Offline GATE Mock -5 _ Solutions

General Aptitude (GA)

One Mark Solutions:

01. Ans: (B)

Sol: $\sec\theta - \tan\theta = \frac{1}{\sqrt{3}}$

$\Rightarrow \frac{1-\sin\theta}{\cos\theta} = \frac{1}{\sqrt{3}}$

$\Rightarrow \sqrt{3} - \sqrt{3}\sin\theta = \cos\theta$

$\Rightarrow \theta = 30^o$

$\therefore \sec\theta.\tan\theta = \frac{2}{\sqrt{3}} \times \frac{1}{\sqrt{3}}$

$= 2/3$

02. Ans: (B)

03. Ans: (B)

04. Ans: (C)

05. Ans: (D)

Sol: irretrievably means impossible to recover or get back, so irrevocably is the correct synonym, which means not capable of being changed : impossible to revoke.

Two Mark Solutions:

06. Ans: (C)

Sol: P & Q one day work $= \frac{1}{6}$

Q & R one day work $= \frac{7}{60}$

Q & R work on 6 days $= \frac{7}{60} \times 6 = \frac{7}{10}$

$\therefore$ P's work in 3 days $= \frac{3}{10}$

P's one day work $= \frac{1}{10}$

Q's one day work $= \frac{1}{6} - \frac{1}{10} = \frac{1}{15}$

R's one day work $= \frac{7}{60} - \frac{1}{15} = \frac{1}{20}$

$\therefore$ R-P = 20-10=10 days

07. Ans: (B)

Sol: Spent on library $= \frac{60}{360} \times 100 = 16.6\%$

08. Ans: (B)

Sol: The pattern followed is

I = $(2 + 6 + 3 + 2)^2 - 1 = (13)^2 - 1 = 169 - 1$
= 168

II = $(5 + 1 + 2 + 3)^2 - 1 = (11)^2 - 1 = 121 - 1$
= 120

$III = (5 + 4 + 2 + 3)^2 - 1 = (14)^2 - 1 = 196 - 1$

$= 195$

09. Ans: (D)

Sol: 15 men can complete total work = 7 × 3

= 21 days

$M_1D_1 = M_2D_2$

$\Rightarrow 15 \times 21 = 5 \times M_2$

$\Rightarrow M_2 = 63$

10. Ans: (B)

Sol: Total students = 20 + 30 = 50

Total pass students = (20 ×0.8) + (30 ×0.6)

= 16 + 18

= 34

$\therefore$ Pass percentage = $\frac{34}{50} = 68\%$

10. Ans: (B)

Specific Section (EE)

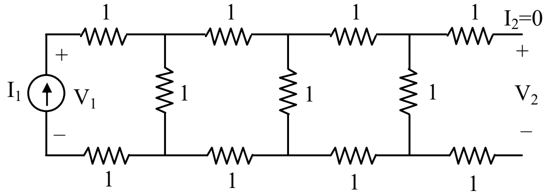
One mark Solutions:

01. Ans: (A)

Sol: Consider the equivalent two port network

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

$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0}$$



$$Z_{11} = \frac{V_1}{I_1} = [[(3 \| 1) + 2] \| 1] + 2 = 2.73\ \Omega$$

02. Ans: (B)

03. Ans: (A)

Sol: Maximum value of restriking voltage

= 2 × peak value of the system voltage

$$= 2 \times \frac{17.32}{\sqrt{3}} \times \sqrt{2} = 28.28 \text{ kV}$$

04. Ans : (A)

Sol: $f(z) = \frac{1}{(z+2)^2\ (z-2)^2}$

z = 2 is a pole of f(z) of order 2

Res (f(z) : z = z_o)

$$= \frac{1}{(m-1)!}\left[\underset{Z \to Z_0}{Lt} \frac{d^{m-1}}{dz^{m-1}} \left((z - z_o)^m\ f(z)\right)\right]$$

Res (f(z) : z = 2)

$$= \frac{1}{(2-1)!}\left[\underset{Z \to 2}{Lt} \frac{d^{2-1}}{dz^{2-1}}\left((z-2)^2 \frac{1}{(z+2)^2\ (z-2)^2}\right)\right]$$

$$= \underset{Z \to 2}{Lt}\left[\frac{(-2)}{(z+2)^3}\right] = -1/32$$

05. Ans: (A)

06. Ans: 1 [Range : 1]

Sol: $\vec{E} = -\nabla.V$,

$$\vec{E} = -[y(2x+z)\hat{x} + x(x+z)\hat{y} + xy\hat{z}]\text{ V/m}$$

$$\vec{E}_{(0,1,1)} = -\hat{x}$$

$$|\vec{E}| = 1$$

07. Ans: 1.14 Ω [Range 1.1 to 1.2]

Sol: $E_{b1} = V - I_a R_a = 240 - 40(0.3) = 228$ V

$$\frac{E_{b2}}{E_{b1}} = \frac{N_2}{N_1}$$

$$\Rightarrow E_{b2} = \frac{1200}{1500} \times 228$$

$$= 182.4 \text{ V}$$

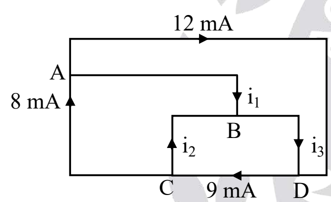
Now $E_{b2} = V - I_a (R_a + R_{se}) = 182.4$ V

$\Rightarrow 240 - 40(0.3 + R_{se}) = 182.4$

$\Rightarrow R_{se} = 1.14\ \Omega$

08. Ans: (C)

Sol: Let name the nodes of the figure



KCL at node A

$8 = 12 + i_1 \Rightarrow i_1 = -4$ mA

KCL at Node D

$12 \text{ mA} + i_3 = 9$ mA

$i_3 = -3$ mA

KCL at Node B

$i_1 + i_2 = i_3$

$i_2 = i_3 - i_1 = -3 \text{ mA} + 4 \text{ mA}$

$= 1$ mA

$i_1 + i_2 + i_3 = -4 + 1 - 3$

$= -7 + 1 = -6$ mA

09. Ans: (D)

Sol: $$\frac{C(s)}{R(s)} = \frac{10}{(s-1)(s+2)}$$

For unit step input

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

$$\Rightarrow C(s) = \frac{10}{s(s-1)(s+2)}$$

By applying initial value theorem

$$c(0) = \underset{s\to\infty}{\text{Lt}}\, sC(s)$$

$$= \underset{s\to\infty}{\text{Lt}} \frac{10}{(s-1)(s+2)} = 0$$

$c(0) = 0$

Final value theorem cannot be applied since poles are in the right half of s-plane. Output is unbounded

$\therefore c(\infty) = \infty$

10. Ans: 132 (Range: 130 to 134)

Sol: Full load Cu loss = $I_{fl}^2 R_{eq} = 80$ W

We want to know rated load (nothing but rated current I) at which a short circuit test can be regarded as an economic heat run test.

In heat run test, losses = Iron loss + Fl cu loss

= 80 + 60 = 140 W

Let us calculate rated current (load) at which these losses will take place.

Copper losses $\propto I^2$

$$\frac{I}{I_{fl}} = \sqrt{\frac{140}{80}} = 1.32 \times 100 = 132\ \%$$

11. Ans: (C)

Sol: The given Newton's iterative formula is

$$x_{n+1} = \frac{1}{2}\left(x_n + \frac{R}{x_n}\right)$$

Let us suppose the formula converges to the root after n iterations

Then $x_n = x_{n+1} = x$ (root)

The formula becomes $x = \frac{1}{2}\left(x + \frac{R}{x}\right)$

$\therefore x = \sqrt{R}$

12. Ans: 5.49 (Range: 5.3 to 5.6)

Sol: Given that

$I_E = 1$ mA

Then $I_B = \frac{I_E}{1+\beta} = 10\mu A$

$I_C = \beta I_B = 0.99$ mA

$V_B = -50 \times 10^3 I_B = -0.5$ V

$V_B - V_E = 0.7$

$\Rightarrow V_E = V_B - 0.7$

$= -1.2$ V

$V_C = 9 - 4.7 \times 10^3 I_C$

$= 9 - 4.7(0.99)$

$V_C = 4.347$ V

Then $V_{CE} = V_C - V_E = 5.547$V

The power dissipation in transistor is

$P_D = V_{CE} \times I_C$

$= 5.547 \times 0.99 \times 10^{-3}$

$= 5.49$ mW

13. Ans: (A)

Sol: Nodal $\Rightarrow -5 + \frac{V_1}{4} + \frac{V_1}{4} + 2I = 0$

$\Rightarrow -5 + \frac{2V_1}{4} + 2\times\frac{V_1}{4} + = 0$

$\Rightarrow V_1 = 5$ V

BY KVL $\Rightarrow V_2 - 20 - 5 = 0 \Rightarrow V_2 = 25$ V

14 Ans: (A)

Sol: To eliminate any harmonic from the output waveform, the amplitude of the waveform should be equal to zero. For that value of n . By referring Fourier analysis expression,

Sin nd = 0

$\therefore nd = \pi \Rightarrow d = \frac{\pi}{n}$

Width of pulse $(\alpha) = 2d = \frac{2\pi}{n} = \frac{2\pi}{5} = 72^o$

15. Ans: (A)

Sol: $\phi(x) = \int_0^{x^2} \sqrt{t}\, dt = \frac{2}{3}x^3$

$\Rightarrow \frac{d\phi}{dx} = 2x^2$

16. Ans: (C)

Sol: $\int_0^1 x\log x\, dx = \log x.\frac{x^2}{2} - \int \frac{x^2}{2}.\frac{1}{x}dx$

$= \left[\frac{x^2}{2}\log x - \frac{x^2}{4}\right]_0^1$

$= \left(0 - \frac{1}{4}\right) - \lim_{x\to 0}\left[\frac{x^2 \log x}{2}\right] - 0$

$= \frac{-1}{4}$

17. Ans : (D)

Sol: Given $\frac{dy}{dx} + \frac{y}{x} = x$ --------- (1) and

y = 1 at x = 1 -------- (2)

I.F = $e^{\int\frac{1}{x}dx} = e^{\log x} = x$

The general solution of (1) is

$$xy = \frac{x^3}{3} + C \quad \text{------- (3)}$$

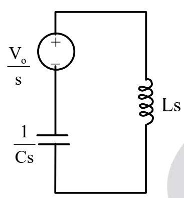
Using (2), (3) becomes

$$1 = \frac{1}{3} + C \Rightarrow \qquad C = 2/3$$

$$\therefore y = \frac{x^2}{3} + \frac{2}{3x}$$

18. Ans: 1 (No Range)

Sol:



Applying KVL in s-domain,

$$I(s) = \frac{V_o/s}{\frac{1}{Cs} + Ls}$$

$$= \frac{V_o C}{Lcs^2 + 1}$$

$$\Rightarrow \ i(t) = V_o\sqrt{\frac{C}{L}}\sin\frac{1}{\sqrt{LC}}t$$

$$\Rightarrow i(max) = V_o\sqrt{\frac{C}{L}}$$

$$= 10\sqrt{\frac{10^{-6}}{0.1\times10^{-3}}} = 1A$$

19. Ans: (C)

Sol $E = \{(1,2),(1,3),(1,4),(1,5),(1,6),(2,3),(2,4),(2,5),(2,6)$
$(3,4),(3,5),(3,6),(4,5),(4,6),(5,6)\}$

$n(E) = 15, \quad n(S) = 36$

Required probability$= \frac{n(E)}{n(S)} = \frac{15}{36} = \frac{5}{12}$

20. Ans: 0.396 (Range: 0.35 to 0.45)

Sol: $X = X_{(pu)(old)} \times \frac{MVA_{new}}{MVA_{old}}\left(\frac{kV_{old}}{kV_{new}}\right)^2$

$$= 0.6 \times \frac{80}{100}\left(\frac{10}{11}\right)^2$$

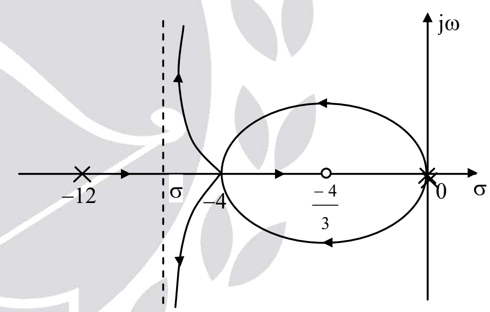
$$= 0.6\times\frac{4}{5}\left(\frac{10}{11}\right)^2$$

$$= 0.396$$

21. Ans: 48 [Range 48]

Sol: Since the roots are equal at the point. Therefore the point must be a break point.

$\therefore$ At the break point $\frac{dk}{ds} = 0$



$$\Rightarrow \frac{d}{ds}\left[\frac{s^3 + 12s^2}{s + 4/3}\right] = 0$$

$\Rightarrow s = 0, -4$

The root locus for the given transfer function is

At s = –4, the three root locus branches meet and the three roots are equal

At s = –4,

$$k = \frac{4\times4\times8}{8/3} = 48$$

$\therefore k = 48$

22. Ans: (B)

Sol: $-X = \overline{X} + 1$ in 2's complement form

MVI A,X ; (A) = X

CMA ; (A) = $\overline{X}$

ADI 01H ; $(A) = \overline{X} + 1$

23. Ans: (A)

Sol: given I = 100 ± 2 A = 100 ± 2%

R = 100 ± 1 Ω = 100 ± 1%

we know that

$P = I^2 R$

Limiting error will be ⇒ 2 × 2 + 1 = 5%

24. Ans: (C)

Sol: Pick up value = Operating current × current setting

= 8 × 0.15 = 1.2 A

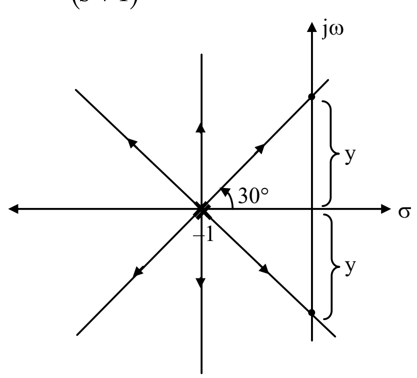
25. Ans: (D)

Two Marks Solutions:

26. Ans: (A)

Sol: Method-I: The root locus for the given open loop transfer function

$G(s) = \frac{k}{(s+1)^6}$ is as shown below



In this case asymptotes become the root locus branches. When 'k' is increased two of the root locus branches moves towards jω axis

And these two root locus branches cut the jω axis at the point which is obtained as follows

$\text{Tan } 30° = \frac{y}{1} \Rightarrow y = \frac{1}{\sqrt{3}}$

∴ Root locus cuts the jω axis at $s = \pm \frac{j}{\sqrt{3}}$

At $s = \frac{j}{\sqrt{3}}$, $k = \left(\sqrt{1+\frac{1}{3}}\right)^6$

$= \left(\frac{2}{\sqrt{3}}\right)^6 = \frac{64}{27}$

∴ For stability $0 < k < \frac{64}{27}$

Method-II

For marginal stability gain margin = 1

Phase margin = 0

$\text{Gain margin} = \frac{1}{|G(s)H(s)|_{\omega=\omega_{pc}}}$

At $\omega = \omega_{pc}$ $\angle G(s)H(s) = -180°$

$\Rightarrow -6\tan^{-1}(\omega_{pc}) = -180° \Rightarrow \omega_{pc} = \frac{1}{\sqrt{3}}$

And gain margin = 1

$\Rightarrow \frac{k}{\left(\sqrt{1+\left(\frac{1}{\sqrt{3}}\right)^2}\right)^6} = 1$

$\Rightarrow k = \left(\frac{2}{\sqrt{3}}\right)^6 = \frac{64}{27}$

$\therefore 0 < k < \frac{64}{27}$

27. Ans: (A)

Sol: $\overline{F} = q\overline{V}\times\overline{B} = qV_0\hat{x}\times B_0\hat{z} = ma$

$$s = ut + \frac{1}{2}at^2$$

$$s = V_0\hat{x}t + \frac{1}{2}\left(\frac{qv_0\,\hat{x}}{m}\right)(-\hat{y})$$

28. Ans: (D)

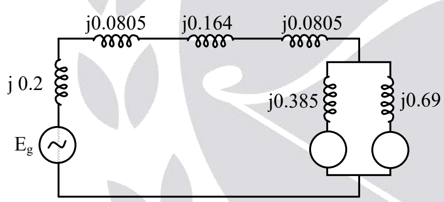
Sol: Transmission line base voltages = $11 \times \frac{121}{10.8}$

$= 123.2$ kV

Motor voltage in base $123.2 \times \frac{10.8}{121} = 11\text{kV}$

Transformer = $0.1 \times \frac{25}{30}\times\left(\frac{10.8}{11}\right)^2$

$= 0.0805$



Line reactance = $\frac{100\times 25}{(123.2)^2} = 0.164$ pu

Motor 1 = $0.28\times\frac{25}{15}\left(\frac{10}{11}\right)^2$

$= 0.385$ pu

Motor 2 = $0.25\times\frac{25}{75}\times\left(\frac{10}{11}\right)^2$

$= 0.069$ pu

29. Ans: 0.5 [Range 0.5]

Sol: $H_1(Z) = \frac{Z}{Z-\alpha}$, $H_2(Z) = \frac{Z}{Z+\alpha}$

$H_C(Z) = H_1(Z)\,H_2(Z) = \frac{Z}{Z^2-\alpha^2}$

$H_P(Z) = H_1(Z)+H_2(Z) = \frac{Z}{Z-\alpha} + \frac{Z}{Z+\alpha} = \frac{2Z^2}{Z^2-\alpha^2}$

$H_P(Z) = 2H_C(Z)$

$H_C(z) = 0.5H_P(z)$.

30. Ans: 14.414 [Range 13.5 to 15]

Sol: Let V_s is rms value of input voltage, I is current in the load under fully discharged condition

for diode bridge rectifier,

The average output $V_0 = \frac{2V_m}{\pi} = \frac{2\sqrt{2}V_s}{\pi}$

$$I_0 = \frac{V_0 - E}{R}$$

$E = V_0 - I_0 R$ ………(1)

Substitute the given values in the equation (1)

Under fully discharge condition

$10.2 = \frac{2\sqrt{2}V_s}{\pi} - I0.1$ ………(2)

Under fully charge condition

$12.7 = \frac{2\sqrt{2}V_s}{\pi} - (I\times 0.1)\times 0.1$ …….(3)

Solve (2) & (3)

$2.5 = 0.09I$

$I = \frac{2.5}{0.09} = 27.78\text{ A}$

$V_0 = E + IR$

$= 10.2 + 27.78 \times 0.1$

$= 12.98$ V

For full bridge rectifier $V_0 = \frac{2V_m}{\pi}$

$V_s = \frac{12.98\times\pi}{2\sqrt{2}} = 14.414$ V

31. Ans: (A)

Sol: From the Bode plot, $G(s) = \dfrac{K\left(1+\dfrac{s}{1}\right)}{s\left(1+\dfrac{s}{100}\right)}$

$\theta(\omega) = \angle G(j\omega)$

$= -90° + \tan^{-1}(\omega) - \tan^{-1}\left(\dfrac{\omega}{100}\right)$

$\theta(\omega)$ is absolute minimum at

$\omega = \sqrt{(1)(100)} = 10$ rad/sec

$\therefore$ Minimum phase angle

$= -90° + 84.3° - 5.7°$

$= -11.4°$

32. Ans: 27% [Range 27]

Sol: $I_{st} = 3\, I_{full}$ and $S_f = 0.03$

$\dfrac{\tau_{st}}{\tau_{full}} = \left(\dfrac{I_{st}}{I_{full}}\right)^2 S_f$

$= \left(\dfrac{3\, I_{full}}{I_{full}}\right)^2 \times 0.03$

$= 0.27$

In percentage is 27%

33. Ans: (A)

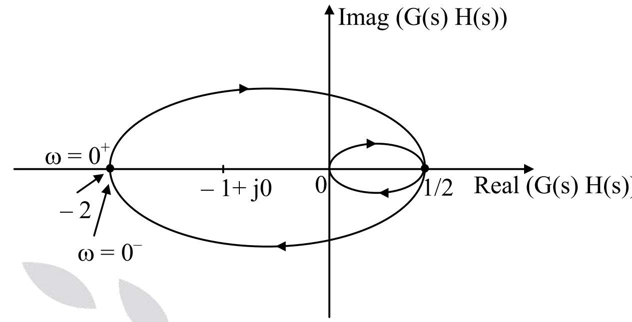
Sol: Let X = Number of tosses required for head (or) four tails

X	H	TH	TTH	(TTTH) or (TTTT)
P(x)	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$

$E(X) = 1\times\dfrac{1}{2} + 2\times\dfrac{1}{4} + 3\times\dfrac{1}{8} + 4\times\dfrac{1}{8} = \dfrac{15}{8}$

34. Ans: (C)

Sol: The nyquist plot of $G(s)H(s) = \dfrac{(s-2)}{(s+1)^2}$ is as shown below



Number of anticlockwise encirclements about origin = $(P - Z)_{OLTF}$

Where 'P' and 'Z' are the number of right side poles and number of right side zeros of openloop transfer function.

$\therefore N_{(0,0)} = 0 - 1 = -1$

$\therefore$ It will encircle the origin once in clockwise direction

To find anticlockwise encirclements about (–1 +j0), N = P – Z

Where, P = number of right side poles of OLTF

Z = number of right side poles of CLTF

The characteristic equation is

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

$\Rightarrow 1 + \dfrac{(s-2)}{(s+1)^2} = 0$

$\Rightarrow s^2 + 2s + 1 + s - 2 = 0$

$\Rightarrow s^2 + 3s - 1 = 0$

$\Rightarrow s = 0.302, -3.302$

$\therefore Z = 1$

$\therefore N_{(-1,\,0)} = 0 - 1 = -1$

$\therefore$ It will encircle (–1, 0) once in clockwise direction

(or)

From the figure we can directly say that number of encirclements.

35. Ans: 13.982 [Range: 13 to 14]

Sol: Given data, $V_t = 300 - 0.5\, I_L$, $P_0 = 6$ kW

$P_0 = V_t I_L$

$6 \times 10^3 = (300 - 0.5\, I_L)\, I_L$

$0.5\, I_L^2 - 300\, I_L + 6 \times 10^3 = 0$

$$I_L = \frac{300 \pm \sqrt{9\times10^4 - 12\times10^3}}{1}$$

$= 300 \pm 279.28$

$= 579.28$ and 20715 A for a load 6 kW, 20.7156 A is suitable load current

$I_L^2 R_L = 6000$

$\Rightarrow R_L = 13.982\ \Omega$

36. Ans: (D)

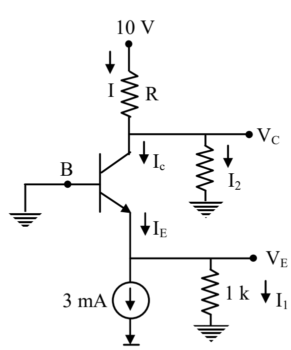
37. Ans: 1.86 (Range: 1.8 to 1.9)

Sol: The given circuit can be redrawn as

$V_B = 0$

$V_E = -0.7$ V

$I_1 = \frac{V_E}{1k} = -0.7\text{mA}$



$I_E = I_1 + 3\text{mA}$

$I_E = 2.3$ mA

$I_E \approx I_C = 2.3$ mA

Given $V_{CE} = 2.7$ V

$V_C - V_E = 2.7$

$V_C = V_E + 2.7$

$V_C = 2$ V then $I_2 = \frac{V_C}{1k} = 2$ mA

$\Rightarrow I = I_C + I_2$

$I = 4.3\text{ mA} = \left(\frac{10 - V_C}{R}\right)$

$R = \frac{10-2}{4.3\times10^{-3}} = 1.86\text{ k}\Omega$

38. Ans: (C)

Sol: electrical input = $P_{mech.output}$ + friction Loss + core Loss

= 9kW + 2kW + 0.8kW

$P_{in} =$ 11.8kW.

$\sqrt{3} V_L I_L \cos\phi = 11800$

$\Rightarrow \sqrt{3}\times400\times I_L\times0.8 = 11800 \Rightarrow I_L = 21.29\text{A}$

39. Ans: (B)

Sol: $V_{dc} = 6V$, $V_0 = 15V$

$$V_0 = \frac{V_{dc}}{1 - D}$$

$$1 - D = \frac{V_{dc}}{V_0}$$

$$D = 1 - \frac{V_{dc}}{V_0}$$

$$= 1 - \frac{6}{15}$$

$$= 0.6$$

$$R_{cr} = \frac{2L}{D(1-D)^2 T}$$

$$= \frac{2\times 250\times 10^{-6}}{0.6(1-0.6)^2 \times (1/20\times 10^3)}$$

$$= 104.17\ \Omega$$

40. Ans : (A)

Sol: Given $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$

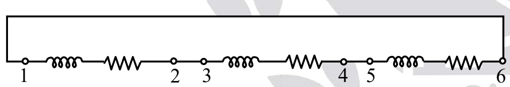
$\Rightarrow |A| = 1 \neq$ and

$$\text{adj}(A) = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

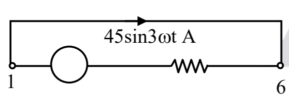
$$\therefore A^{-1} = \frac{adj(A)}{|A|} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

41. Ans: (C)

Sol:



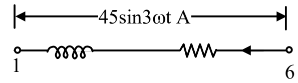
It can be redrawn as follows



$300[\sin\omega t + \sin(\omega t - 120^o) + \sin(\omega t + 120^o)] + 135\sin 3\omega t = 135\sin 3\omega t + V$

It is seen that the current in the delta loop is $45\sin 3\omega t$ A, flowing from terminal 1 to 6 through resistance.

Now consider only the winding between terminals 1 and 2



The voltage across terminals 1 and 2 is 300 $\sin\omega t$

42. Ans: (C)

Sol: $SI - A = \begin{bmatrix} s & -1 \\ 0 & s+3 \end{bmatrix}$

$$(SI-A)^{-1} = \begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+3)} \\ 0 & s+3 \end{bmatrix}$$

$$e^{At} = L^{-1}\left[(SI-A)^{-1}\right]$$

$$= \begin{bmatrix} 1 & \frac{1}{3}(1-e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$$

$$x(t) = e^{At}x(0) + \int_0^t e^{A(t-\tau)}BU(\tau)d\tau$$

$U(\tau)$ =unit step input

$$x(t) = \begin{bmatrix} 1 & \frac{1}{3}(1-e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}\begin{bmatrix} -1 \\ 3 \end{bmatrix} + \int_0^t \begin{bmatrix} 1 & \frac{1}{3}(1-e^{-3(t-\tau)}) \\ 0 & e^{-3(t-\tau)} \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix}(1)d\tau$$

$$= \begin{bmatrix} -e^{-3t} \\ 3e^{-3t} \end{bmatrix} + \int_0^t \begin{bmatrix} 1 \\ 0 \end{bmatrix} d\tau$$

$$= \begin{bmatrix} -e^{-3t} \\ 3e^{-3t} \end{bmatrix} + \begin{bmatrix} t \\ 0 \end{bmatrix}$$

$$x(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} t - e^{-3t} \\ 3e^{-3t} \end{bmatrix}$$

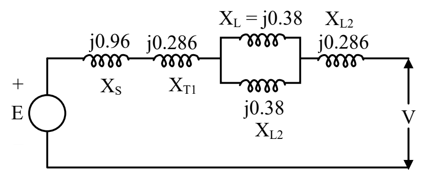
43. Ans: 1.722 [Range: 1.6 to 1.8]

Sol: $X_S = 0.96$ pu

$X_{T1} = X_{T2} = 0.286$ pu,

$X_{L1} = X_{L2} = 0.38$ pu

$E = 1.2$ pu $\quad V = 1.0$ pu



$X_T = j0.96 + j0.286 + j(0.38 \parallel 0.38) + j0.286$

$= 1.722$ pu

$$P_0 = \frac{EV}{X}\sin\delta$$

$P_0 = 1$ pu

Minimum value $\sin\delta = 1$

$$E_{min} = \frac{PX}{V}$$

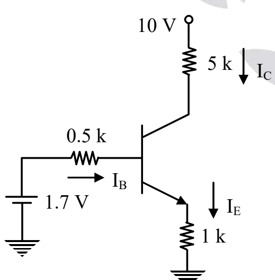
$$E_{min} = \frac{1\times1.722}{1} = 1.722 \text{ pu}$$

44. **Ans: (B)**

Sol: Given that $\beta = 100$

To calculate 'r_e' value, apply DC Analysis

Apply KVL to input loop



$1.7 - 0.5 \times 10^3 I_B - 0.7 - 10^3(1+\beta)I_B = 0$

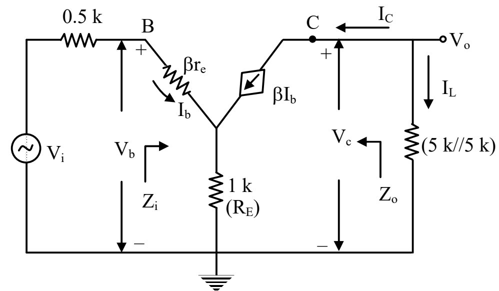
$$I_B = \frac{1}{10^3(0.5+101)} = 9.852\ \mu A$$

$I_E = (1+\beta) I_B = 0.995$ mA

$$r_e = \frac{V_T}{I_E} = 25.12\ \Omega$$

To calculate voltage gain apply AC Analysis

Voltage gain



$$A_V = \left(\frac{V_o}{V_b}\right) = \frac{-I_C(2.5k)}{I_b\left[\beta r_e + (1+\beta)R_E\right]}$$

$$A_V = \frac{-\beta\times2.5\times10^3}{\beta r_e + (1+\beta)R_E} = \frac{-100\times2.5\times10^3}{(2.512+101)\times10^3}$$

$$= \frac{-250}{103.512}$$

$= -2.415$

Voltage amplification $A = A_v\left(\frac{z_i^1}{z_i^1 + R_s}\right)$

Where $Z_i^1 = Z_i = \beta r_e + (1+\beta) R_E$

$= 103.512$ kΩ

$$A = -2.415\left(\frac{103.512}{104.012}\right)$$

$= -2.4034$

$\therefore A = -2.4$

45. **Ans: (B)**

Sol: Given $\cos\theta = 0.8$

$\theta = \cos^{-1} 0.8 = 36.86°$

$P_1 = V_L I_L \cos(30 - 36.86)$

$P_2 = V_L I_L \cos(30 + 36.86)$

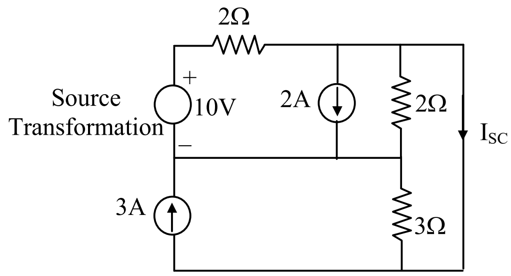
$P_1 = 208 \times 12 \cos(30 - 36.86)$

$P_1 = 2478$W

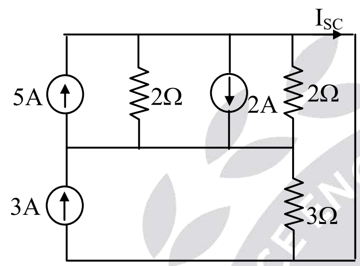
$P_2 = 208 \times 12 \cos(30 + 36.86) \Rightarrow P_2 = 980$W

46. Ans: 3 [Range 3]

Sol: Find out short circuit current (I_{SC})



⇒



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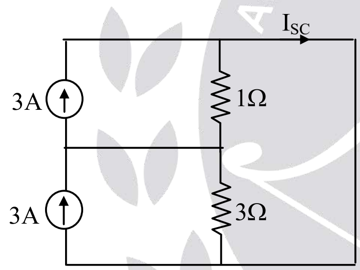
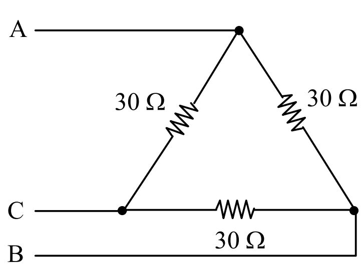


$\therefore I_{SC} = 3A$

47. Ans: (B)

Sol: Convert delta connected load into star connected load.



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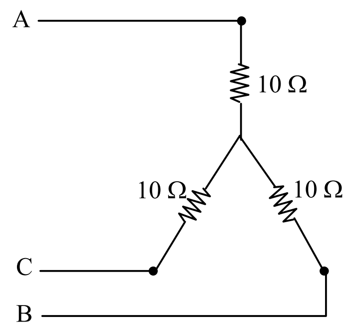


∴ In 120° conduction scheme,

$$V_{ph} = \frac{V_{dc}}{\sqrt{6}} = 163.3\,V$$

3-ϕ load power

$$P_0 = 3\left[\frac{V_{ph}^2}{R}\right] = 3 \times \frac{163.3^2}{10} = 8kW$$

48. Ans: (C)

Sol: $f(A, B, C, D) = \Sigma m(1, 3, 4, 7, 9, 12, 14, 15)$

$$= \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD$$
$$+ A\bar{B}\bar{C}D + AB\bar{C}\bar{D} + ABC\bar{D} + ABCD$$

$$= \bar{B}\bar{C}D(A + \bar{A}) + \bar{B}CD\bar{A} + B\bar{C}\bar{D}(A + \bar{A})$$
$$+ BCD(A + \bar{A}) + BC\bar{D}A$$

$$= \bar{B}\bar{C}D + \bar{B}CD\bar{A} + B\bar{C}\bar{D} + BCD + BC\bar{D}A \; ....(1)$$

The output of the multiplexer = $m_0I_0 + m_1I_1 + m_2I_2 + m_3I_3 + m_4I_4 + m_5I_5 + m_6I_6 + m_7I_7$

$$= \bar{B}\bar{C}\bar{D}I_0 + \bar{B}\bar{C}DI_1 + \bar{B}C\bar{D}I_2 + \bar{B}CDI_3 + B\bar{C}\bar{D}I_4$$
$$+ B\bar{C}DI_5 + BC\bar{D}I_6 + BCDI_7$$

……….(2)

(1) = (2)

$\Rightarrow I_0 = 0, I_1 = 1, I_2 = 0, I_3 = \bar{A}, I_4 = 1, I_5 = 0,$

$I_6 = A, I_7 = 1$

49. Ans: (B)

Sol: All sheets will produce electric field at point P is –Ve Z direction.

$$E_T = \left[\frac{\sigma}{2\varepsilon_0} + \frac{2\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}\right](-\hat{Z})$$

$$= \frac{4\sigma}{2\varepsilon_0}(-\hat{Z}) = \frac{2\sigma}{\varepsilon_0}(-\hat{Z})$$

50. Ans: 50 [Range 50]

Sol: Peak to peak value of unknown ac voltage.

V_{P-P} = length of trace × deflection sensitivity

$V_{P-P} = 10 \times 10 = 100V$

Peak value of the voltage $= \frac{V_{P-P}}{2} = 50\text{Volt}$

51. Ans: (A)

Sol: $\frac{x(t)}{t} \leftrightarrow \int_s^\infty X(S)\,ds$

$x(t) = \sin at \,.\, u(t),\ X(S) = \frac{a}{s^2 + a^2}$

$$\int_s^\infty X(s)ds = \int_s^\infty \frac{a}{s^2 + a^2}\,ds$$

$$= a.\ \frac{1}{a}\tan^{-1}(s/a)\Big|_s^\infty$$

$= \tan^{-1}(\infty) - \tan^{-1}(s/a)$

$= \frac{\pi}{2} - \tan^{-1}(s/a)$

$= \cot^{-1}(s/a)$

$= \tan^{-1}(a/s)$

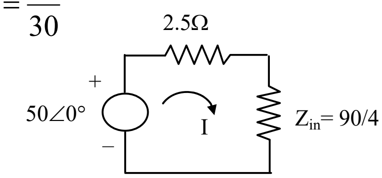
52. Ans: 90 [Range 90]

Sol: By using impedance transformation from output to input. The transformer are ideal (no power loss)

$$Z_{in} = \frac{Z_L}{k_1^2 k_2^2}$$

$$k_1 = \frac{20}{1} = 20,\ k_2 = \frac{1}{30}$$

$Z_L = 10\Omega$



$$Z_{in} = \frac{10 \times 30 \times 30}{20 \times 20} = \frac{90}{4}$$

$I = 2A$

This current is transformed input to output

then $I_L = \frac{I_{in}}{k_1^2 k_2^2} = \frac{2 \times 30}{20} = 3A$

$P_{dissipated\ '10\Omega'} = I^2R = (3)^2 \times 10 = 90\ W$

53. Ans: (3) [Range]

Sol: $(143)_5 = (x3)_y$

$\Rightarrow 1 \times 5^2 + 4 \times 5 + 3 = xy + 3$

$\Rightarrow xy = 45$

$y > 3$ and $y > x$

Possible solutions are

$x = 1,\ y = 45$

$x = 3,\ y = 15$

$x = 5,\ y = 9$

54. Ans: (B)

Sol: For uniform distribution, $f(x) = \frac{1}{b-a}$

for $a < x < b$

Here $f(x) = \frac{1}{0.5 - 0} = 2$

$$E(x^4) = \int_0^{0.5} x^4 f(x)dx = 1/80$$

55. Ans: 980 (Range: 978 to 982)

Sol: Developed power,

$$P = \frac{735.5}{75} \times Q \times W \times H \times \eta \text{ Watts}$$

Here,

Discharge of water (Q) = $1 m^3/s$,

Efficiency (η) =100% and

Water head (H) = 1m

$$\therefore \ P = \frac{735.5}{75} \times 1000 \times 10 \times 10 = 980 \, kW$$