DETAILED SOLUTIONS

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ESE 2020 : Prelims Exam

CLASSROOM TEST SERIES

E & T ENGINEERING

Test 22

Full Syllabus Test 6 : Paper-II

1.	(b)	26.	(b)	51.	(b)	76.	(b)	101.	(c)	126.	(d)
2.	(b)	27.	(a)	52.	(b)	77.	(d)	102.	(c)	127.	(b)
3.	(b)	28.	(c)	53.	(c)	78.	(a)	103.	(b)	128.	(b)
4.	(b)	29.	(c)	54.	(a)	79.	(b)	104.	(c)	129.	(b)
5.	(c)	30.	(c)	55.	(a)	80.	(d)	105.	(b)	130.	(a)
6.	(d)	31.	(b)	56.	(c)	81.	(d)	106.	(a)	131.	(c)
7.	(c)	32.	(a)	57.	(c)	82.	(c)	107.	(d)	132.	(a)
8.	(a)	33.	(a)	58.	(c)	83.	(c)	108.	(a)	133.	(c)
9.	(d)	34.	(d)	59.	(c)	84.	(b)	109.	(b)	134.	(b)
10.	(b)	35.	(d)	60.	(c)	85.	(b)	110.	(d)	135.	(b)
11.	(b)	36.	(c)	61.	(c)	86.	(c)	111.	(b)	136.	(d)
12.	(b)	37.	(d)	62.	(c)	87.	(a)	112.	(b)	137.	(c)
13.	(d)	38.	(d)	63.	(b)	88.	(a)	113.	(a)	138.	(c)
14.	(a)	39.	(a)	64.	(c)	89.	(b)	114.	(a)	139.	(d)
15.	(a)	40.	(d)	65.	(c)	90.	(c)	115.	(d)	140.	(c)
16.	(a)	41.	(c)	66.	(c)	91.	(d)	116.	(d)	141.	(a)
17.	(b)	42.	(a)	67.	(b)	92.	(c)	117.	(c)	142.	(d)
18.	(c)	43.	(c)	68.	(d)	93.	(c)	118.	(a)	143.	(b)
19.	(a)	44.	(c)	69.	(c)	94.	(b)	119.	(a)	144.	(d)
20.	(c)	45.	(a)	70.	(b)	95.	(d)	120.	(d)	145.	(d)
21.	(b)	46.	(a)	71.	(c)	96.	(a)	121.	(b)	146.	(d)
22.	(a)	47.	(b)	72.	(d)	97.	(c)	122.	(d)	147.	(a)
23.	(b)	48.	(b)	73.	(b)	98.	(d)	123.	(b)	148.	(b)
24.	(b)	49.	(b)	74.	(b)	99.	(b)	124.	(b)	149.	(d)
25.	(c)	50.	(b)	75.	(c)	100.	(b)	125.	(b)	150.	(c)

DETAILED EXPLANATIONS

1. (b)

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}$$

Since copper is also a non-magnetic material,

$$\delta \propto \frac{1}{\sqrt{f\sigma}}$$

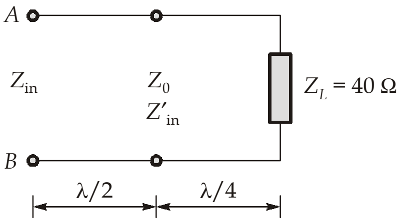
$$\therefore \quad \frac{\delta_1}{\delta_2} = \sqrt{\left(\frac{f_2\sigma_2}{f_1\sigma_1}\right)}$$

$$1 = \left(\frac{20\times\sigma_2}{16\times\sigma_1}\right)^2$$

$$\sigma_2 = \frac{16}{20}\sigma_1 = \frac{4}{5}\sigma_1$$

$$\sigma_2 = \frac{4}{5}\times 6\times 10^7 = 48\times 10^6 \ \mho/\text{m}$$

2. (b)



For $\lambda/2$ line, $$Z_{in} = Z_L = Z'_{in} = 160\ \Omega$$

For $\lambda/4$ line, $$Z'_{in} = \frac{Z_0^2}{Z_L}$$

$$Z_0 = \sqrt{Z'_{in}\times Z_L} = \sqrt{160\times 40} = 4 \times 2 \times 10 = 80\ \Omega$$

3. (b)

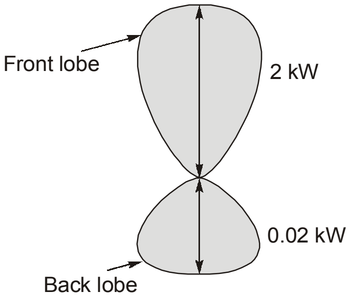
Here, $m = 3$, $n = 2$

$$f_c = \frac{v_0}{2\pi}\sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

$$= \frac{v_0}{2\pi}\sqrt{\left(\frac{3\pi}{6}\right)^2 + \left(\frac{2\pi}{4}\right)^2} = \frac{v_0}{2}\sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2} = \frac{v_0}{2\sqrt{2}}$$

$$= \frac{3\times 10^{10}}{2\times\sqrt{2}}\times\frac{1}{\sqrt{2}} = \frac{3\times 10^{10}}{4} = 7.5 \text{ GHz}$$

4. (b)



Front-to-back ratio in dB,

$$\text{FB} = 10\log_{10}\left(\frac{P_F}{P_B}\right) = 10\log_{10}\left(\frac{2000}{20}\right)$$

$$= 10\log_{10}(100) = 20 \text{ dB}$$

5. (c)

According to boundary conditions for electric field,

$$E_{t_1} = E_{t_2}$$

i.e. tangential component is continuous.

$$D_{n_1} - D_{n_2} = -\rho_s$$

If region is charge free, $\rho_s = 0$

Then, $$D_{n_1} = D_{n_2}$$

i.e. normal component of flux density is continuous across the charge free boundary.

In case of perfect conductor $E_{t_2} = 0$ since electric field does not exist inside a perfect conductor but in case of finite conductivity it can't be zero so statement 3 is wrong.

6. (d)

$$\nabla . J = -\rho_v$$

7. (c)

$$Z_0 = \sqrt{\frac{L}{C}} \qquad \text{...(i)}$$

and $$\beta = \omega\sqrt{LC} \qquad \text{...(ii)}$$

From equation (*i*) and (*ii*), $$Z_0\beta = \omega L$$

or $$L = \frac{Z_0\beta}{\omega} = \frac{60\times 1.2}{2\pi\times 3\times 10^9} = \frac{30\times 0.4}{\pi}\times 10^{-9}$$

$$= \frac{12}{\pi} \text{ nH/m} \simeq 3.82 \text{ nH/m}$$

8. (a)

9. **(d)**

Electric field E due to infinite sheet charge,

$$\vec{E} = \frac{\rho_s}{2\in_0}\hat{n}$$

For sheet 1 (at 3 m):

$$\vec{E}_1 = \frac{\rho_s}{2\in_0}\hat{n} = \frac{20}{2\in_0}(+\hat{a}_x) = \frac{10}{\in_0}\hat{a}_x \ \mu\text{V/m.}$$

For sheet 2 (at 5 m):

$$\vec{E}_2 = \frac{\rho_s}{2\in_0}\hat{n} = \frac{20}{2\in_0}(-\hat{a}_x) = \frac{-10}{\in_0}\hat{a}_x \ \mu\text{V/m}$$

$$\begin{aligned} \vec{E}_r &= \vec{E}_1 + \vec{E}_2 \\ &= \frac{10}{\in_0}\hat{a}_x - \frac{10}{\in_0}\hat{a}_x = 0 \end{aligned}$$

10. **(b)**

For parabolic reflector antenna

$$G = 6\left(\frac{D}{\lambda}\right)^2$$

$$G \propto \left(\frac{1}{\lambda}\right)^2 \propto (f)^2$$

$$\frac{G_1}{G_2} = \left(\frac{f_1}{f_2}\right)^2$$

For 6 dB increment,

$$G_2 = 4G_1$$

So,

$$\sqrt{\frac{1}{4}} = \frac{f_1}{f_2}$$

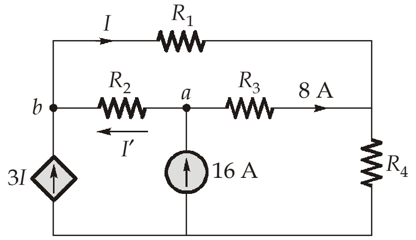
$$f_2 = f_1\sqrt{4} = 2f_1 = 8 \text{ GHz}$$

11. **(b)**

$$\begin{aligned} V &= -\int_A^B \vec{E}.\vec{dl} = -\left[\int_1^2 x\,dx + \int_2^0 Ky\,dy + \int_3^0 z\,dz\right] \\ &= -\left(\frac{x^2}{2}\right)_1^2 - \left(\frac{Ky^2}{2}\right)_2^0 - \left(\frac{z^2}{2}\right)_3^0 \\ &= -\left(\frac{4-1}{2}\right) - \left(-K\frac{4}{2}\right) - \left(-\frac{9}{2}\right) \\ 8 &= -\frac{3}{2} + 2K + \frac{9}{2} = 2K + 3 \\ K &= \frac{8-3}{2} = 2.5 \end{aligned}$$

12. **(b)**

Redrawing the circuit, we get,



KCL at node ‘a’ $\quad 16 = I' + 8$

$\therefore \quad I' = 8$ A

KCL at node ‘b’ $\quad 3I + I' = I$

$$I = -\frac{I'}{2} = -\frac{8}{2} = -4\text{ A}$$

13. **(d)**

$$C_A = C_1 + C_2 + C_3 \,....... + C_n$$
$$= C + C + C \,........ + C = nC$$
$$\frac{1}{C_B} = \frac{1}{C} + \frac{1}{C} + ... = \frac{n}{C}$$

$$\therefore \quad \frac{C_A}{C_B} = \frac{nC}{C/n} = n^2$$

14. **(a)**

The voltage induced across the inductor when the current through it changes with time is given by

$$v = L\frac{di}{dt}$$

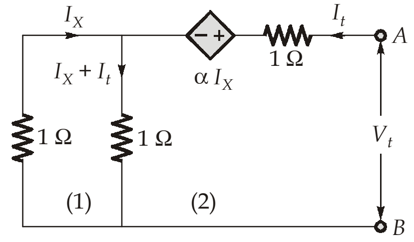
Here, $\quad \dfrac{di}{dt} = \dfrac{5-(-5)}{-2} = -5\text{ A/sec}$

$\therefore \quad |v| = 2 \times 10^{-3} \times 5 = 10^{-2}\text{ V} = 10\text{ mV}$

15. **(a)**

16. **(a)**

In order to determine Thevenin’s equivalent resistance the circuit can be redrawn as



Here $\quad Z_{\text{Th}} = \dfrac{V_t}{I_t}$ ...(i) at loop (1)

$$I_X + (I_t + I_X) = 0$$

$$I_X = -\frac{I_t}{2}$$

at loop (2)

$$V_t = I_t + \alpha I_X + (I_X + I_t)$$

$$= I_t - \frac{\alpha I_t}{2} + \left(I_t - \frac{I_t}{2}\right) = \frac{3}{2}I_t - \frac{\alpha I_t}{2} = \left(\frac{3-\alpha}{2}\right)I_t$$

$\therefore$ $$Z_{Th} = \frac{V_t}{I_t} = \frac{3-\alpha}{2}$$

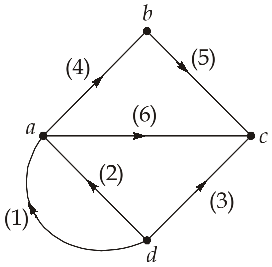
$\because$ $$Z_{Th} = 1\ \Omega$$

$\therefore$ $$\frac{3-\alpha}{2} = 1\ \Omega$$

or $$\alpha = 1$$

Note that the units of α will be ohms.

17. (b)



	Branches					
Nodes	1	2	3	4	5	6
a	–1	–1	0	1	0	1
b	0	0	0	–1	1	0
c	0	0	–1	0	–1	–1
d	1	1	1	0	0	0

18. (c)

Using superposition theorem, $$P = \left[\pm\sqrt{P_1} \pm \sqrt{P_2} \pm \sqrt{P_3}\right]^2 = \left[\pm\sqrt{30} \pm \sqrt{120} \pm \sqrt{270}\right]^2$$

$$P_{\max} = \left[\sqrt{30} + \sqrt{120} + \sqrt{270}\right]^2$$

$$= \left[\sqrt{3\times10} + \sqrt{4\times3\times10} + \sqrt{3\times3\times3\times10}\right]^2$$

$$= \left(\sqrt{3\times10}\right)^2\left[1 + \sqrt{4} + \sqrt{9}\right]^2$$

$$= 30[1 + 2 + 3]^2 = 30 \times 36 = 1080 \text{ W}$$

19. **(a)**

From the given circuit,

$$Z_{\text{in}} = (R \parallel Z_2) + (R \parallel Z_1)$$

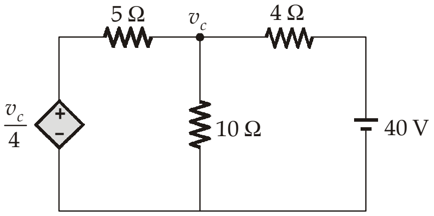
When $Z_1 = Z_2 = R$,

$$Z_{\text{in}} = (R \parallel R) + (R \parallel R) = R$$

20. **(c)**

At $t = 0^-$, the switch was closed, the capacitor will be acting as open circuited.

∴ The circuit can be redrawn as



Using KCL, we get,

$$\frac{(v_c - v_c/4)}{5} + \frac{v_c}{10} + \frac{v_c - 40}{4} = 0$$

On solving, we get,

$$v_c(0^-) = v_c(0^+) = 20 \text{ V}$$

21. **(b)**

$$P_{\text{avg}} = I_{\text{rms}}^2 \times R$$

$$= \left(\frac{2}{\sqrt{2}}\right)^2 \times 4 = 8 \text{ W}$$

22. **(a)**

For parallel *RL* circuit,

$$Y = \frac{1}{Z} = \frac{1}{(5+j20)} = \frac{5-j20}{5^2+20^2}$$

$$= \frac{5-j20}{25+400} = \frac{5}{425} - \frac{j20}{425} = \frac{1}{R} - \frac{j}{\omega L}$$

$$R = \frac{425}{5} = 85\ \Omega$$

and

$$\frac{1}{\omega L} = \frac{20}{425}$$

$$L = \frac{425}{2\pi \times 10^3 \times 20} \text{H} \simeq 3.4 \text{ mH}$$

23. (b)

Given, characteristic equation, $1 + G(s)H(s) = 0$

$$H(s) = 1$$

$$\therefore \quad 1 + G(s) = 0$$

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

$$\text{Open-loop T/F} = \frac{K(s+1)}{s^2(s+2)}$$

$$\therefore \quad \text{centroid} = \frac{-2-(-1)}{2} = -0.5$$

24. (b)

From the given closed-loop system,

$$\text{characteristic equation, } 1 + G(s)H(s) = 0$$

$$s^2 + 2s + 25 + 25s\tau = 0$$

$$s^2 + (2 + 25\tau)s + 25 = 0$$

$$2\xi(5) = 2 + 25\tau$$

given, damping ratio, $\xi = 0.7$

$$\Rightarrow \quad 7 = 2 + 25\tau$$

$$\therefore \quad \tau = \frac{5}{25} = 0.2 \text{ sec}$$

25. (c)

Polar plot of system-1 started at 0° ⇒ type = 0

Bode plot of system-2 has initial slope of –20 dB/dec ⇒ type = 1

26. (b)

Transfer function, $T(s) = \dfrac{G(s)}{1+G(s)H(s)}$

the sensitivity of the closed loop transfer function of the system with respect to feedback,

$$S_H^T = \frac{-GH}{1+GH} = \frac{-\dfrac{2.5}{s(s+1)}\times 2}{1+\dfrac{2.5}{s(s+1)}\times 2}$$

$$S_H^T = \frac{-5}{s^2+s+5}$$

at $s = j1$,

$$S_H^T = \frac{-5}{-\omega^2+j\omega+5} = \frac{-5}{-1+j1+5}$$

$$S_H^T = \frac{-5}{4+j1}$$

$$\left|S_H^T\right| = \frac{5}{\sqrt{16+1}} = \frac{5}{\sqrt{17}} = 1.21$$

27. **(a)**

Given, $$\text{Gain margin} = 6\text{ dB}$$

i.e., $$20\log GM = 6\text{ dB} \Rightarrow GM = 2$$

but $$\text{Gain margin} = \frac{K(\text{critical})}{K(\text{desired})}$$

$$\therefore \quad K(\text{desired}) = \frac{K(\text{critical})}{GM} = \frac{40}{2} = 20$$

28. **(c)**

Given, open loop transfer function,

$$G(s) = \frac{100}{s(s+\alpha)}$$

by comparing with standard equation,

i.e., $$G(s) = \frac{\omega_n^2}{s(s+2\xi\omega_n)}$$

$$\therefore \quad 2\xi\omega_n = \alpha$$

given, $$t_{\text{peak}} = \frac{\pi}{8} = \frac{\pi}{\omega_d}$$

$$\therefore \quad \omega_d = 8 \Rightarrow \omega_n\sqrt{1-\xi^2} = 8$$

$$10\sqrt{1-\xi^2} = 8$$

$$\sqrt{1-\xi^2} = 0.8$$

$$1 - \xi^2 = 0.64$$

$$\xi = 0.6$$

$$\therefore \quad 2\xi\omega_n = \alpha$$

$$2 \times 0.6 \times 10 = \alpha \Rightarrow \alpha = 12$$

29. **(c)**

Given, PD controller transfer function,

$$T(s) = (0.1 + 0.01s)$$

magnitude, $$20\log|T(j\omega)| = 20\text{ dB}$$

$$|T(j\omega)| = 10^1 = 10$$

i.e., $$|0.1 + j0.01\,\omega| = 10$$

$$\sqrt{(0.1)^2 + (0.01)^2\omega^2} = 10$$

$$(0.1)^2 + (0.01)^2\omega^2 = 100$$

$$\frac{1}{100} + \frac{\omega^2}{10000} = 100$$

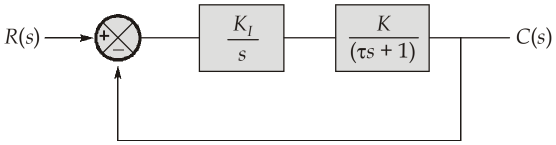
$$100 + \omega^2 = 10^6$$

$$\therefore \quad \omega \simeq 10^3\text{ rad/sec}$$

30. **(c)**

31. (b)

Given,



$$\frac{C(s)}{R(s)} = \frac{K_I K}{s(s\tau+1)+K_I K}$$

$$\frac{C(s)}{R(s)} = \frac{K_I K/\tau}{s^2+\frac{1}{\tau}s+\frac{K_I K}{\tau}}$$

damping ratio ξ:
$$2\xi\sqrt{\frac{K_I K}{\tau}} = \frac{1}{\tau}$$

$$\xi = \frac{\frac{1}{\tau}}{2\sqrt{\frac{K_I K}{\tau}}} = \frac{1}{2\sqrt{K_I K\tau}}$$

$\therefore$
$$\xi \propto \frac{1}{\sqrt{K_I}}$$

i.e., if K_I increases damping decreases.
Since the system become type-1, the steady-state offset to step commands will be zero.

32. (a)
The order of the auxiliary equation is always even.

33. (a)

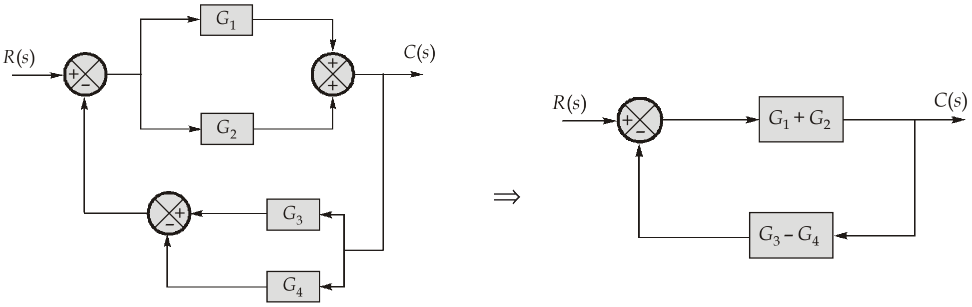
Transfer function,
$$\frac{Y(s)}{U(s)} = \frac{3s+2}{s^2+7s+9}$$

Phase-variable form representation,

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -9 & -7 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

and
$$y = [2 \quad 3]x$$

34. (d)



$$\frac{C(s)}{R(s)} = \frac{G_1+G_2}{1+(G_1+G_2)(G_3-G_4)}$$

35. **(d)**

For the given Lissajous pattern,

$$\phi = 180° - \sin^{-1}\left[\frac{2}{4}\right] = 150°$$

36. **(c)**

In dual slope integrating type digital voltmeter,

$$V_{\text{in}} = V_{ref}\left(\frac{t_2}{t_1}\right)$$

where t_1 is first integration time

$$t_1 = 10 \times \frac{1}{50} = 0.2 \text{ sec.}$$

$$V_{\text{in}} = 1 \text{ V}$$

$$V_{\text{ref}} = 2 \text{ V}$$

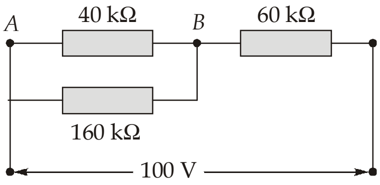
$$\Rightarrow \quad t_2 = V_{in} \times \frac{t_1}{V_{ref}} = \frac{1\times 0.2}{2} = 0.1 \text{ sec.}$$

$$\text{Total conversion time} = (t_1 + t_2) = 0.3 \text{ sec}$$

37. **(d)**

38. **(d)**

The resistance of voltmeter having a 100 V FSD and sensitivity 1.6 kΩ/V is 100 V × 1 .6 kΩ/V = 160 kΩ. When voltmeter is connected across A and B,



The equivalent resistance of the parallel resistors between A and B is $\left(\frac{160\times 40}{200}\right)\text{k}\Omega = 32\text{ k}\Omega$

$\therefore$ the voltage indicated by the voltmeter is equal to $\left(\frac{32}{32+60}\right)100 = 34.78\text{ V}$.

39. **(a)**

Given, $\quad$ Strain, $\in = \frac{S}{E} = \frac{100\times 10^6}{200\times 10^9}$

$\therefore \quad \in = 500 \times 10^{-6}$ (or) 500 microstrain

We have, $$\frac{\Delta R}{R} = G_f \in$$

$$\frac{\Delta R}{R} = 2 \times 500 \times 10^{-6} = 0.001 \text{ (or) } 0.1\%$$

∴ percentage change in resistance is 0.1%.

40. (d)

41. (c)

For platinum thermometer, the resistance at any temperature is,

$$R_\theta = R_{\theta_0}[1 + \alpha_{\theta_0}\Delta\theta]$$

where as, $R_{\theta_0} = 100\ \Omega$

$\alpha_{\theta_0} = 0.005/°C$

$\Delta\theta = 65°C - 25°C = 40°C$

∴ $R_\theta = 100[1 + 0.005(40)]$

$R_\theta = 100[1 + 0.2]$

∴ $R_\theta = 120\ \Omega$

42. (a)

43. (c)

Resistance, $$R = \frac{V}{I} = \frac{25}{5} = 5\ \Omega$$

Voltage error is ±2% of 50 V = ± 1.0 V and expressed as a percentage of the voltmeter reading as,

$$\frac{\pm 1}{25} \times 100\% = \pm 4\%$$

Current error is ±2% of 10 A = ±0.2 A and expressed as a percentage of the ammeter reading as,

$$\frac{\pm 0.2}{5} \times 100\% = \pm 4\%$$

∴ Maximum relative error = 4% + 4% = ±8%

∴ resistance $R = 5\ \Omega \pm 8\%$

44. (c)

Given, $S_{DC} = 20\ k\Omega/V$

$V_{FSD} = 10\ V$

$V_{measured} = 5\ V$

∴ input resistance of DC voltmeter $R_V = S_{DC} \times V_{FSD}$

∴ $R_V = 20\ k\Omega/V \times 10\ V$

$R_V = 200\ k\Omega$

∴ $$I_{coil} = \frac{V_{measured}}{R_V} = \frac{5}{200 \times 10^3} = 25\ \mu A$$

45. (a)

46. (a)

47. (b)

$$n_{at} = \frac{\rho N_A}{M_{at}} = \frac{n}{a^3}$$

For FCC lattice, number of atoms/unit cell (n) = 4

So, Lattice constant (a) $= \left(\frac{nM_{at}}{\rho N_A}\right)^{1/3}$

$$= \left(\frac{4 \times 60.2}{6.25 \times 10^6 \times 6.02 \times 10^{23}}\right)^{1/3} = \left(\frac{400}{6.25} \times 10^{-30}\right)^{1/3} \text{ m}$$

$$a = 4\ \text{Å}$$

interplannar distance (d) $= \frac{a}{\sqrt{h^2 + k^2 + l^2}} = \frac{4}{\sqrt{1+0+0}} = 4\ \text{Å}$

48. (b)

Given, $\lambda = 1.4$ Å, $(h\ k\ l) = (1\ 1\ 1)$; $a = 1.4$ Å

Interplannar spacing (d_{111}) $= \frac{1.4\ \text{Å}}{\sqrt{1^2 + 1^2 + 1^2}}$

$$d_{111} = \frac{1.4}{\sqrt{3}}\ \text{Å}$$

$\because$ $2d \sin\theta = n\lambda$ [where $n = 1$]

$$\sin\theta = \frac{1.4 \times 10^{-10} \times \sqrt{3}}{2 \times 1.4 \times 10^{-10}}$$

$$\sin\theta = \frac{\sqrt{3}}{2}$$

$$\theta = 60°$$

49. (b)

Active dielectrics are dielectrics which can easily adopt themselves to store the electrical energy in them.

50. (b)

51. (b)

52. (b)

For a half-wave quartz plate,

Thickness, $L = \frac{(\lambda/2)}{n_e - n_0} = \frac{640}{2(1.549 - 1.541)}$ nm

$$= \frac{640}{2 \times 0.008} = \frac{640}{0.016} \text{ nm} = 40\ \mu\text{m}$$

53. (c)

Thermal current
$$J_T = -K\frac{AdT}{dx}$$
$$J_T \propto A$$
$$J_T \propto \frac{dT}{dx}$$

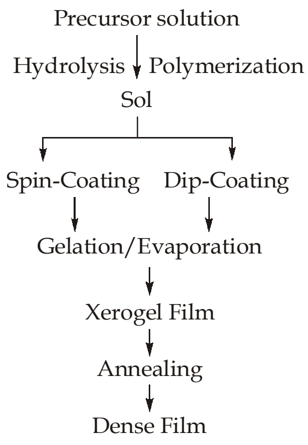
also, $\frac{K}{\sigma} = LT$ where L is known as Lorentz number.

$$L = \frac{\pi^2}{3}\left(\frac{k_B}{q}\right)^2$$

54. (a)

55. (a)

56. (c)



The sol-gel process involves the transition of a system from a liquid "sol" (mostly colloidal) into a solid "gel" phase. Then drying of the gel followed by calcination at different temperatures to obtain the metal oxide nanopowder. In sol-gel method, it is possible to control the shape, morphology and textual properties of the final materials. In contrast to high-temperature processes, Sol-gel method has large advantages such as possibility of obtaining metastable materials, achieving superior purity and compositional homogeneity of the products at moderate temperature.

57. (c)

$$V_{\text{out}} = \left(1+\frac{6}{2}\right)\times 0.5\sin\omega t$$
$$V_{\text{out}} = 2\sin(\omega t)\text{ V}$$
$$\left|\frac{dv_0}{dt}\right|_{\max} = \text{Slew rate}$$

$$2\omega = 1\text{ V/ns} = 10^9\text{ V/s}$$

$$f = \frac{500\times10^6}{2\pi} \simeq 79.6\text{ MHz}$$

58. (c)

Peak to peak ripple = 10 V

Hence the output voltage drop from 50 V to 40 V.

$$V_{LDC} = \frac{50+40}{2} = 45\text{ V}$$

$$\therefore \quad I_{DC} = \frac{45}{500} = 90\text{ mA}$$

Now, assuming discharge time to be linear.

$$C = \frac{I_{DC}}{V_{PP}f} = \frac{90\times10^{-3}}{10\times50} = 180\ \mu\text{F}$$

59. (c)

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS}-V_T)^2(1+\lambda V_{DS})$$

$$\therefore \quad I_{D2} = I_{D1}\cdot\frac{1+\lambda V_{DS2}}{1+\lambda V_{DS1}}$$

$$= 1\times10^{-3}\cdot\left[\frac{1+0.4\times2}{1+0.4\times0.5}\right] = 1.5\text{ mA}$$

60. (c)

For a push-pull amplifier,

$$\eta = \frac{\text{Power delivered to the load}}{\text{Power delivered to load + 2 × Power dissipated in one transistor}}$$

$$= \frac{(V_P)^2/2R_L}{\left(\dfrac{V_P^2}{2R_L}\right)+\dfrac{2(V_P)}{R_L}\left[\dfrac{V_{CC}}{\pi}-\dfrac{V_m}{4}\right]}$$

$$= \frac{\dfrac{(V_{CC}/2)^2}{2R_L}}{\dfrac{(V_{CC}/2)^2}{2R_L}+\dfrac{2(V_{CC}/2)}{R_L}\left[\dfrac{V_{CC}}{\pi}-\dfrac{V_{CC}}{8}\right]}$$

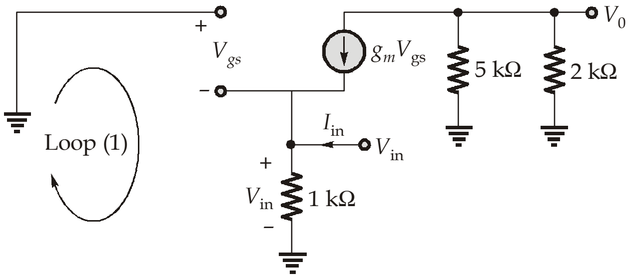
$$\%\eta = \frac{1}{1+\left(\dfrac{8}{\pi}-1\right)}\times100\% = \frac{\pi}{8}\times100\% = 39.27\% \simeq 39\%$$

61. **(c)**

For saturation,

$$\begin{aligned} V_{DS} &\geq V_{GS} - V_{\text{Th}} \\ V_D &\geq V_G - V_{\text{Th}} \\ (V_{DD} - I_D R_D) &\geq V_{DD} - V_{\text{Th}} \\ I_D R_D &\leq V_{\text{Th}} \\ R_D &\leq \frac{V_{\text{Th}}}{I_D} = \frac{0.4}{1\times 10^{-3}}\ \Omega \\ R_{D(\max)} &= 400\ \Omega \end{aligned}$$

62. **(c)**



Applying KVL in loop (1), we get,

$$\begin{aligned} V_{\text{in}} + V_{gs} &= 0 \\ V_{\text{in}} &= -V_{gs} \\ I_{\text{in}} + g_m V_{gs} &= \frac{V_{\text{in}}}{1\text{ k}\Omega} \\ I_{\text{in}} &= \frac{V_{\text{in}}}{1\text{ k}\Omega} - g_m V_{gs} = \frac{V_{\text{in}}}{1000} + \frac{V_{\text{in}}}{250} \\ R_{\text{in}} &= \frac{V_{\text{in}}}{I_{\text{in}}} = (1000 \,||\, 250) = 200\ \Omega \end{aligned}$$

63. **(b)**

$$\begin{aligned} g_m &= g_{mo}\left(1 - \frac{V_{GSQ}}{V_p}\right) \\ g_{mo} &= \frac{2I_{DSS}}{|V_p|} = \frac{2\times(8\times 10^{-3})}{8} = 2\text{ mS} \end{aligned}$$

$\therefore$ $$g_m = 2\left(1 - \frac{(-2)}{(-8)}\right)\text{mS} = 1.5\text{ mS}$$

64. **(c)**

65. **(c)**

66. (c)

$$C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}} = \frac{3.45\times10^{-13}}{5\times10^{-6}} = 6.9\times10^{-8}\,\text{F/cm}^2$$

$$Q'_{ss} = 10^{11}\text{ electrons charge/cm}^2 = 1.6\times10^{-19}\times10^{11}$$

$$= 1.6\times10^{-8}\text{ C/cm}^2$$

$$\therefore \quad V_{FB} = \phi_{ms} - \frac{Q'_{ss}}{C_{ox}} = -1.1 - \left(\frac{1.6\times10^{-8}}{6.9\times10^{-8}}\right) \simeq -1.33\text{ V}$$

67. (b)

68. (d)

The value of incremental diffusion capacitance C_d, is given as

$$C_d = \left(\frac{\tau}{V_T}\right)I$$

thus, $V_T \propto T$

∴ C_d is dependent on temperature.

and $C_d \propto I$

69. (c)

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 49$$

$$I_{CEO} = (\beta+1)I_{CBO} = (49+1)(5\times10^{-6}) = 0.25\text{ mA}$$

now, $$I_{CQ} = \beta I_{BQ} + I_{CEO}$$

$$= (49\times100\times10^{-6}) + (0.25\times10^{-3}) = 5.15\text{ mA}$$

70. (b)

Given that, $p_0 = 1.5\,n_i$ and $\mu_p = 500\text{ cm}^2/\text{V-sec}$.

Conductivity will be minimum, when

$$p_0 = n_i\sqrt{\frac{\mu_n}{\mu_p}}$$

$$1.5n_i = n_i\sqrt{\frac{\mu_n}{\mu_p}}$$

So, $$\frac{\mu_n}{\mu_p} = (1.5)^2 = 2.25$$

$$\mu_n = 2.25\,\mu_p = 2.25\times500 = 1125\text{ cm}^2/\text{V-sec}$$

71. **(c)**

$W_B \uparrow$ (Recombinations in base region) $\uparrow$ (Current gain) $\downarrow \Rightarrow$ Statement-1 is true

$W_B \uparrow$ (Base transit time) $\uparrow$ (Unity gain frequency) $\downarrow \Rightarrow$ Statement-2 is false

$W_B \uparrow$ (Early voltage) $\uparrow \Rightarrow$ Statement-3 is true

72. **(d)**

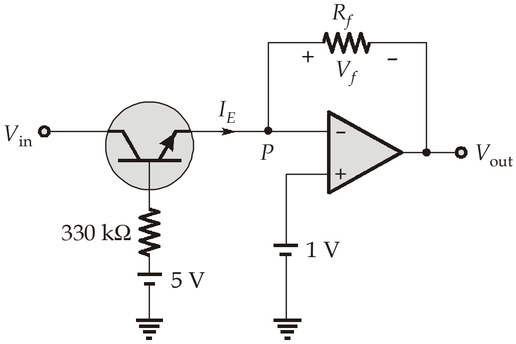
The given circuit is of voltage doubler circuit.

$\therefore \quad V_{C1} = 5\text{ V}$

and $\quad V_{C2} = -10\text{ V}$

$$\therefore \quad \frac{V_{C2}}{V_{C1}} = -\frac{10}{5} = -2$$

73. **(b)**



The value of output voltage is equal to

$$V_P - V_f = V_0$$

now, $\quad V_0 = 0$

$\therefore \quad V_P = V_f = 1\text{ V}$

now, $\quad I_E = (1 + \beta)I_B$

$$I_B = \frac{5 - V_{BE} - V_P}{330\text{ k}\Omega} = \frac{3.3\text{ V}}{330\text{ k}\Omega} = 10\ \mu\text{A}$$

$\therefore \quad I = I_E = 1000\ \mu\text{A} = 1\text{ mA}$

$\therefore \quad 1 \times 10^{-3} \times R_f = 1$

$$R_f = 1\text{ k}\Omega$$

74. **(b)**

For a current amplifier, input resistance should be very small and output resistance should be very high. Hence, current-shunt (shunt-series) topology should be used.

75. **(c)**

$$\begin{aligned} Z &= A\bar{B}\bar{C}D + ABCD + \bar{A}\bar{D} \\ &= AD[\bar{B}\bar{C} + BC] + \bar{A}\bar{D} \\ &= AD(B \odot C) + \bar{A}\bar{D} \end{aligned}$$

76. (b)

$$\frac{2.86\text{ V}}{30\text{ mV}} = 95.3$$

Thus, at 95th step output = 2.85 V

Since SAC type produces an output that is one step below the final input, the output would be

$$(95)_{10} = (01011111)_2$$

77. (d)

Given,

$$\begin{aligned}(73)_x &= (54)_y\\ 7x + 3 &= 5y + 4\\ 7x - 5y &= 1\end{aligned}$$

Put all options and option (d) satisfies.

78. (a)

Fanout in CMOS : > 50

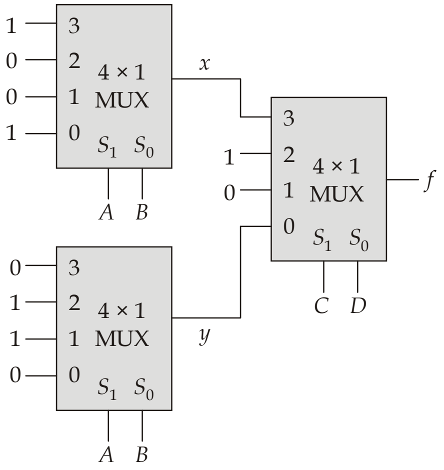
ECL : 25

TTL : 10

RTL : 5

$\therefore$ CMOS > ECL > TTL > RTL

79. (b)



$$x = A\odot B \quad ; \quad y = A\oplus B$$

$$\begin{aligned}f &= \bar{C}\bar{D}y + C\bar{D} + CDx = \bar{C}\bar{D}(A\oplus B) + C\bar{D} + CD(A\odot B)\\ &= \bar{C}\bar{D}(\overline{A\odot B}) + CD(A\odot B) + C\bar{D}\end{aligned}$$

80. (d)

$$\text{Resistance of LSB} = (2^{n-1}) \text{ MSB resistance}$$

where, $n = 6$ (given)

$$\text{LSB} = (2^{6-1})2 \text{ k}\Omega = 64 \text{ k}\Omega$$

$$\text{Smallest quantized output current} = \frac{8}{64}\text{mA} = 125\,\mu\text{A}$$

81. (d)

82. (c)

$$\because \quad Q + \bar{Q} = 1 \text{ always, thus the flip-flop will toggle always.}$$

$$\therefore \quad f_{\text{out}} = \frac{f_{clk}}{2} = \frac{10}{2} \times 10^3 = 5\,\text{kHz}$$

83. (c)

84. (b)

Uplink frequency bandwidth = 25 MHz
Downlink frequency bandwidth = 25 MHz
Carrier bandwidth = 200 kHz

$$\text{Total number of carriers} = \frac{25 \times 10^6}{200 \times 10^3} = 125$$

There are total 125 carriers but only 124 will be used and

$$\text{number of channel in each cell} = \frac{124}{4} = 31$$

85. (b)

$$C/N = \text{EIRP} + G/T - \text{losses} + 228.6 - [\text{BW}]$$
$$= 25 + 32 - 196 + 228.6 - 73 = 16.6 \text{ dB}$$

$\because$ [BW] = $10\log_{10}(2 \times 10^7)$ = 73 dB-Hz

86. (c)

87. (a)

Material dispersion (Chromatic dispersion) Occurs due to variation of refractive index inside core material as a function of wavelength.

$$\tau_m \propto \lambda^2$$

Waveguide Dispersion: Reason for waveguide dispersion is the variation in the propagation of the light in the core and cladding layers.

Whenever any optical signal is passed through the optical fiber, practically 80% of optical power is confined to core and rest 20% optical power into cladding. It occurs due to microscopic variations in the material density, compositional fluctuations, structural inhomogeneities and manufacturing defects.

88. **(a)**

89. **(b)**

Point-to-Point Protocol (PPP) is a data link layer protocol.

90. **(c)**

Since given address is class-C IP address therefore it will have 24 bit net ID to get Net ID → masking given IP with class C default mask. 255.255.255.0

We get:

$$\begin{array}{rcccc} & 194 & 38 & 14 & 13 \\ & 11000010 & 00100110 & 00001110 & 00001101 \\ \text{(AND)} & 11111111 & 11111111 & 11111111 & 00000000 \\ \hline & 194 & 38 & 14 & 0 \end{array}$$

So Net ID : 194.38.14.0

91. **(d)**

92. **(c)**

Scrambling means alteration of speech frequency of a broadcast transmission so as to make it secure. Satellite communication uses scrambling to limit power spectral density.

93. **(c)**

94. **(b)**

$$R = \frac{(n_1 - n_2)^2}{(n_1 + n_2)^2} = \frac{(3.5-1)^2}{(3.5+1)^2} \simeq 0.31$$

95. **(d)**

96. **(a)**

For given block diagram, $H(z) = \dfrac{1 - z^{-1}}{1 - \lambda z^{-1}} \quad \lambda < 1$

$$H(e^{j\omega}) = \frac{1 - e^{-j\omega}}{1 - \lambda e^{-j\omega}} \quad (z \to e^{j\omega})$$

Putting, $\omega \Rightarrow 0 \qquad H(e^{j\omega}) = 0$

So, it removes zero freq. component.

So, answer is (a).

97. **(c)**

$\because \qquad \log(1 + x) = x - \dfrac{x^2}{2} + \dfrac{x^3}{3} - \dfrac{x^4}{4} + \ldots..$

when $x < 1$

so for, $\log\left(1 - \dfrac{1}{2}z^{-1}\right)$; where $\left(\dfrac{1}{2}z^{-1} < 1\right)$

$$X(z) = -\left(\frac{1}{2}z^{-1} + \frac{1}{2}\left(\frac{1}{2}z^{-1}\right)^2 + \frac{1}{3}\left(\frac{1}{2}z^{-1}\right)^3 + \dots\right)$$

$$= -\sum_{n=1}^{\infty}\frac{1}{n}\left(\frac{1}{2}z^{-1}\right)^n$$

$$X(z) = -\sum_{n=-\infty}^{\infty}\left[\frac{1}{n}\left(\frac{1}{2}\right)^n u(n-1)\right]z^{-n}$$

So,
$$x(n) = -\frac{1}{n}\left(\frac{1}{2}\right)^n u(n-1) \qquad \left[\because X(z) = \sum_{-\infty}^{\infty} x(n)z^{-n}\right]$$

98. (d)

$$x(t) \xleftrightarrow{CTFT} X(f)$$

$$x_1(t) = x(t+3) \xleftrightarrow{CTFT} X_1(f) = X(f)\, e^{j(2\pi f)3} = X(f)e^{j6\pi f}$$

$$x_2(t) = x(2t+3) = x_1(2t) \xleftrightarrow{CTFT} X_2(f) = \frac{1}{2}X_1\left(\frac{f}{2}\right) = \frac{1}{2}X\left(\frac{f}{2}\right)e^{j3\pi f}$$

99. (b)

Output, $y(t) = e^{-t}\, u(t)$

Input, $x(t) = e^{-2t}\, u(t)$

$$Y(s) = \frac{1}{s+1}$$

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

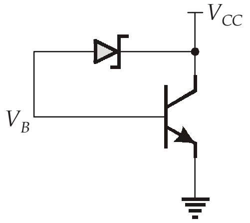
Transfer function,
$$H(s) = \frac{\dfrac{1}{(s+1)}}{\dfrac{1}{(s+2)}} = \frac{s+2}{s+1} = 1 + \frac{1}{s+1}$$

By taking inverse Laplace transform, we get,

Unit impulse response, $h(t) = \delta(t) + e^{-t}u(t)$

100. (b)

For a schottkey transistor circuit is shown below:



- A schottkey diode is connected between base and collector and hence collector voltage is locked to some value which is greater than saturation voltage (Due to forward voltage drop across schottkey diode, say ($V_C = V_B - V_{(\text{cut in schottkey})}$)) so it never goes to saturation.

- Schottkey transistor can be fabricated easily by just extending base metal contact to collector region.

101. (c)

102. (c)

1.5 μm technology means, minimum channel length (L_{min}) = 1.5 μm

As per the scaling rules, minimum thickness of the oxide layer will be decreased in the same proportion of decrease in L_{min}.

Minimum t_{ox} for 0.13 μm technology is $\frac{25}{1.5}(0.13)\text{ nm} = \frac{13}{6}\text{ nm} = 2.167\text{ nm}$

103. (b)

104. (c)

Both the given statements are correct.

105. (b)

The given state diagram is a sequence detector which detects the sequences 101 and 010.

106. (a)

107. (d)

108. (a)

Modulation index, $\beta = 5$

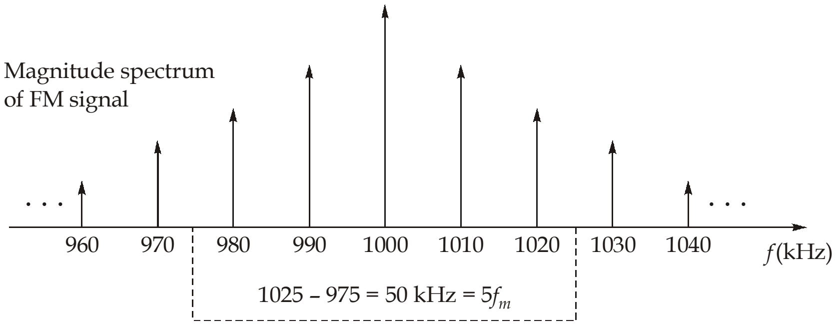
Modulating frequency, $f_m = \frac{1250}{2\pi}\text{Hz}$

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

$$= (1+5)\times 2\times\frac{1250}{2\pi}\text{Hz}$$

$$= \frac{6\times 1.25}{\pi} = \frac{7.5}{\pi} = 2.387 \simeq 2.4\text{ kHz}$$

109. (b)



Band of frequencies allowed by the BPF

So, the highest frequency component that will present in the signal at the filter output is 1020 kHz.

110. (d)

For single-tone FM system, $(\text{FOM}) = \frac{3}{2}\beta^2$

For $\beta = 4$, $(\text{FOM}) = \frac{3}{2}(4)^2 = 24$

111. (b)

A high value of intermediate frequency increases tracking difficulties. Hence, statement-3 is incorrect.

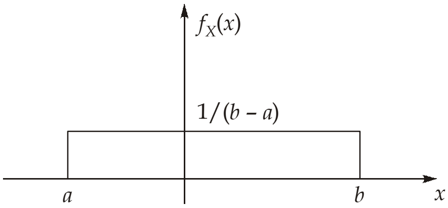
112. (b)

Entropy,
$$\begin{aligned} H(X) &= \log_2(5) \text{ bits/symbol} \\ &= \log_2(10) - \log_2(2) \text{ bits/symbol} \\ &= 3.322 - 1 = 2.322 \text{ bits/symbol} \end{aligned}$$

Code efficiency,
$$\begin{aligned} \eta &= \frac{H(X)}{\bar{L}} \times 100 \\ &= \frac{2.322}{2.4} \times 100 \simeq 96.75\% \end{aligned}$$

113. (a)

Let us assume the probability density function of X as shown below:



Mean, $$\bar{X} = \frac{a+b}{2} = 1 \Rightarrow (a+b) = 2 \quad \text{...(i)}$$

Variance, $$\sigma_X^2 = \frac{(b-a)^2}{12} = \frac{4}{3} \Rightarrow (b-a)^2 = 16 \Rightarrow (b-a) = 4 \quad \text{...(ii)}$$

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

$$a = -1 \text{ and } b = 3$$

So, $$P(X > 0) = \int_0^{\infty} f_X(x)dx = \int_0^3 \frac{1}{4}dx = \frac{3}{4}$$

114. (a)

Mean square value, $$E[X^2(t)] = R_X(0) = \frac{36}{4} = 9$$

Square of mean, $$(\bar{X})^2 = \lim_{|\tau|\to\infty} R_X(\tau) = \frac{25}{6.25} = 4$$

Variance, $$\sigma_X^2 = E[X^2(t)] - (\bar{X})^2 = 9 - 4 = 5$$

115. **(d)**

116. **(d)**

The carrier phase changes by ±180° whenever both in-phase and quadrature components of the QPSK signal changes sign.

117. **(c)**

op-code	operand-1	operand-2	operand-3

$|\leftarrow n\text{-bits} \rightarrow|\leftarrow n\text{-bits} \rightarrow|\leftarrow n\text{-bits} \rightarrow|$

Where, N = total number of registers available

If N become double, the value of "n" will be increased by "1" and hence, each operand field increased by 1-bit. So, the instruction size would increase by 3 bits.

118. **(a)**

119. **(a)**

120. **(d)**

Formatting of floppy disk refers to writing identification information on all tracks and sectors.

121. **(b)**

Time to read on record from file = 12 μs
Time to execute 100 instructions = 1 μs
Time to write one record to file = 12 μs

$$\text{Percent CPU utilization} = \frac{1\ \mu s}{12\ \mu s + 1\ \mu s + 12\ \mu s} \times 100\% = \frac{1}{25} \times 100 = 4\%$$

122. **(d)**

123. **(b)**

The execution time depends on how the operating system schedules the programs. All the possible schedules are given in the following table:

CPU 1	CPU 2	Total execution time
P_0	P_1, P_2	30 ms
P_1	P_0, P_2	25 ms
P_2	P_0, P_1	20 ms
P_0, P_1, P_2	–	35 ms

So, the minimum time, required to complete the execution of the three programs is 20 ms.

124. **(b)**

Main memory size = 2^{24} bytes
Each partition size = 65536 = 2^{16} bytes

$$\text{Total number of partitions} = \frac{2^{24}}{2^{16}} = 2^8$$

So, minimum 8 bits are needed to record the partition to which a process has been allocated.

125. (b)

			C	D	A	B	E	E	E	C	D	D
		B	B	C	D	A	B	B	B	E	C	C
First-in →	A	A	A	B	C	D	A	A	A	B	E	E
Page referred	A	B	C	D	A	B	E	A	B	C	D	E
Page fault	*	*	*	*	*	*	*			*	*	

Total number of page faults = 9

126. (d)

To compute f(5), initially r = 5.

$f(3) + 2 = 18 \quad [(n > 3) : f(n-2) + 2]$

$\uparrow$

$f(2) + 5 = 16 \quad [f(n-2) + r]$

$\uparrow$

$f(1) + 5 = 11 \quad [f(n-2) + r]$

$\uparrow$

$f(0) + 5 = 6 \quad [f(n-2) + r]$

$\uparrow$

$1 \quad [n \le 0]$

127. (b)

We can choose the correct option by finding the closure of each option

(a) $(CD)^+ = \{C, D, F\}$

$\therefore$ CD is not a key for R.

(b) $(EC)^+ = \{A, B, C, D, E, F\}$

$\therefore$ EC is a key for R.

(c) $(AE)^+ = \{A, B, E\}$

$\therefore$ AE is not a key for R

(d) $(AC)^+ = \{A, B, C, F\}$

$\therefore$ AC is not a key for R

Therefore, EC is a key for R.

128. (b)

$$\text{e.m.f.} = Blv \sin\theta = 1.5 \times 2 \times 50 \times \sin(30°)\ \text{V}$$

$$= 150 \times \frac{1}{2} = 75\ \text{V}$$

129. (b)

We know, Power input, $I^2R = 1200$ W

$$R = \frac{1200}{(100)^2} = 0.12\ \Omega$$

The impedance,

$$Z = \frac{V}{I} = \frac{60}{100} = 0.6\ \Omega$$

∴ The leakage reactance,

$$X = \sqrt{Z^2 - R^2}$$

$$= \sqrt{(0.6)^2 - (0.12)^2}$$

$$= 0.587 \approx 0.59\ \Omega$$

130. (a)

An auto transformer has lower voltage regulation and lower per unit impedance which results in higher short circuit current.

$$\text{Copper saving} = \frac{1}{a_{\text{auto}}}$$

Also,

$$\frac{\text{Conductive transfer}}{\text{Total transfer}} = \frac{1}{a_{\text{auto}}}$$

131. (c)

Given,

Iron loss of transformer, $P_i = 900$ W

Copper loss of transformer, $P_{cu} = 1600$ W

Let the maximum efficiency occurs at x times of full load, then

$$x = \sqrt{\frac{P_i}{P_{cu}}} = \sqrt{\frac{900}{1600}} = \frac{3}{4} = 0.75$$

For maximum efficiency output power at unity power factor,

$$P_{\text{out}} = 0.75 \times 40 \times 1$$

$$= 30 \text{ kW}$$

$$\text{Total losses, } P_{\text{loss}} = P_i + x^2 P_{\text{cu}}$$

$$= 900 + \left(\frac{3}{4}\right)^2 1600$$

$$= 900 + \frac{9}{16} \times 1600 = 1800 \text{ W or } 1.8 \text{ kW}$$

So, maximum efficiency,

$$\eta = \frac{P_{\text{out}}}{P_{\text{out}} + P_{\text{loss}}} = \frac{30}{30 + 1.8} = \frac{30}{31.8}$$

$$= 0.9433 \text{ or } 94.33\%$$

132. (a)

Stiffness is improved by decreasing the synchronous reactance.

133. (c)

$$P = V I \cos\phi$$

$$I \cos\phi = \text{constant}$$

(for same voltage and load)

$$\Rightarrow \quad I_1 \cos\phi_1 = I_2 \cos\phi_2$$
$$200 \times 1 = I_2 \times 0.5$$
$$I_2 = 400 \text{ A}$$

134. (b)

Voltage drop in armature is

$$I_{a1}R_a = 50 \times 0.5 = 25 \text{ V}$$

The emf generated is

$$E_1 = 250 + 25 = 275 \text{ V}$$

Immediately after the change of flux, the speed remains same,

Thus, $$\frac{E_2}{E_1} = \frac{\phi_2}{\phi_1}$$

$$\Rightarrow \quad E_2 = \frac{0.029}{0.03} \times 275 = 265.8 \text{ V}$$

Armature current immediately after the change of flux is

$$I_a = \frac{265.8 - 250}{0.5} = \frac{15.8}{0.5} = 31.6 \text{ A}$$

135. (b)

- The effect of armature reaction in case of dc motor is that it shifts MNA in the direction which is against the rotation of motor from GNA.
- $$\text{Power} = EI = E\left(\frac{V-E}{R}\right) = \frac{EV}{R} - \frac{E^2}{R}$$

$$\frac{dP}{dE} = \frac{V}{R} - \frac{2E}{R}$$

for maximum power,

$$\frac{dP}{dE} = 0 \qquad \text{i.e. } E = \frac{V}{2}$$

Maximum mechanical power occurs when back emf is equal to half of the applied voltage.

136. (d)

$$\text{Current in each lamp, } I = \frac{P}{V} = \frac{100}{120} = \frac{5}{6}\text{A}$$

$$\text{Total load current, } I_L = \frac{5}{6} \times 60 = 50 \text{ A}$$

$$\text{Field current, } I_{sh} = \frac{120}{60} = 2\text{A}$$

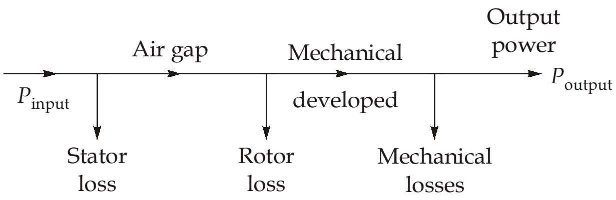
$$\text{Armature current, } I_a = I_{fL} + I_{sh} = 50 + 2 = 52 \text{ A}$$

A wave winding has 2 parallel paths, so current in each armature conductor $= \frac{52}{2} = 26\text{A}$

137. (c)

Primary cells: Laclanche cell, zinc-chlorine cell, alkaline-manganese cell, metal air cell etc.
Secondary cells: Lead-acid cell, nickel-cadmium cell, nickel-iron cell, silver-zinc cell etc.

138. (c)



Given, Slip, $s = 0.03$

Per phase output power,

$$P_0 = \frac{30}{3} = 10 \text{ kW}$$

Now, Mechanical losses $= \dfrac{10 \times 1.5}{100} = 0.15$ kW

Mechanical developed power,

$$= 10.15 \text{ kW}$$

$$\text{Per phase rotor copper loss} = s(\text{air gap power})$$

$$= \frac{s(\text{Mechanical developed power})}{1-s}$$

$$P_{\text{cu (rotor)}} = \frac{0.03}{0.97} \times 10.15 = 314 \text{ W}$$

139. (d)

$$\text{Synchronous speed, } N_s = \frac{120 \times 50}{4} = 1500 \text{ rpm}$$

$$\text{Slip, } s = \frac{E_{(\text{injected})}}{E_{(\text{rotor})}} = \frac{18}{54} = \frac{1}{3}$$

$$\text{Rotor speed, } N_r = N_s(1 - s) = 1500\left(1 - \frac{1}{3}\right) = 1000 \text{ rpm}$$

140. (c)

At starting, a large portion of starting current flows in the top cage due to large leakage reactance of inner (bottom cage) at starting.

141. (a)

$$(\text{FOM})_{\text{DSBSC}} = 1$$

$$(\text{FOM})_{\text{AM}} = \frac{\mu^2}{2 + \mu^2} < 1$$

Higher value of (FOM) indicates the better noise performance.

142. (d)

The number of states in a Moore machine and in its equivalent Mealy machine are not always same.

143. (b)

144. (d)

JFET is less noisy device than BJT.

145. (d)

For an intrinsic semiconductor,

$$\sigma = ne\mu_n + pe\mu_p$$

$$n = p = n_i$$

But, $$\mu_n \neq \mu_p$$

146. (d)

In liquids and gases breakdown does not generally damage the material permanently. In solids, the breakdown process leads to formation of conducting channel.

147. (a)

148. (b)

149. (d)

Since the perfectly conducting surface is equipotential, no electric field component exists tangential to the surface and therefore electric field lines out normal to a conducting surface boundary.

150. (c)

- The given circuit is reciprocal, since it has purely resistors.
- A reciprocal network will have $h_{12} = -h_{21}$.
- Statement (I) is correct and statement (II) is incorrect.

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