text{or} \quad x(t) \leftrightarrow x(t - t_0)$$

which is causal.

For its inverse system, $x(t)$ will be output and $y(t)$ will be input.

i.e.,

$$x(t - t_0) \to x(t)$$

$$x(t - t_0 + t_0) \to x(t + t_0) \qquad \text{[using shift invariance]}$$

which is non-causal.

Statement 3:

Let $x(t) \xleftrightarrow{h_1(t)} x(t+t_0)$ which is non causal

$x(t) \xleftrightarrow{h_2(t)} x(t-t_0)$ which is causal.

Cascade of the two systems.

$x(t) \longrightarrow \boxed{h_1(t)} \longrightarrow \boxed{h_2(t)} \longrightarrow x(t)$ which is clearly causal.

97. **(c)**

Here,

$$h(n) = \frac{1}{2}\delta(n+T) + \delta(n) + \frac{1}{2}\delta(n-T)$$

$$H(e^{j\omega}) = \frac{1}{2}e^{j\omega T} + 1 + \frac{1}{2}e^{-j\omega T}$$

So,

$$H(e^{j\omega}) = 1 + \cos \omega T$$

98. **(c)**

By the definition of z-transform,

$$X(z) = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$$

$$= \sum_{n=-\infty}^{\infty} \sum_{k=0}^{\infty} a^k \delta[n-5k] z^{-n}$$

The term $\delta[n - 5k]$ is equal to 1 if $n = 5k$ and equal to zero otherwise.

$$\therefore \qquad X(z) = \sum_{k=0}^{\infty} a^k z^{-5k} \qquad [\because n = 5k]$$

$$= \frac{1}{1 - az^{-5}} = \frac{z^5}{z^5 - a}$$

99. **(b)**

Force required,

$$F = \frac{B^2 A}{2\mu_0} = \frac{(0.1)^2 \times 100 \times 10^{-4}}{2 \times 4\pi \times 10^{-7}} \text{N}$$

$$= \frac{1000}{8\pi} = \frac{125}{\pi} \simeq 39.8 \text{ N}$$

100. **(c)**

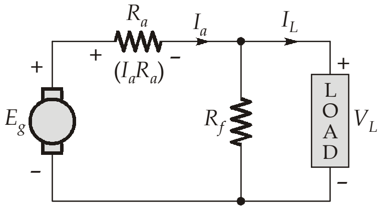
101. **(c)**

102. (b)

103. (a)

For lap-wound generator, the generated e.m.f. will be,

$$E_g = \frac{\phi ZN}{60} = \frac{0.1 \times 300 \times 1000}{60} = 500 \text{ V}$$



$$V_L = E_g - I_aR_a = E_g - \left(I_L + \frac{V_L}{R_f}\right)R_a$$

$$= 500 - \left(100 + \frac{V_L}{100}\right)(1) = 400 - \left(\frac{1}{100} \times V_L\right)$$

$$V_L = 400 \times \frac{100}{101} \simeq 396 \text{ V}$$

104. (a)

105. (c)

Efficiency will be maximum when copper loss equals iron loss.

106. (c)

$$\% \text{ drop} = (\text{fraction of load})\,(\%R\cos\theta + \%X\sin\theta)$$

$$= \frac{400}{500}(2.5 \times 0.8 + 5 \times 0.6) = \frac{4}{5}(2+3) = 4\%$$

107. (b)

When a 3-phase induction motor is loaded, its speed will decrease. As a result, slip will increase and as slip increases, the rotor current will increase.

108. (d)

Synchronous speed, $N_s = \frac{120 \times f}{P} = \frac{120 \times 50}{6} = 1000 \text{ rpm}$

slip, $s = \frac{N_s - N}{N_s} = \frac{1000 - 950}{1000} = 0.05$

Rotor input-power, $P_{r(\text{in})} = \frac{P_{\text{mech}}}{(1-s)} = \frac{3.8}{(1-0.05)} = \frac{3.8}{0.95} = 4 \text{ kW}$

Stator input power, $P_{s(\text{in})} = 4000 + 250 = 4250 \text{ W}$

109. (c)

110. (d)

Electrostatic precipitators are used to collect dust particle from flue gases.

111. (a)

112. (d)

Both envelope detector and square law demodulator do not require local carrier signal for demodulation.

113. (b)

Modulation index, $\beta = \dfrac{\Delta f}{f_m}$

Carson's rule bandwidth, $\text{BW} = (1 + \beta)2f_m = 2(f_m + \Delta f)$

By increasing modulating frequency (f_m) and keeping frequency deviation (Δf) constant, β will be decreased and BW will be increased.

114. (b)

For the given frequency synthesizer, in the steady state,

$$\frac{f_{\text{out}}}{N} = f_{\text{in}}$$

$$f_{\text{out}} = Nf_{\text{in}} = 50 \times 0.48 = 24 \text{ MHz}$$

115. (c)

$$F = 1 + \frac{N_{\text{int}}}{N_i}$$

N_{int} = Internal noise power referred to the input

N_i = Input noise power

Given that, $N_{\text{int}} = 7 \text{ nW}, [S_i] = -38 \text{ dBm and } \left[\frac{S}{N}\right]_i = 22 \text{ dB}$

$$\left[\frac{S}{N}\right]_i = [S_i] - [N_i] = 22 \text{ dB}$$

$$[N_i] = [S_i] - 22 \text{ dB} = -38 \text{ dBm} - 22 \text{ dB} = -60 \text{ dBm}$$

$$[N_i] = -60 \text{ dBm} \quad \Rightarrow \quad N_i = 10^{-6} \text{ mW} = 1 \text{ nW}$$

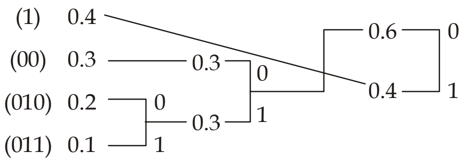
So, $F = 1 + \dfrac{7 \text{ nW}}{1 \text{ nW}} = 8$

In decilogs, $[F] = 10 \log_{10}(F) = 10 \log_{10}(8) = 10 \log_{10}(2^3) \simeq 9 \text{ dB}$

116. (d)

Quartz crystal filters offer very high degrees of selectivity and hence they often preferred in the IF stages of high performance superheterodyne receivers. However, they are costly.

117. (b)



$$\bar{L} = (1 \times 0.4) + (2 \times 0.3) + (3 \times 0.2) + (3 \times 0.1) \text{ bits/symbol}$$
$$= 0.4 + 0.6 + 0.6 + 0.3 = 1.9 \text{ bits/symbol}$$

118. (c)

Mean of X,
$$E[X] = \int_{-\infty}^{\infty} x\, f_X(x)dx = \int_0^{\infty} 3x\, e^{-3x}dx$$
$$= -\left[xe^{-3x} + \frac{e^{-3x}}{3}\right]_0^{\infty} = \frac{1}{3}$$
$$Y = 3X + 5$$

So, mean of Y,
$$E[Y] = 3E[X] + 5 = 3\left(\frac{1}{3}\right) + 5 = 6$$

119. (b)

$$Y(t) = X(t - T_0)$$

$X(t)$ and $Y(t)$ are uncorrelated.

So, $$C[X(t)Y(t)] = 0 \qquad \text{...(i)}$$
$$C[X(t)Y(t)] = E[X(t)Y(t)] - E[X(t)]E[Y(t)]$$

$X(t)$ is a zero mean process.

So, $$E[X(t)] = 0$$

and $$C[X(t)Y(t)] = E[X(t)X(t - T_0)] = R_X(T_0) \qquad \text{...(ii)}$$

From equations (i) and (ii),
$$R_X(T_0) = 0$$

120. (a)

Signal power,
$$S = \int_{-\infty}^{\infty} x^2 f_X(x)dx = \int_{-2}^{2} \frac{1}{4}x^2 dx = \frac{4}{3}$$

step-size,
$$\Delta = \frac{2-(-2)}{2^n} = \frac{4}{2^4} = \frac{1}{4}$$

Quantization noise power,
$$N_Q = \frac{\Delta^2}{12} = \frac{(1/4)^2}{12} = \frac{1}{16 \times 12}$$
$$(\text{SQNR}) = \frac{S}{N_Q} = \frac{4}{3} \times 16 \times 12 = 256$$

121. (c)

122. (a)

Variable-length instruction formats are used in CISC architecture.

123. (c)

$$\text{Speedup} = \frac{1}{0.7+\left(\frac{0.3}{3}\right)}$$

$$= \frac{1}{0.8} = 1.25 \text{ (or) } 25\% \text{ speedup}$$

124. (d)

Variable names cannot have spaces. Hence, statement-1 is incorrect.

125. (b)

Main memory size = 4K × 128 = $2^2 \times 2^{10} \times 2^7 = 2^{19}$ words

$$\text{Total number of sets in cache} = \frac{64 \text{ lines}}{4 \text{ lines/set}} = 16 \text{ sets}$$

To represent 16 sets ⇒ $\log_2(16)$ = 4 bits are needed

To represent 128 words ⇒ $\log_2(128)$ = 7 bits are needed

	TAG	SET	WORD
Main memory address ⇒	8 bits	4 bits	7 bits

|← 19 bits →|

So, TAG field contains (19 – 4 – 7) = 8 bits

126. (b)

$$(-1)_{10} = (-)^1 \times 2^0 \times 1.0$$

Decimal equivalent of the biased exponent = 0 + 127 = 127

$$(127)_{10} = (0111111)_2$$

32	31 23	22 0
1	01111111	00000000000000000000000
Sign bit	Exponent	Mantissa

1011	1111	1000	0000	0000	0000	0000	0000
B	F	8	0	0	0	0	0

127. (d)

Both the given statements are incorrect.

The correct statements must be as follows:

- Computer architecture is concerned with the structure and behaviour of the computer as seen by the user. It includes the information formats, the instruction set, and techniques for addressing memory.
- Computer organization is concerned with the way the hardware components operate and the way they are connected together to form the computer system.

128. (a)

Virtualization technology enables a single PC or server to simultaneously run multiple operating systems or multiple sessions of a single OS.

129. (b)

Process *A* requests the records in the order 1, 2, 3. If process *B* also asks for "1" first, then one of the processes will get it and other will be blocked. This situation is always deadlock free, since the winner can now run to completion without interference.

The six possible cases are as follows:

B requests in the order,

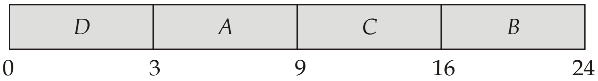
1 2 3 ⇒ deadlock free
1 3 2 ⇒ deadlock free
2 1 3 ⇒ possible deadlock
2 3 1 ⇒ possible deadlock
3 1 2 ⇒ possible deadlock
3 2 1 ⇒ possible deadlock

Since two of the six combinations guaranteed deadlock free situation, the required fraction

$$= \frac{2}{6} = \frac{1}{3}$$

130. (b)

Using Gantt chart,



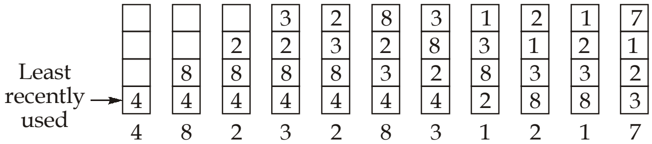
$$\text{Average waiting time} = \frac{0+3+9+16}{4} = \frac{28}{4} = 7 \text{ ms}$$

131. (b)

Internal fragmentation is not possible in dynamic partitioning.

132. (a)

Since main memory size is 4 kB and page size is 1 kB, total 4 pages can reside in the main memory.



So, the final pages that reside in the main memory are: 1, 2, 3, 7.

133. (b)

Apply membership test for all the given Functional Dependencies.

1. $CD \rightarrow AC$

   $CD^+ = CDEAB$

2. $BD \rightarrow CD$

   $BD^+ = BD$

i.e. BD cannot derive CD and hence is not implied. Similarly for rest two can be done.

134. (c)

For inductor filter, $r \propto R_L$

for capacitor filter, $r \propto \dfrac{1}{R_L}$

135. (a)

Since, $np = n_i^2$

So, when donar dopants are added hole concentration falls below intrinsic level.

136. (a)

137. (a)

138. (b)

139. (a)

140. (d)

Smith chart can be used for waveguide calculations.

141. (c)

Additional pole will reduce the bandwidth of the system.

142. (a)

143. (d)

The minimum possible input voltage which can be sensed and displayed is called sensitivity.

144. (a)

A client server application such as DNS uses UDP because client sends a question and DNS answers it with an IP (if it is in the records). All done with simple datagram packets. No worry if a packet is lost or corrupt, the client can ask for it again.

145. (a)

146. (a)

Pass-transistors suffer from threshold drop problem. This problem becomes worse if the output of a pass-transistor connected to gate of another pass-transistor.

147. (a)

148. (a)

149. (a)

150. (d)

Coherent detectors are free from threshold effect.

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