DETAILED SOLUTIONS

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ESE 2022 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 18

Full Syllabus Test 2 : Paper-II

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

DETAILED EXPLANATIONS

1. (c)

$$\sin\phi = \frac{\omega L}{Z}$$

$$\frac{\omega(0.02)}{17.85} = \sin(63.5°)$$

$$\omega = \frac{(0.895)(17.85)}{0.02} = 798.73 \text{ rad/sec}$$

2. (b)

$$\text{The average power dissipated} = \frac{\text{Energy absorbed over one period}}{\text{Total time period}}$$

$$P = \frac{1}{T}\int_0^T i^2 R dt$$

$$= \frac{1}{1 \text{ sec}}\int_0^1 (10t)^2 \times 30 dt = 3000\int_0^1 t^2 dt$$

$$= 3000 \times \frac{1}{3} = 1000 \text{ W}$$

3. (d)

For maximum power to be transferred,

$$Z_L = Z_s^*$$

Here, $Z_s = (2 - j4)\Omega$

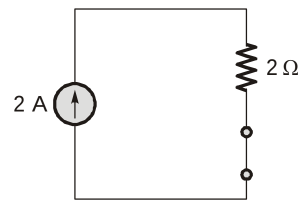
$\therefore$ $Z_s^* = (2 - j4)^* = (2 + j4)\ \Omega$

4. (d)

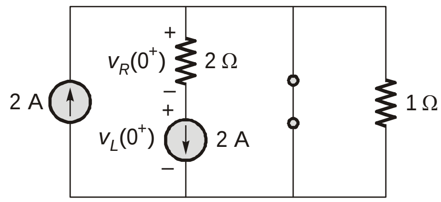
When the switch was open, the current source drives the current through R-L circuit with inductor acting as short-circuit at steady state. Thus,

$$i_L(0^-) = i_L(0^+) = 2 \text{ A}$$

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



After closing the switch, at $t = 0^+$ the capacitor acts as a short circuit.



However, the inductor current remains at 2 A.

$\therefore$ $v_R(0^+) + v_L(0^+) = 0$ V

$$v_L(0^+) = -v_R(0^+) = -i_L(0^+) \times R = -2 \times 2 = -4 \text{ V}$$

5. (c)

From Z-parameter model, we have

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

where, $$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \quad \text{...(i)}$$

Similarly from Y-parameter model, we have

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

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} \quad \text{...(ii)}$$

Considering the above two conditions for transmission parameter model, we get,

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

By keeping $I_2 = 0$, $$A = \frac{V_1}{V_2} \quad \text{and} \quad C = \frac{I_1}{V_2}$$

or, $$\frac{V_1}{I_1} = \frac{A}{C} = Z_{11} \quad \text{...(iii)}$$

and by keeping $V_2 = 0$, $$B = -\frac{V_1}{I_2} \quad \text{and} \quad D = -\frac{I_1}{I_2}$$

or $$\frac{I_1}{V_1} = \frac{D}{B} = Y_{11} \quad \text{...(iv)}$$

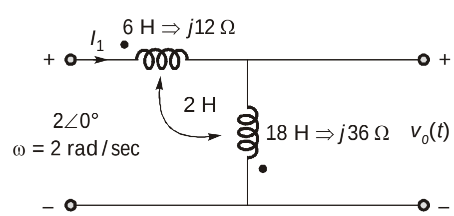
$\because$ $$Z_{11} = \frac{1}{Y_{11}} \quad \text{(Given in the question)}$$

From equations (iii) and (iv), we get,

$$\frac{A}{C} = \frac{B}{D}$$

or $$AD - BC = 0$$

6. (b)



Using KVL in the first loop,

$$2 - j12\, I_1 - j36\, I_1 + 2(j4)I_1 = 0$$

$$j48\, I_1 = 2 + j8\, I_1$$

or $$j40\, I_1 = 2$$

or $$I_1 = \frac{2}{j40} = \frac{1}{20}\angle -90^\circ$$

$\because$ $$v_o = (j36 - j4)I_1 = j32\, I_1 = j32 \times \frac{2}{j40} = \frac{4}{5} \times 2 = \frac{8}{5}\angle 0^\circ$$

$\therefore$ $$v_o(t) = \frac{8}{5}\cos 2t \text{ V}$$

7. (c)

The impedance matrix is given by,

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} j\omega L_1 & -j\omega M \\ -j\omega M & j\omega L_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Here $L_1 = 3$ H, $L_2 = 8$ H, and $M = 2$ H

From figure (B),

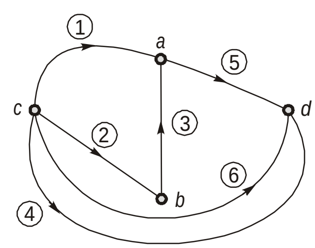
$$L_{eq} = L_1 + L_2 + 2M = 3 + 8 + 4 = 15 \text{ H}$$

8. (c)

Parameters	Condition for symmetrical	Condition for reciprocal
Z-parameter	$Z_{11} = Z_{22}$	$Z_{12} = Z_{21}$
Y-parameter	$Y_{11} = Y_{22}$	$Y_{12} = Y_{21}$
h-parameter	$\Delta h = 1$	$h_{12} = -h_{21}$
$ABCD$ parameter	$A = D$	$\Delta A = 1$

9. (b)

The connected graph is



From the above graph, we can see that Branches 4 and 6 are in parallel.

10. (b)

By writing the given AM signal in standard form, we get,

$$s(t) = 12\left[1+\frac{1}{12}m(t)\right]\cos(2\pi f_c t) \text{ V}$$

The modulation index of the AM signal can be given as,

$$\mu = \frac{1}{12}|m(t)|_{max} = \frac{m_p}{12};$$

m_p = peak value of $m(t)$

Given that, $\mu = 0.75$

So, $\frac{m_p}{12} = 0.75$

$$m_p = 12 \times 0.75 = 9 \text{ V}$$

11. (b)

Maximum frequency deviation, $\Delta f_{max} = k_f A_m = 5 \times 12 = 60 \text{ kHz}$

Modulation index, $\beta = \frac{\Delta f_{max}}{f_{m(max)}} = \frac{60}{2.5} = 24 \quad \because f_{m(max)} = \frac{5000\pi}{2\pi} \text{ Hz} = 2.5 \text{ kHz}$

Bandwidth of FM signal according to Carson's rule is,

$$BW = 2(1+\beta)f_{m(max)}$$
$$= 2(1+24)\,2.5 = 125 \text{ kHz}$$

12. (c)

The phase deviation of the given modulated signal is,

$$\phi(t) = 12\sin(2000\pi t) + 5\cos(2000\pi t) \text{ rad}$$
$$= \sqrt{(12)^2+(5)^2}\left[\cos(2000\pi t-\alpha)\right] \text{rad}$$
$$= 13\cos(2000\pi t - \alpha) \text{ rad}$$

Where, $\alpha = \tan^{-1}\left(\frac{12}{5}\right)$

Maximum phase deviation of the signal $s(t)$ is,

$$\Delta\phi_{max} = |\phi(t)|_{max} = 13 \text{ rad}$$

13. (c)

- Tracking is superior in FM receivers than in AM receivers.
- Double spotting is a major problem in AM receivers than in FM receivers.
- AM can be used for long distance transmission than FM.

Hence, option (c) is correct.

14. (b)

$P(m_1|r_0)$ = Probability of finding the transmitted symbol as m_1 when r_0 is received

$$P(m_1|r_0) = \frac{P(m_1 \cap r_0)}{P(r_0)}$$

$$P(r_0) = P(r_0|m_0)\,P(m_0) + P(r_0|m_1)\,P(m_1)$$
$$= (0.6)(0.4) + (0.4)(0.6) = 0.48$$

$$P(m_1 \cap r_0) = P(r_0 | m_1)\, P(m_1)$$
$$= (0.4)\,(0.6) = 0.24$$

So, $$P(m_1 | r_0) = \frac{0.24}{0.48} = 0.50$$

15. (d)

The variance of a random variable "X" can be given as,

$$\sigma_X^2 = E[X^2] - (E[X])^2$$

$$E[X] = \sum_{i=0}^{1} x_i P(x_i) = 1(p) + 0(q) = p$$

$$E[X^2] = \sum_{i=0}^{1} x_i^2 P(x_i) = (1)^2(p) + (0)^2(q) = p$$

So the variance, $\sigma_X^2 = p - (p)^2 = p(1-p) = pq$ $\quad \because p + q = 1$

Hence, option (d) is correct.

16. (d)

Sampling rate, $f_s = 44.1$ kHz

Bits per sample, $n = 16$

Number of bits for piece of music with a duration of 1 minute is,

$$R = n \times f_s \times (60 \text{ sec})$$

$\because$ 1 minute = 60 seconds

$$= 16 \times 44.1 \times 10^3 \times 60 \text{ bits}$$
$$= 42.336 \times 10^6 \text{ bits}$$

17. (a)

Number of cells per cluster, $N = 4$

Total bandwidth assigned for the cellular system = 33 MHz

Bandwidth occupied by each cell = $\frac{33 \text{ MHz}}{4} = 8.25$ MHz

Bandwidth required by a full duplex channel = 2 × 25 = 50 kHz

Maximum number of full duplex channels/cell = $\frac{8.25 \times 1000}{50} = 165$

19. (b)

$$\hat{a}_E \times \hat{a}_H = \hat{a}_k$$

Given that, $\hat{a}_E = \hat{a}_y$ and $\hat{a}_k = \hat{a}_z$

$\Rightarrow$ $$\hat{a}_y \times \hat{a}_H = \hat{a}_z$$

$\Rightarrow$ $$\hat{a}_H = -\hat{a}_x$$

20. (b)

$$\text{Range, } R \propto (P_{rad})^{1/4}$$

21. (c)

$$\vec{E}_1 = \frac{\rho_{s_1}}{2\varepsilon_0}\hat{a}_n = \frac{20\times 10^{-9}}{2\times\frac{10^{-9}}{36\pi}}\hat{a}_y = 360\pi\,\hat{a}_y$$

$$\vec{E}_2 = \frac{\rho_{s_2}}{2\varepsilon_0}\hat{a}_n = \frac{40\times 10^{-9}}{2\times\frac{10^{-9}}{36\pi}}(-\hat{a}_y) = 720\pi\,(-\hat{a}_y)$$

$$\Rightarrow \quad \vec{E} = \vec{E}_1 + \vec{E}_2 = -360\pi\,\hat{a}_y \text{ V/m}$$

22. (a)

- $$P_{avg} = \frac{1}{2}\frac{|E|^2}{\eta} = \frac{1}{2}\frac{(10^2+20^2)}{120\pi} = 0.663 \text{ W/m}^2$$
- $$\begin{aligned}\text{Power} &= P_{avg} \times \text{area}\\ &= 0.663 \times \pi \times (10^{-2})^2 \text{ W}\\ &= 2.083 \times 10^{-4} \text{ W}\\ &= 208.30\ \mu\text{W}\end{aligned}$$

24. (b)

- $$Z_{in_3} = \frac{Z_{03}^2}{Z_{L3}} = \frac{300^2}{200} = 450\ \Omega$$
- $$Z_{in_2} = \frac{Z_{02}^2}{Z_{L2}} = \frac{100^2}{0} = \infty \text{ (open)}$$
- $$Z_{L(eff)} = Z_{in_3} || Z_{in_2} = 450\ \Omega$$
- $$Z_{in} = Z_{in_1} = \frac{100^2}{450} = 22.22\ \Omega$$

25. (b)

$$D = \frac{4\pi U_{max}}{\iint U(\theta,\phi)\,d\Omega} = \frac{4\pi}{\int_{\phi=0}^{2\pi}\int_{\theta=0}^{60^\circ}\sin\theta\, d\theta\, d\phi} \qquad \{\because U_{max} = 1\}$$

$$= \frac{4\pi}{\left[2\pi\times(\cos\theta)\right]_{60^\circ}^{0^\circ}} = \frac{2}{1-\frac{1}{2}} = 4$$

$$D \text{ (dB)} = 10\log 4 = 6 \text{ dB}$$

26. (b)

$$\text{Duty cycle} = \frac{\text{Pulse width}}{\text{Pulse repetition time}} = \frac{1.5 \times 10^{-6}}{1/8000} = 0.012$$

$$\text{Average power} = \text{Peak power} \times \text{Duty cycle}$$
$$= 500 \times 0.012 \text{ kW} = 6 \text{ kW}$$

27. (b)

$$\vec{k} \cdot \vec{E} = 0$$
$$\vec{k} = 2\hat{a}_x - 4\hat{a}_y$$
$$\vec{k} \cdot \vec{E} = 2E_0 - 4 = 0$$

$\Rightarrow$ $$E_0 = \frac{4}{2} = 2$$

28. (b)

Spectrum $F(j\omega)$ is imaginary and odd.

$\Rightarrow f(t)$ is real and odd.

29. (d)

Pole is at $r = 2 \Rightarrow h(n)$ should be a left sided signal to include unit circle in the ROC of $H(z)$.

$\Rightarrow$ $$h(n) = -(2)\,(-2)^n\, u[-n-1]$$
$$= (-2)^{n+1}\, u[-n-1]$$

30. (b)

Linearity :

$$x_1(t) \to 3x_1(\sin t) = y_1(t)$$
$$x_2(t) \to 3x_2(\sin t) = y_2(t)$$
$$x_1(t) + x_2(t) \to 3[x_1(\sin t) + x_2(\sin t)] = y_1(t) + y_2(t)$$ $\Rightarrow$ System is linear.

Causality :

At $t = -\pi$, $y(-\pi) = 3x(0)$ $\Rightarrow$ Non-causal i.e. output depends on the future values of the input.

31. (b)

$$X(s) - \frac{3H(s)}{s^2} = H(s)$$

$\Rightarrow$ $$X(s) = \left(1 + \frac{3}{s^2}\right) H(s)$$

$$2H(s) + \frac{H(s)}{s} = Y(s)$$

$\Rightarrow$ $$\left(2 + \frac{1}{s}\right) H(s) = Y(s)$$

$\Rightarrow$ $$\left(2 + \frac{1}{s}\right) \frac{X(s)}{\left(1 + \frac{3}{s^2}\right)} = Y(s)$$

$$\Rightarrow \quad \frac{Y(s)}{X(s)} = \frac{2+\frac{1}{s}}{\frac{3}{s^2}+1} = \frac{s+2s^2}{3+s^2}$$

$$\Rightarrow \quad \frac{d^2y(t)}{dt^2} + 3y(t) = \frac{dx(t)}{dt} + 2\frac{d^2x(t)}{dt^2}$$

32. (c)

$$e^{-5t}\,u(t) \longleftrightarrow \frac{1}{s+5}$$

$$e^{-5(t+3)}\,u(t+3) \longleftrightarrow \frac{e^{3s}}{s+5}$$

$$e^{-5(-t+3)}\,u(-t+3) \longleftrightarrow \frac{e^{-3s}}{5-s}$$

$$e^{5t}\,u(-t+3) \longleftrightarrow \frac{e^{15}\,e^{-3s}}{5-s}, \text{Re}[s] < 5 = -\frac{e^{-3(s-5)}}{s-5}, \text{Re}[s] < 5$$

33. (c)

$u[n] = 0$ for $n < 0 \Rightarrow$ causal.

$\sum_{n=-\infty}^{\infty} u[n]$ is unbounded $\Rightarrow$ unstable.

35. (a)

DFT of $x[n]$,
$$X[k] = \sum_{n=0}^{N-1} x[n]\, e^{-j\frac{2\pi}{N}kn}$$

For 4-point DFT,
$$X[k] = \sum_{n=0}^{3} x[n]\, e^{-j\frac{\pi}{2}kn}$$

$$X[0] = \sum_{n=0}^{3} x[n] = 1+2+2+1 = 6$$

$$X[1] = \sum_{n=0}^{3} x[n]\, e^{-j\frac{\pi}{2}n} = 1-j2-2+j = -1-j$$

$$X[2] = \sum_{n=0}^{3} x[n]\, e^{-j\pi n} = 1-2+2-1 = 0$$

$$X[3] = X^*(1) = -1+j$$

$$X[k] = \{6, -1-j, 0, -1+j\}$$

36. (c)

$$Y(s) = X(s)H(s) = \frac{1}{s}\cdot\frac{s+1}{s^2+2s+3}$$

$$y(\infty) = \underset{s\to 0}{\text{Lt}}\ s\left[\frac{s+1}{s(s^2+2s+3)}\right]$$

Steady state value of $y(t)$, $$y(\infty) = \frac{1}{3}$$

37. (d)

(a) Forward current is mainly diffusion current.

(b) Law of junction,

$$p_n(0) = p_{n0}e^{V/V_T}$$

$p_n(0) \rightarrow$ total hole concentration at the edge of depletion region on N-side.
and $V \rightarrow$ forward bias voltage.

(c) $$I_s = Aen_i^2\left[\frac{D_P}{L_P}\times\frac{1}{N_D}+\frac{D_n}{L_n}\times\frac{1}{N_A}\right]$$

Since, $D_p \propto \sqrt{\mu_p}$ and $N_A >> N_D$ for P^+N Diode

$\therefore$ $$I_s \propto \sqrt{\mu_p}$$

(d) Reverse saturation current is directly proportional to the area perpendicular to the direction of current flow.

38. (b)

The thermal equilibrium concentration of holes,

$$p_0 = \frac{n_i^2}{N_D} = \frac{(1.5\times10^{10})^2}{10^{16}} = 2.25\times10^4\,\text{cm}^{-3}$$

The generation rate of EHPs or we can say, excess minority carriers,

$$G_L = \frac{(p-p_0)}{\tau_p} = \frac{4\times10^4-2.25\times10^4}{10^{-6}}$$

$$G_L = 1.75\times10^{10}\ \text{cm}^{-3}/\text{sec}$$

$$\text{Excess hole concentration} = 1.75\times10^{10}\ \text{cm}^{-3}$$

This method is called as photo excitation.

40. (c)

$$FF = \frac{P_{L\max}}{V_{oc}I_{sc}}$$

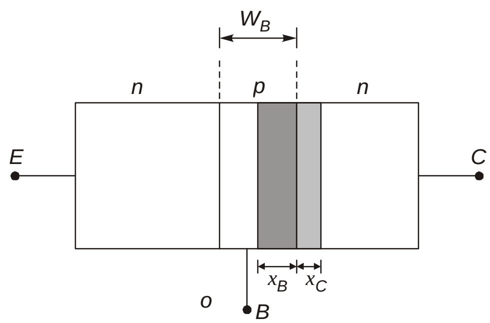
$$P_{L\max} = (\text{FF})(V_{oc}I_{sc}) = (0.71)(0.82)(100)\ \text{mW} = 58.22\ \text{mW}$$

41. (c)

Depletion width in base region,

$$x_B \simeq \sqrt{\frac{2\,\varepsilon_{si}}{qN_A}V_{CB}} \qquad (\because N_D >> N_A)$$

Punch through will occur when x_B equals to W_B.



So,
$$\frac{2\,\varepsilon_{si}}{qN_A}V_{PT} = (W_B)^2$$

$$V_{PT} = \frac{W_B^2 qN_A}{2\varepsilon_{si}} = \frac{(5\times10^{-4})^2\,(1.6\times10^{-19})\,(10^{15})}{2\times1\times10^{-12}} = 20\text{ V}$$

42. (b)

Given,

Conductivity of sample, $\sigma = 0.0125\,\mho/\text{cm}$

Intrinsic carrier concentration, $n_i = 2.5 \times 10^{13}\text{ cm}^{-3}$

But conductivity, $\sigma = n_i(\mu_n + \mu_p)q$

Given that, $\mu_p = 0.5\mu_n \quad \Rightarrow \mu_n = 2\,\mu_p$

$\therefore \quad \sigma = n_i(3\,\mu_p)q$

$$0.0125 = 2.5 \times 10^{13}[3\mu_p] \times 1.6 \times 10^{-19}$$

$\therefore$
$$\mu_p = \frac{0.0125}{2.5\times10^{13}\times3\times1.6\times10^{-19}} = 1041\text{ cm}^2/\text{V-sec}$$

43. (a)

Saturation drain current, $I_D = 2\text{ mA}$

Gate to source saturation voltage, $V_{GS} = 4.8\text{ V}$

Threshold voltage, $V_T = 0.8\text{ V}$

Drain to source saturation current,

$$I_D = k_n(4.8 - 0.8)^2 = 16k_n$$

$$k_n = \frac{2\times10^{-3}}{16} = 0.125\text{ mA/V}^2$$

44. (b)

Given,

Intrinsic carrier concentration,

$$n_i = 2.5 \times 10^{13}\ \text{cm}^{-3}$$

Mobility of electron, $\mu_n = 3800\ \text{cm}^2/\text{V-sec}$

Mobility of hole, $\mu_p = 1800\ \text{cm}^2/\text{V-sec}$

Resistivity of intrinsic Germanium sample is

$$\rho_i = \frac{1}{n_i[\mu_n + \mu_p]q}$$

After adding donor impurity to pure Ge sample, the resistivity drops to 15%.

i.e., $\rho_{new} = 15\%\ (\rho_i)$

$$\rho_{new} = 0.15\ \rho_i$$

$$\frac{1}{N_D q \mu_n} = 0.15\left(\frac{1}{n_i[\mu_n + \mu_p]q}\right)$$

$$N_D = \frac{100}{15} \times n_i \times \left(\frac{\mu_n + \mu_p}{\mu_n}\right) = \frac{100}{15} \times \frac{56}{38} \times 2.5 \times 10^{13}\ \text{cm}^{-3}$$

$$= 2.46 \times 10^{14}\ \text{cm}^{-3}$$

45. (d)

Given,

Cross sectional area of conductor, $A = 1\ \text{cm}^2$

Free electron density, $n = 10^{19}$ electrons/cm^3

The current through conductor, $I = 0.24$ A

We know that current density, $J = nev_d$

But, $$J = \frac{I}{A} = nev_d$$

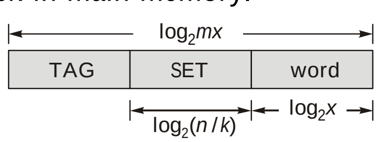
$\therefore$ $$v_d = \frac{I}{Ane}$$

$$v_d = \frac{0.24}{1 \times 10^{19} \times 1.6 \times 10^{-19}} = 0.15\ \text{cm/sec}$$

46. (a)

Number of sets $= n/k$

Let there are x words per block in main memory.



$$\text{No. of TAG bits} = \log_2(mx) - \left(\log_2 \frac{n}{k} + \log_2 x\right)$$

$$= \log_2(mx) - \log \frac{nx}{k} = \log_2 \frac{mk}{n}$$

47. (d)

In a Vertical micro-programmed control unit, the control signals are represented in the encoded binary format. Here, 'n' control signals require $\log_2 n$ bit encoding. Hence, signal decoders are required.

48. (b)

Time required for non-pipelined processor,

$$T_{\text{non-pipeline}} = 5 \text{ nsec} + 5 \text{ nsec} + 4 \text{ nsec} + 3 \text{ nsec} + 4 \text{ nsec}$$
$$= 21 \text{ nsec}$$

Time required for pipelined processor,

$$T_{\text{pipeline}} = (t_p + \text{Register})$$
$$= (5 \text{ nsec} + 1 \text{ nsec}) = 6 \text{ nsec}$$

$$\text{Speed-up} = \frac{T_{\text{Non-pipeline}}}{T_{\text{Pipeline}}} = \frac{21 \text{ nsec}}{6 \text{ nsec}} = 3.5$$

49. (c)

In block transfer, the entire block of data is transferred then only CPU again becomes bus master.
In vectored interrupt, I/O device along with interrupts send vector address of interrupt service routine which guide CPU to execute for a specific I/O device.

50. (b)

- More than one word are put in one cache block to exploit the spatial locality of reference in a program.
- By the help of virtual memory, programs can exceed from the size of primary memory, hence increases the degree of multi programming.
- Increasing RAM will result in fewer page faults.

Hence S_1 and S_2 are the correct statement.

51. (a)

$$\text{Number of lines} = \frac{64K}{32} = 2^{11}$$

$$\text{Number of sets} = \frac{2^{11}}{4} = \frac{2^{11}}{2^2} = 2^9$$

32 bits

Tag	SO	WO
18 bits	$\log_2 2^9 = 9$	$\log_2 32 = 5$ bit

$$\text{Tag memory size} = S \times P \times \# \text{ tag bits} = 2^9 \times 4 \times (18 + 1 + 1 + 2)$$
$$= 2^9 \times 2^2 \times 22 \text{ bits} = 2^{10} \times 2 \times 22 \text{ bits}$$
$$= 44 \text{ K bits}$$

52. (b)

$$T_{avg} = h_1 t_1 + (1 - h_1)h_2 (t_2 + t_1) + (1 - h_1)(1 - h_2)(t_3 + t_2 + t_1)$$
$$= 0.65 \times 0.02 + 0.35 \times 0.45 \times 0.22 + 0.35 \times 0.55 \times 2.22$$
$$= 0.013 + 0.03465 + 0.42735$$
$$= 0.475 = 475 \ \mu\text{sec}$$

53. (b)

$$\log \log n < \sqrt{n} < n^2 < 2^n$$

So, A_2 algorithm is best (algorithm is best if it take less time).

54. (a)

Binary search on array has time complexity $O(\log n)$ while for linked list $O(n)$.

55. (a)

Stored energy, $$W = \frac{1}{2}\vec{P}\cdot\vec{E}$$

$\vec{P} \rightarrow$ Polarization

$\vec{E} \rightarrow$ Electric field

56. (a)

$$\text{Loss tangent, } \tan\delta = \frac{\text{Imaginary part of relative permittivity}}{\text{Real part of relative permittivity}} = \frac{\varepsilon_r''}{\varepsilon_r'}$$

$$\Rightarrow \quad 0.004 = \frac{\varepsilon_r''}{2.5}$$

$$\Rightarrow \quad \varepsilon_r'' = 0.01$$

57. (c)

Quartz crystal is piezoelectric but not ferroelectric.

58. (b)

The volume of the bar magnet is:

$$V = \frac{6.6 \times 10^{-3}\,\text{kg}}{7.9 \times 10^3\,\text{kg/m}^3} = 8.3 \times 10^{-7}\ \text{m}^3$$

$$\therefore \quad \text{Intensity of Magnetization, } I = \frac{M}{V} = \frac{2.5\,\text{A-m}^2}{8.3 \times 10^{-7}\,\text{m}^3} = 3 \times 10^6\ \text{A/m}$$

59. (c)

By losing or gaining electrons $\rightarrow$ Ionic bond.

By sharing of electrons $\rightarrow$ Covalent bond.

61. (c)

Total polarizability

$$\alpha = \alpha_e + \alpha_i + \alpha_0$$

where $\alpha_e = 4\pi\varepsilon_0 R^3$ = electronic polarizability

α_i = ionic polarizability

$$\alpha_0 = \frac{p_p^2}{3KT} = \text{orientational polarizability}$$

We see that orientational polarizability depends on the temperature.

Polarization $P = \alpha E$. Hence, the polarization increases with applied field at a constant temperature.

62. (d)

Primary bonds are interatomic whereas secondary bonds are inter-molecular bonds.

63. (d)

MVI A, 7F H → A = 7F H

ORA A → A (OR) A = $\frac{A}{\boxed{7F\ H}}$

CPI A2 H → 7F H – A2 H = DD H and CY = 1

After compare instruction, A = 7F H, Carry flag = 1

64. (c)

To enable the 2 to 4 decoder $\bar{E} = 0$. i.e., $\bar{M}$ is activated.

O_2 will be active, when A_1 get active input (logic - 0) and A_0 get inactive input (logic - 1).

$A_1 = 0$ i.e., $\overline{RD}$ signal is active.

So, the output control signal generated is $\overline{MEMR}$.

65. (a)

DI disable all interrupts except TRAP.

66. (b)

Given, Clock period = 0.5 μsec

For execution of main program to provide delay, it take 2 msec.

$$\therefore \text{ The number of T-states} = \frac{\text{Total time}}{\text{Clock period}} = \frac{2 \times 10^{-3}}{0.5 \times 10^{-6}} = 4000$$

Given that loop requires 2400 T-states to execute it.

∴ The number of T-states required to execute instructions outside the loop is 4000 – 2400 = 1600 T-states.

∴ The time required to execute 1600 T-states is 1600 × 0.5 μsec = 800 μsec.

67. (b)

LXI SP, 209F H ; SP = 209F H
MVI C, 00 H ; C = 00 H
PUSH B ; [B] → [209E H], [C] = 00 H → [209D H]
POP PSW ; [209E H] → [A] and [209D H] = 00 H → Flag register
RET

∴ Accumulator contains the contents of (209E H) and flag register contains the contents of (209D H) which is 00 H.

68. (d)

All the given features are related with Mode-0 of 8255.

69. (c)

Physical address = 23450H + 1000H = 24450H

70. (b)

8051 microcontroller have a 16-bit addressing bus and are capable of addressing 64 KB memory.

71. (b)

The resolution is equal to the value of the output corresponding to the LSB input of logic '1':

∴

$$V_{out} = -\frac{R_F}{R} \times b_0$$

$$-0.1 = -\frac{R_F}{8 \times 10^3} \times 5$$

$$R_F = \frac{0.1 \times 8 \times 10^3}{5} \Omega = 160\ \Omega$$

72. (a)

The flash-type ADC is the fastest ADC.

73. (b)

N-MOS can be fabricated with the required area less then that of P-MOS and RTL logic family. Thus an N-MOS logic family has the highest packing density.

74. (a)

In a programmable ROM, a decoder circuit is used to create all the possible minterms possible at the output and these minterms are then used to implement the required logic operation. Thus, to create 32 minterms we require a 5 × 32 decoder circuit.

75. (b)

(a) A MUX is a combinational circuit since it has no feedback element present.
(b) A MUX has only 1 output line.
(c) An AND and a NOT gate can form a complete set and can be used as a NAND universal gate.
(d) A MUX can be used to construct any logic gate.

76. (d)

In a Moore circuit, the output depends only on the present state of flip-flops and in a Mealy circuit, the output depends on both present state of flip-flops and present input.

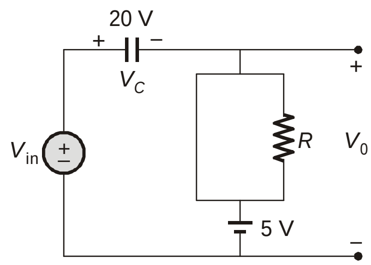
77. (a)

The output logic function of the given circuit can be expressed as,

$$f = \overline{\left(\overline{(\overline{AB})C}\right)\left(\overline{\bar{C}D}\right)} = (\overline{AB})C + \bar{C}D = (\bar{A}+\bar{B})C + \bar{C}D$$

78. (b)

The given circuit is a negative clamper,

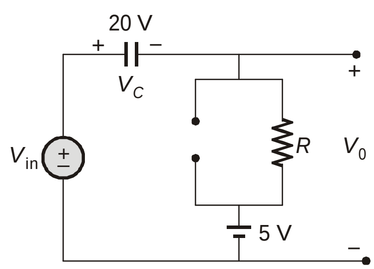


For positive half cycle, diode is ON.

Capacitor charges to voltage, $V_C = V_{in} - 5 = 20$ V

$V_0 = 5$ V

For negative half cycle, diode is open circuited and the diode, thereafter remains reverse-biased.



$V_0 = V_{in} - 20$

Hence, $V_0 = -25 - 20 = -45$ V for $V_{in} < 0$

$V_0 = 25 - 20 = 5$ V for $V_{in} > 0$

79. (a)

V_1	V_2	Y	M_1	M_2	M_3	M_4
0	0	V_{DD}	OFF	OFF	ON	ON
0	V_{DD}	0	OFF	ON	OFF	ON
V_{DD}	0	0	ON	OFF	ON	OFF
V_{DD}	V_{DD}	0	ON	ON	OFF	OFF

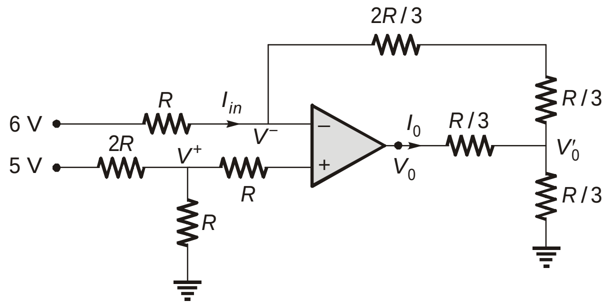
Thus, the circuit represents a positive NOR gate.

80. (c)

1st and 2nd are not necessary conditions to realize a logic function, they are only sufficient.

81. (c)

Using delta to star conversion, the circuit can be drawn as below:



As the op-amp is ideal, therefore input current is zero.

$$\therefore \quad V^+ = V^-$$

$$V^+ = 5 \times \frac{R}{3R}$$

$$V^+ = \frac{5}{3}\text{Volt} = V^-$$

$$I_{\text{in}} = \frac{6 - V^-}{R} = \frac{6 - \frac{5}{3}}{R}$$

$$I_{\text{in}} = \frac{13}{3R}$$

$$V_0' = \frac{-13}{3R} \times \left(\frac{2R}{3} + \frac{R}{3}\right) + V^-$$

$$V_0' = \frac{-13}{3R} \times R + \frac{5}{3}$$

$$V_0' = -\frac{8}{3}\text{ volt}$$

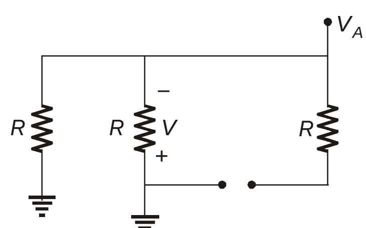
$$V_0 = I_0\frac{R}{3} + V_0'$$

$$V_0 = \left(\frac{I_0 R}{3} - \frac{8}{3}\right)\text{V}$$

82. (c)

For $0 < t < T$, Diode D_1 ON

and Diode D_2 OFF

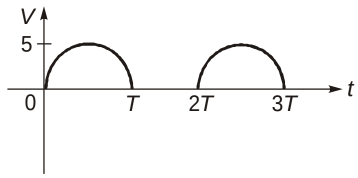


$$V_A = -V$$

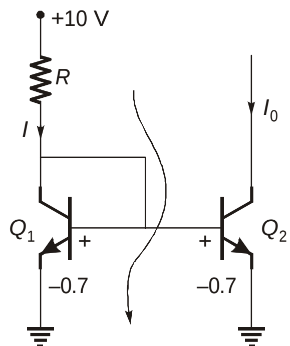
for $0 < t < 2T$, $\quad V_A = 0$

∴ No independent source in the circuit.

$$V = 0$$



83. (c)



I_0 is given as,

$$I_0 = \frac{I}{1+\frac{2}{\beta}}$$

given, $\quad I_0 = 50 \times 10^{-6}$ A

$$50 \times 10^{-6} = \frac{I}{1+\frac{2}{50}}$$

$$I = 50 \times \frac{52}{50} \times 10^{-6}$$

$$I = 52\ \mu A$$

Using KVL, $\quad 10 = IR + 0.7$

$$IR = 9.3$$

$$R = \frac{9.3}{52} \times 10^6 = \frac{9300}{52} \simeq 179\ k\Omega$$

84. (d)

$$f_L = 64\text{ kHz},\ f_H = 200\text{ kHz}$$

For multistage amplifier lower cutoff frequency is given as,

$$f_L^* = \frac{f_L}{\sqrt{2^{1/n}-1}}$$

Higher cut-off frequency, $f_H^* = f_H\sqrt{2^{1/n}-1}$

For $n = 2$,

$$\sqrt{2^{1/2}-1} = 0.64$$

$$f_L^* = \frac{f_L}{0.64} = \frac{64}{0.64} \simeq 100\text{ kHz}$$

$$f_H^* = f_H\sqrt{2^{1/n}-1}$$

$$= 200 \times 0.64$$

$$= 128\text{ kHz}$$

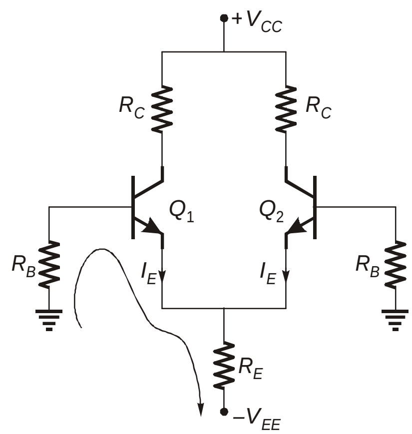
Bandwidth $= f_H^* - f_L^*$

$$= 128 - 100$$

$$= 28\text{ kHz}$$

85. (a)

Using dc analysis to find the operating point,



Using KVL, $I_B R_B + 0.7 + 2I_E R_E = 10$

$$\frac{I_{CQ}}{\beta}R_B + 2(I_{CQ} + I_B)R_E = 9.3$$

$$\frac{I_{CQ}R_B}{\beta} + 2I_{CQ}R_E + \frac{2R_E I_{CQ}}{\beta} = 9.3$$

$$I_{CQ}\left(\frac{R_B}{\beta}+2R_E+\frac{2R_E}{\beta}\right) = 9.3$$

$$I_{CQ} = \frac{9.3\beta}{2R_E(1+\beta)+R_B}$$

$$I_{CQ} = \frac{9.3}{2\frac{R_E(1+\beta)}{\beta}+\frac{R_B}{\beta}}$$

$$1+\beta \simeq \beta$$

$$I_{CQ} = \frac{9.3}{2R_E+\frac{R_B}{\beta}}$$

$\because$ $$2R_E >> \frac{R_B}{\beta}$$

$$I_{CQ} = \frac{9.3}{2R_E} = \frac{9.3}{2(1\text{ k}\Omega)}$$

$$I_{CQ} = 4.65\text{ mA}$$

86. (d)

Double-tuned amplifier is a tuned amplifier with transformer coupling between the amplifier stages.

87. (b)

$$V_{DS} = V_D$$

$\therefore$ $$V_{DS} > V_{GS} - V_{th}$$

when $V_D > V_{th}$; Current I_D flows

88. (b)

When a zero is added to the system in LHS of s-plane,

- Root locus shifts away from $j\omega$-axis.
- Damping improves, hence less oscillatory.
- Relative stability increases.
- Operating range of K for stable operation increases.

90. (a)

From figure (B), the closed loop transfer function,

$$\frac{C(s)}{R(s)} = \left[\frac{G}{(s+3)}\right]+1 = \frac{G}{s+3}+1 \quad ...(i)$$

From figure (A), $$\frac{C(s)}{R(s)} = \frac{(s+4)}{(s+3)} \quad ...(ii)$$

On equating both the equations, we get,

$$\frac{s+4}{s+3} = \frac{G}{s+3}+1$$

$$\Rightarrow \quad \frac{s+4}{s+3} - 1 = \frac{G}{(s+3)}$$

$$\Rightarrow \quad \frac{1}{s+3} = \frac{G}{s+3}$$

or, $\quad G = 1$

91. (b)

$$e^{-s} \approx (1-s)$$

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

Characteristic equation,

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

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

$$s^3 + 2s^2 + s + K - Ks = 0$$

$$s^3 + 2s^2 + s(1-K) + K = 0$$

Routh's Array,

s^3	1	$1-K$
s^2	2	K
s^1	$\frac{2(1-K)-K}{2}$	0
s^0	K	

For stability,
1st column of routh array must be positive.

$$K > 0 \quad \text{and}$$

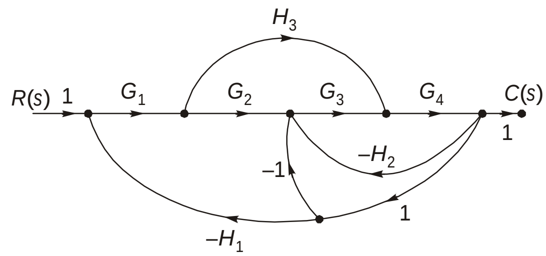
$$2(1-K) - K > 0$$

$$2 - 3K > 0$$

$$K < \frac{2}{3}$$

Range of K : $0 < K < \frac{2}{3}$.

92. (d)



Forward paths:

$P_1 = G_1G_2G_3G_4,\quad P_2 = G_1G_4H_3$

Loops:

$L_1 = -G_3G_4H_2 \qquad L_2 = -G_1G_2G_3G_4H_1$

$L_3 = -G_3G_4 \qquad L_4 = -G_1H_3G_4H_1$

93. (c)

Given;

$$A = \begin{bmatrix} 0 & 1 \\ -2 & 3 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$[sI - A] = \begin{bmatrix} s & -1 \\ 2 & s-3 \end{bmatrix}$$

$$[sI - A]^{-1} = \frac{1}{(s^2 - 3s + 2)}\begin{bmatrix} s-3 & 1 \\ -2 & s \end{bmatrix}$$

$$= \begin{bmatrix} \dfrac{s-3}{(s-1)(s-2)} & \dfrac{1}{(s-1)(s-2)} \\ \dfrac{-2}{(s-1)(s-2)} & \dfrac{s}{(s-1)(s-2)} \end{bmatrix}$$

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

$$\phi(t) = L^{-1}(sI - A)^{-1} = \begin{bmatrix} 2e^t - e^{2t} & -e^t + e^{2t} \\ 2e^t - 2e^{2t} & -e^t + 2e^{2t} \end{bmatrix}$$

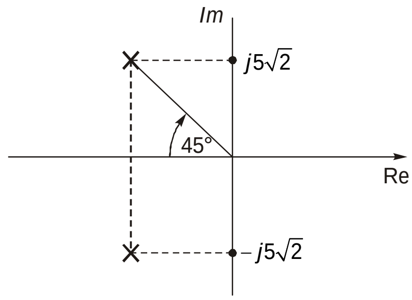
$$\text{ZIR} = \phi(t) \cdot x(0)$$

$$= \begin{bmatrix} 2e^t - e^{2t} & -e^t + e^{2t} \\ 2e^t - 2e^{2t} & -e^t + 2e^{2t} \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$\text{ZIR} = \begin{bmatrix} 2e^t - e^{2t} \\ 2e^t - 2e^{2t} \end{bmatrix}$$

94. (d)

From pole diagram



$$\xi = \cos(45°) = \frac{1}{\sqrt{2}}$$

$$\omega_d = 5\sqrt{2}$$

$$\omega_d = \omega_n\sqrt{1-\xi^2}$$

$$5\sqrt{2} = \omega_n\sqrt{1-\left(\frac{1}{\sqrt{2}}\right)^2}$$

$$\omega_n = 10 \text{ rad/sec}$$

Settling time, for 5% tolerance band is

$$t_s = \frac{3}{\xi\omega_n} = \frac{3}{\frac{1}{\sqrt{2}}\times 10} = 0.3\times\sqrt{2}$$

$$= 0.424s$$

$$t_s = 0.424s$$

95. (c)

The open loop transfer function,

$$G(s)H(s) = \frac{K}{\left(\frac{s}{1/3}+1\right)\left(\frac{s}{1/2}+1\right)\left(\frac{s}{1}+1\right)}$$

$$= \frac{K}{(3s+1)(2s+1)(s+1)}$$

$$20 \log K = 0$$

$$K = 1$$

$$G(s)H(s) = \frac{1}{(3s+1)(2s+1)(s+1)}$$

Closed loop transfer function,

$$T(s) = \frac{G(s)}{1+G(s)H(s)}$$

For unity feedback, $H(s) = 1$. Hence,

$$T(s) = \frac{1}{6s^3+11s^2+6s+2}$$

100. (c)

During in-situ cleaning, the dry hydrogen @ 1200°C is passed through the chamber and samples are flushed, to reduce any oxide that are present on the sample.

103. (c)

TDMA utilizes power efficiently.

104. (a)

Given, Radius of earth, $R = 6400$ km

height of satellite above the surface of earth,

$$h = 1000 \text{ km}$$

radius of orbit of satellite, $r = R + h$

$$r = 6.4 \times 10^6 + 1.0 \times 10^6 \text{ m} = 7.4 \times 10^6 \text{ m}$$

Critical velocity, $V_c = 7364$ m/s

We know that, $$V_c = \frac{2\pi r}{T}$$

$$\therefore \quad T = \frac{2\pi r}{V_c} = \frac{2 \times 3.14 \times 7.4 \times 10^6}{7364}$$

$$T = 6.31 \times 10^3 \text{ sec}$$

$$\therefore \quad T = \frac{6.31 \times 10^3}{60 \times 60} = 1.75 \text{ hrs}$$

105. (c)

Given, velocity of satellite, $V_c = 6.8$ km/s

radius of earth, $R = 6400$ km

$$g = 9.8 \text{ m/s}^2$$

Let 'h' be the height of the satellite above the surface of planet,

we know that, critical velocity, $$V_c = \sqrt{\frac{GM}{r}} = \sqrt{\frac{R^2 g}{r}} \qquad (r = R + h)$$

$$\therefore \quad r = \frac{R^2 g}{V_c^2}$$

$$r = \frac{(6.4 \times 10^6)^2 \times 9.8}{(6.8 \times 10^3)^2} = 8.681 \times 10^6 \text{ m}$$

$$\therefore \quad r = 8681 \text{ km}$$

$$h = r - R = 8681 - 6400 = 2281 \text{ km}$$

106. (a)

By using narrow beam or spot beam antennas, the area on the earth covered by the satellite can be divided into segments. Earth stations in each segment may actually use the same frequency, but because of the very narrow beam widths of the antennas, there is not interference between adjacent segments.

108. (d)

We know, Power, $P = \sqrt{3} VI \cos\phi$

Since power and voltage are same.

So, $I\cos\phi = \text{Constant}$

$$I_2\cos\phi_2 = I_1\cos\phi_1$$

$$I_2 = \left(\frac{\cos\phi_1}{\cos\phi_2}\right)I_1 = \frac{0.5}{0.8} \times 100 = 62.5 \text{ A}$$

109. (b)

Given : $\frac{V}{f} = \text{Constant}$

Core loss, $P_c = Af + Bf^2$ ...(i)

A = Hysteresis loss constant

B = Eddy current loss constant

$$\frac{P_c}{f} = A + Bf$$

The equation of line from graph,

$$\frac{P_c}{f} = 20 + \frac{25-20}{50} f$$

$$\frac{P_c}{f} = 20 + 0.1f$$

$$P_c = 20f + 0.1f^2 \quad \text{...(ii)}$$

On comparing equation (i) and (ii),

$$A = 20 \quad ; \quad B = 0.1$$

So, at f = 25 Hz

$$P_h = Af = 20 \times 25 = 500 \text{ W}$$

$$P_e = Af^2 = 0.1 \times (25)^2 = 62.5 \text{ W}$$

110. (b)

The maximum torque will occur at slip $S_{T_{max}}$,

$$S_{T_{max}} = \frac{R_2}{X_2} = \frac{0.1}{0.5} = 0.2$$

$$\frac{T_{max}}{T_{FL}} = 2.125$$

We know,

$$\frac{T_{FL}}{T_{max}} = \frac{2S_{T_{max}}S_{FL}}{S_{T_{max}}^2 + S_{FL}^2}$$

$$\frac{1}{2.125} = \frac{2\times 0.2\times S_{FL}}{(0.2)^2 + S_{FL}^2}$$

$$S_{FL}^2 + 0.04 = 2 \times 0.2 \times 2.125\ S_{FL}$$

$$S_{FL}^2 + 0.04 - 0.85S_{FL} = 0$$

$$S_{FL}^2 - 0.8S_{FL} - 0.05S_{FL} + 0.04 = 0$$

$$(S_{FL} - 0.8)\ (S_{FL} - 0.05) = 0$$

$$S_{FL} = 0.8, \quad 0.05$$

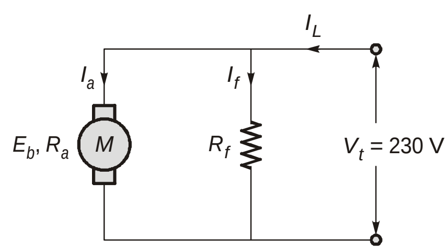
Since, S_{FL} can't be greater than $S_{T_{max}}$.

∴ $$S_{FL} = 0.05$$

$$S_{FL} = 5\%$$

111. (b)

Given : 10 kW, 230 V DC shunt motor ; $R_a = 0.4\ \Omega$; $R_f = 230\ \Omega$; $N_{NL} = 2000$ rpm
$(I_L)_{NL} = 6$A ; $(I_L)_{FL} = 41$ A



At no load, $$(I_L)_{NL} = 6 \text{ A}$$

$$I_f = \frac{230}{230} = 1 \text{ A}$$

$$(I_a)_{NL} = 6 - 1 = 5 \text{ A}$$

$$(E_b)_{NL} = V_t - (I_a)_{NL} \cdot R_a = 230 - 5 \times 0.4 = 228 \text{ V}$$

At full load, $$(I_L)_{FL} = 41 \text{ A}$$

$$(I_a)_{FL} = 41 - 1 = 40 \text{ A}$$

$$(E_b)_{FL} = V_t - (I_a)_{FL} \cdot R_a = 230 - 40 \times 0.4 = 214 \text{ V}$$

For shunt motor, $$E_b \propto N$$

$$\frac{(E_b)_{FL}}{(E_b)_{NL}} = \frac{N_{FL}}{N_{NL}}$$

$$N_{FL} = \frac{214}{228} \times 2000 = 1877.193 \text{ rpm}$$

$$N_{FL} = 1877 \text{ rpm}$$

112. (d)

In the pumped storage plant, the turbine will act as a synchronous motor during pumping operation and a synchronous condenser during off peak load for power factor correction.

113. (b)

Reactance voltage is self induced emf in the coil undergoing commutation. The voltage rise in the short circuit coil due to inductive property of the coil, which opposes the current reversal in it during the commutation period, is called the reactance voltage.

114. (d)

All given statements are correct.

115. (c)

Copper loss are not included in no-load losses of dc machine.

116. (a)

The supply frequency, $f = \frac{PN}{120} = \frac{4 \times 1200}{120} = 40 \text{ Hz}$

Total number of stator conductors = 8 × 60 = 480

Stator conductors per phase, $Z_p = \frac{480}{3} = 160$

Let the winding factor be k_w,

Generated voltage, $E_g = 2.22 \times f \times \phi \times Z_p \times k_w$

$$= 2.22 \times 40 \times 0.04 \times 160 \times k_w$$

$$E_g = 2.22 \times (16)^2 k_w$$

117. (c)

Voltage across the meter for current of 1 mA is

$$V_m = 10^{-3} \times 100 = 0.1 \text{ V}$$

Full range of voltage required, $V = 15$ V

∴ Series multiplying factor,

$$m = \frac{V}{V_m} = \frac{15}{0.1} = 150$$

∴ Required multiplier resistance,

$$R_s = (m - 1)R_m$$

$$= (150 - 1)100$$

$$R_s = 14900\ \Omega$$

118. (c)

Given : $P = (200 \pm 2\%)\text{W}$; $I = (4 \pm 1.5\%)\text{A}$

Resistance, $$R = \frac{P}{I^2}$$

$$R = \frac{200}{(4)^2} = 12.5\,\Omega$$

Limiting error, $$\frac{\delta R}{R} = \pm\left(\frac{\delta P}{P} + 2\frac{\delta I}{I}\right) = \pm(2 + 2 \times 1.5) = \pm 5\%$$

$$\delta R = \pm 5\% R = \pm\frac{5}{100} \times 12.5 = \pm 0.625\,\Omega$$

$$\delta R = 0.625\ \Omega$$

$$R_{min} = R - \delta R = 12.5 - 0.625 = 11.875\ \Omega$$

$$R_{max} = R + \delta R = 12.5 + 0.625 = 13.125\ \Omega$$

Range of R : $11.875\ \Omega$ to $13.125\ \Omega$

119. (b)

At the balance, we have magnitude condition

$$Z_1 Z_4 = Z_2 Z_3$$

$$Z_4 = \frac{Z_2 Z_3}{Z_1} = \frac{100 \times 250}{200} = 125\,\Omega$$

Angle condition:

$$\theta_1 + \theta_4 = \theta_2 + \theta_3$$

$$\theta_4 = (\theta_2 + \theta_3) - \theta_1$$

$$\theta_4 = [0° + (-40)°] - (+30°) = -70°$$

$$\theta_4 = -70°$$

∴ Unknown impedance, $$Z_4 = 125\angle{-70°}\ \Omega$$

120. (b)

At balance,

$$(R_1 + j\omega L_1)\left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = R_2 R_3$$

$$R_1 R_4 + j\omega L_1 R_4 = R_2 R_3 + j\omega R_2 R_3 R_4 C_4$$

Separating the real and imaginary terms,

$$R_1 R_4 = R_2 R_3 \quad \text{and} \quad L_1 R_4 = R_2 R_3 R_4 C_4$$

$$R_1 = \frac{R_2 R_3}{R_4} \quad ; \quad L_1 = R_2 R_3 C_4$$

$$R_1 = \frac{400 \times 600}{1000} = 240\,\Omega$$

$$L_1 = R_2 R_3 C_4 = 400 \times 600 \times 0.5 \times 10^{-6} = 0.12\ \text{H}$$

$$Q = \frac{\omega L_1}{R_1} = \frac{2\pi \times 1000 \times 0.12}{240} = 3.14$$

121. (d)

For electrodynamometer,

$$\text{Deflection, } \theta = \frac{I_1 I_2}{K} \cos\phi \frac{dM}{d\theta}$$

where, I_1 = Current through fixed coil

where, I_2 = Current through moving coil

K = Spring constant

$\frac{dM}{d\theta}$ = Rate of change of mutual inductance

Change in mutual inductance = 176 – (–156) = 332 μH

$$I_1 = 3 \text{ A} ; \quad I_2 = \frac{160}{8000} = 0.02 \text{ A} ; \quad \cos\phi = 0.75$$

$$\frac{dM}{d\theta} = \frac{332}{1.66} = 200\,\mu\text{H/rad} ; \quad K = 4.5 \times 10^{-6} \text{ N-m/rad}$$

Deflection,

$$\theta = \frac{3 \times 0.02}{4.5 \times 10^{-6}} \times 0.75 \times 200 \times 10^{-6} = 2 \text{ rad}$$

$$\theta = 114.59°$$

122. (a)

Given : A = 800 mm^2 ; d_1 = 4mm ; Δd = 0.75 mm ; C_1 = 325 μF

We know,

$$C = \frac{\in A}{d}$$

$$C \propto \frac{1}{d}$$

$$d_2 = 4 - 0.75 = 3.25 \text{ mm}$$

$$\frac{C_2}{C_1} = \frac{d_1}{d_2}$$

$$C_2 = \frac{4}{3.25} \times 325 = 400\,\mu\text{F}$$

Change in capacitance,

$$\Delta C = C_2 - C_1 = 400 - 325 = 75\,\mu\text{F}$$

123. (b)

Given : C_1 = 200 pF at f_1 = 2 MHz ; C_2 = 40 pF at f_2 = 4 MHz

The self capacitance of the coil is

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

$$n = \frac{f_2}{f_1} = \frac{4}{2} = 2$$

$$C_d = \frac{200 - (2)^2 \times 40}{2^2 - 1} = \frac{40}{3} = 13.33 \text{ pF}$$

125. (d)

We know that,

$$\frac{f_y}{f_x} = \frac{\text{Horizontal tangencies}}{\text{Vertical tangencies}}$$

$$\frac{f_y}{3} = \frac{5}{2}$$

$$\Rightarrow \quad f_y = 7.5 \text{ kHz}$$

127. (c)

Jump-on-reset circuit allows the processor to move to any location in memory upon reset.

128. (b)

A broadcast address identifies all stations on a network.

129. (b)

$$10\log_{10}(10^8) = 80 \text{ dB}$$

$$\frac{1}{CNR_{\text{overall}}} = \frac{1}{CNR_{\text{up}}} + \frac{1}{CNR_{\text{down}}}$$

$$= \frac{1}{10^8} + \frac{1}{10^8} = \frac{2}{10^8}$$

$$CNR_{\text{overall}} = \frac{10^8}{2}$$

In decilogs,

$$[CNR]_{\text{overall}} = 10\log_{10}\left(\frac{10^8}{2}\right) \text{dB-Hz}$$

$$= 10\log_{10}10^8 - 10\log_{10}2$$

$$\approx 80 - 3 = 77 \text{ dB-Hz}$$

130. (a)

$$N = i^2 + j^2 + ij$$

by trial and error if we put $i = 2$ and $j = 2$, we have

$$N = 4 + 4 + 4 = 12$$

134. (b)

The quality of gate oxide should be very high. Dry oxidation produces better quality oxide than other methods. Hence, dry oxidation is used most widely to form gate oxide.

135. (d)

Without fault,

$$F = \overline{(\overline{ABC} + D) + CD} = \overline{(\overline{ABC} + D)}\,\overline{CD} = (ABC\overline{D})(\overline{C} + \overline{D}) = ABC\overline{D}$$

With stuck-at-0 fault at T,

$$F = \overline{(\overline{ABC} + D) + 0} = \overline{(\overline{ABC} + D)}\,(1) = ABC\overline{D}$$

The input-output logical relation is same with and without fault. So, no input combination can detect the given fault.

136. (c)

1	1	0	0
1	1	1	1

1 + 1 + 2 + 2 = 6 states

Number of states of required Mealy circuit = 6

$$2^n \geq 6 ; \quad n = \text{number of flip-flops}$$

$$n \geq 3 \quad \because n \text{ can be only integer}$$

So, $n_{min} = 3$

138. (d)

The devices fabricated using float zone method are having higher breakdown voltage (~ 1000 V).

139. (c)

The effective height of antenna varies according to the location of mobile unit.

140. (c)

The number of asymptotes is given by $P - Z$, where P and Z represents the number of open-loop poles and zeros respectively.

142. (d)

A universal gate is a gate which can implement all Boolean functions without need to use any other type of gate. The NAND and NOR gates are universal gates and XOR is not a universal gate because it is not possible to implement all Boolean functions using XOR gates only.

143. (a)

While serving to an interrupt, the sequence of execution will alter, therefore processor has to store current value of the program counter and it will respond to the interrupt after completion of current instruction cycle only. So that the processor can start next instruction, using the pre-stored value of PC, after returning from ISR. This process is feasible, when and only processor responds after completion of current instruction cycle otherwise processor may lose some machine cycles.

144. (c)

The polarization that depends on temperature is orientational polarization.

145. (a)

Insertion and deletion in a sorted array can be time-consuming as all the elements following the inserted or deleted element must be shifted appropriately.

Insertion	Deletion
1. Insertion at end takes constant time of order 1. 2. Insertion at beginning takes order of (n) worst case. 3. Average 1 2 3 4 . . . $n-1$ n $(n-1)$ $(n-2)$ $(n-(n-1))$ 0 Insertion operation for average case takes n(n – 1)/2n operations.	1. Deletion at end takes constant time of order 1. 2. Deletion at beginning takes order of (n) worst case. 3. Average 1 2 3 4 . . . $n-1$ n $(n-1)$ $(n-2)$ $(n-(n-1))$ 0 Deletion operation for average case takes $n(n-1)/2n$ operations.

146. (c)

Due to a thin base region, thermal run away is possible in BJT.

149. (a)

Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).

150. (c)

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

Thus, the potential drop across the inductor is proportional to the rate of change of the current. For direct current, $di/dt = 0$ and hence, $v = 0$. Therefore, inductor behaves as a short circuit for direct current.

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