



ACE

Engineering Academy

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Branch: Electrical Engineering

Mock-C - Solutions

GATE-2020 General Aptitude (GA)

01. Ans: (A)

Sol: The right choice is 'on'. 'Tell on' means 'to affect'. 'Tell against' means 'to go against'. 'Tell of' means 'to tell about something'.

02. Ans: (C)

Sol: 'is' tired verb must agree with the first subject when 'as well as' is used.

03. Ans: (A)

04. Ans: (D)

Sol: $L = \frac{5}{2}B$

$$\text{Area} = L \times B = 1000$$

$$L \times \frac{2L}{5} = 1000$$

$$L^2 = 2500 \Leftrightarrow L = 50 \text{ m}$$

05. Ans: (B)

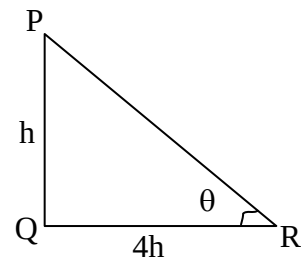
Sol: Supplement of $80^\circ = 180^\circ - 80^\circ = 100^\circ$.

06. Ans: (D)

Sol: Let the height of tower be 'PQ', 'QR' be the length of shadow to tower in ΔPQR .

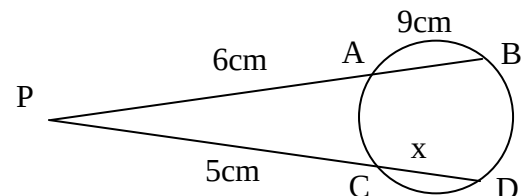
$$\tan \theta = \frac{PQ}{QR} = \frac{h}{4h}$$

$$\therefore \theta = \tan^{-1}\left(\frac{1}{4}\right)$$



07. Ans: (A)

Sol: If two chords of a circle, intersect inside a circle (outside a circle) at any point. Then,



$$PA \times PB = PC \times PD$$

$$\Rightarrow 6 \times 15 = 5 \times (x + 5)$$

$$\Rightarrow x + 5 = 18 \Rightarrow x = 13 \text{ cm}$$

08. Ans: (A)

Sol: Total time between 10 pm to 6 am = 8 hours

% time spent in Light sleep or in Extreme sleep = $30 + 25 = 55\%$

$\Rightarrow$ Time spent in Light sleep or in Extreme sleep = $\frac{55}{100} \times 8$

$$\Rightarrow \frac{22}{5} = 4.4 \text{ hours}$$



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09. Ans: (B)

Sol: Total cost of mobiles = $99 \times 15000 = \text{Rs. } 14,85,000$

Total cost of cameras = $53 \times 13000 = \text{Rs. } 6,89,000$

Total cost of TVs = $29 \times 59000 = \text{Rs. } 17,11,000$

Total cost of Refrigerator = $21 \times 56000 = \text{Rs. } 11,76,000$

Total cost of AC = $97 \times 25000 = \text{Rs. } 24,25,000$

Total cost = $14,85,000 + 6,89,000 + 17,11,000 + 11,76,000 + 24,25,000 = \text{Rs. } 74,86,000$

Total cost in lakhs = Rs. 74.86 lakhs

10. Ans: (A)

Sol: An assumption is an unstated premise. So, we are looking for something that is implied in the argument, and if wrong, will undermine the argument. All that the speaker implies is that Josh is efficient because he has twenty years of practice, and so answer (A) is correct.

Specialization (EE)**01. Ans: (c)**

Sol: $G(s) = \frac{k(s+2)(s+3)}{(s+1)(s+4)}$

$$\text{CLTF} = \left. \frac{G(s)}{1+G(s)} \right|_{k=1} = \frac{(s+2)(s+3)}{(s+1)(s+4) + (s+2)(s+3)}$$

02. Ans: (D)

Sol: The potential due to a dipole can be written as

$$V = \frac{\bar{P} \cdot \bar{a}_r}{4\pi\epsilon_0 r^2} \quad (\text{where } \bar{P} = \text{dipole moment and}$$

$$|\bar{P}| = Qd)$$

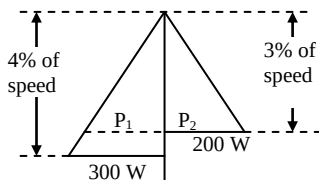
$$\bar{P} = (2\hat{a}_x + 1.5\hat{a}_y + 3\hat{a}_z) \times 10^{-9} \text{ C-m}$$

$$\bar{a}_r = \frac{2\hat{a}_x + \hat{a}_y + 5\hat{a}_z}{\sqrt{4+1+25}} = \frac{2\hat{a}_x + \hat{a}_y + 5\hat{a}_z}{\sqrt{30}}$$

$$V = \frac{(2\hat{a}_x + 1.5\hat{a}_y + 3\hat{a}_z) \cdot (2\hat{a}_x + \hat{a}_y + 5\hat{a}_z)}{4\pi \times 8.854 \times 10^{-12} \times 30\sqrt{30}} \times 10^{-9}$$

$$= \frac{(4+1.5+15)}{4\pi \times 8.854 \times 10^{-12} \times 30\sqrt{30}} \times 10^{-9}$$

$$= 1.12 \text{ V}$$

03. Ans: 425 (No range)**Sol:**

Two alternators are working in parallel, they can share maximum power without over loading of any of the alternator, when speed regulation of two alternators are equal.

$$\therefore \frac{P_1}{3} = \frac{300}{4} = 225 \text{ kW}$$

$$P_2 = 200 \text{ kW}$$

$$\therefore \text{Total power, } P = P_1 + P_2$$

$$P = 425 \text{ kW}$$

04. Ans: (b)

Sol: The L.T of periodic signal $x(t)$, with period 'T' is

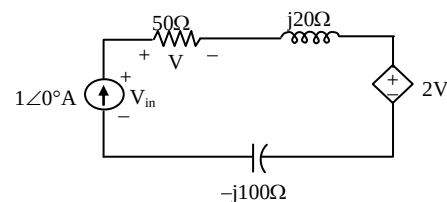
$$X(s) = \frac{1}{1 - e^{-sT}} \int_0^T x(t) e^{-st} dt$$

05. Ans: 170 (169 to 171)

Sol: $2\text{mH} \rightarrow j\omega L = j(10 \times 10^3)(2 \times 10^{-3}) = j20$

$$1\mu\text{F} \rightarrow \frac{1}{j\omega C} = \frac{1}{j(10 \times 10^3)(1 \times 10^{-6})}$$

$$= -j100$$



$$V = (1\angle 0^\circ)(50) = 50$$

$$V_{in} = (1\angle 0^\circ)(50 + j20 - j100) + (2)(50)$$

$$V_{in} = 50 - j80 + 100 = 150 - j80$$

$$Z_{in} = \frac{V_{in}}{1\angle 0^\circ} = 150 - j80\Omega$$

$$= 170\Omega$$

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06. Ans: (B)

Sol: $f(A, B, C, D) = A + \overline{B}\overline{C} + \overline{A}B\overline{D} + ABCD$

$$= \overline{A}\overline{B}\overline{C}\overline{D} + \overline{A}\overline{B}\overline{C}D + \overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}D$$

$$+ \overline{A}B\overline{C}D + \overline{A}BC\overline{D} + \overline{A}BCD + \overline{A}BCD + \overline{A}BCD +$$

$$\overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}D + \overline{A}B\overline{C}\overline{D} + \overline{A}B\overline{C}D$$

$$+ \overline{A}B\overline{C}\overline{D} + \overline{A}BC\overline{D} + \overline{A}BCD$$

$$= \sum m(4, 5, 8, 9, 10, 11, 12, 13, 14, 15)$$

$$= \prod M(0, 1, 2, 3, 6, 7)$$

07. Ans: 6.2 (no range)

Sol: $V_{out} = 0.4V$ for input $(00010)_2 = (2)_{10}$

$$\text{step size} = \frac{0.4}{2} = 0.2$$

$$V_{out} \text{ for input } (11111)_2 = 0.2 \times 31_{10} = 6.2V$$

08. Ans: 2.12 (Range: 2 to 2.3)

Sol: $f(x, y, z) = 2y + z$

$$\text{Directional derivate} = (\nabla f) \cdot \frac{\vec{a}}{|\vec{a}|}$$

$$\nabla f = j \frac{\partial f}{\partial y} + k \frac{\partial f}{\partial z} = j \cdot 2 + k \cdot 1 = 2\vec{j} + \vec{k}$$

$$\therefore \text{Directional derivate} = (2\vec{j} + \vec{k}) \cdot \frac{(\vec{j} + \vec{k})}{\sqrt{2}}$$

$$= \frac{2+1}{\sqrt{2}} = \frac{3}{\sqrt{2}} = 2.12$$

09. Ans: 1.22 (No range)

Sol: $\frac{dy}{dx} = y + x$

$$x_0 = 0, y_0 = 1$$

$$x_1 = x_0 + h = 0.1$$

$$x_2 = x_0 + 2h = 0.2$$

$$y_1 = y_0 + hf(x_0, y_0)$$

$$= 1 + (0.1)(1) = 1.1$$

$$y_2 = y_1 + hf(x_1, y_1)$$

$$= 1.1 + 0.1 [0.1 + 1.1] = 1.1 + 0.12 = 1.22$$

10. Ans: 5 No range

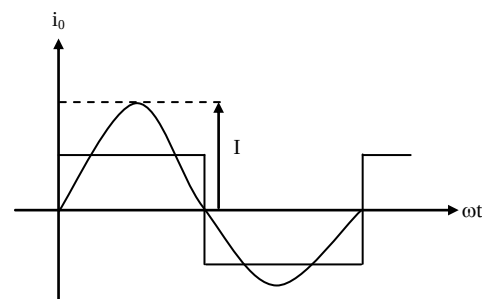
Sol: Let X = Amount the player wins in rupees

The probability distribution for X is given below.

For the game to be fair we have to find x, so that $E(X) = 0$

$$\Rightarrow x \cdot \left(\frac{1}{4}\right) + 1 \cdot \left(\frac{2}{4}\right) + 3 \cdot \left(\frac{1}{4}\right) = 0 \Rightarrow x = 5$$

$\therefore$ Number of rupees, the player has to lose if no head occur = 5.

11. Ans: (A)**Sol:**

$$\therefore 3^{\text{rd}} \text{ harmonic component} = \frac{\text{fundamental}}{3}$$

$$= \frac{1}{3} = \frac{9}{3} = 3 \text{ A}$$

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12. Ans: (A)**13. Ans: 0.2 p.u**

Sol: $Q_s = \frac{|V_s|}{x} [|V_s| - |V_r|]$

$$= (P_{\max}) (V_{\text{reg}}) = 2 \times 0.1 = 0.2 \text{ p.u}$$

14. Ans: 1.256 (1.24 to 1.27)

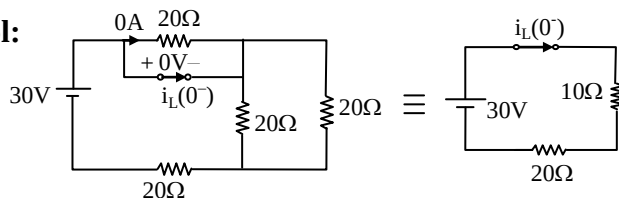
Sol: Energy density = $\frac{1}{2} \mu_0 H^2$

Number of heads	0	1	2
X	x	1	3
P(X)	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{1}{4}$

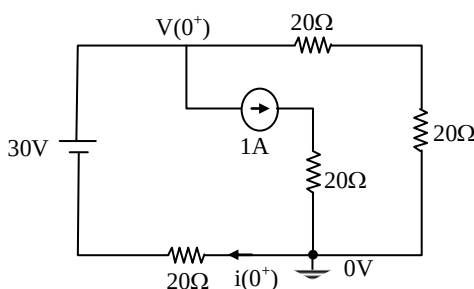
$$= \frac{1}{2} \times 4\pi \times 10^{-7} \times \left(\sqrt{(10^3)^2 + (10^3)^2} \right)^2$$

$$= \frac{1}{2} \times 4\pi \times 10^{-7} \times 2 \times 10^6$$

$$= \frac{4\pi}{10} = 1.25663 \text{ J/m}^3$$

15. Ans: (C)**Sol:**

So, $i_L(0^+) = \frac{30}{30} = 1\text{A} = i_L(0^+)$



Nodal: $\frac{V_L(0^+) - 30}{20} + 1 + \frac{V_L(0^+)}{40}$

$$= 0 \Rightarrow V_L(0^+) = \frac{20}{3} \text{ V}$$

So, $i(0^+) = \frac{30 - V_L(0^+)}{20} = \frac{7}{6} \text{ A}$

16. Ans: 1 (No range)

Sol: $N_s = \frac{120 \times f}{P} = \frac{120 \times 50}{4} = 1500 \text{ r.p.m}$

$$N = 1440 \text{ r.p.m}$$

Full-load slip $S_1 = \frac{N_s - N}{N_s} = \frac{1500 - 1440}{1500}$

$$= 0.04$$

After inserting resistance, $N_2 = 1200 \text{ r.p.m}$

Slip $S_2 = \frac{1500 - 1200}{1500} = 0.2$

For constant load torque, power input to rotor and rotor current remains the same.

So, $\frac{S_2}{S_1} = \frac{R + R_{\text{ext}}}{R}$

$$\frac{0.2}{0.04} = \frac{0.25 + R_{\text{ext}}}{0.25}$$

$$\Rightarrow R = 1\Omega$$

17. Ans: 24 (No range)

Sol: Given that $F(x) = f(g(x))$

$$\Rightarrow F^1(x) = f^1(g(x)). g^1(x) (\because \text{by chain rule})$$

$$\Rightarrow F^1(5) = f^1(g(5)). g^1(5)$$

$$\Rightarrow F^1(5) = f^1(-2) . 6$$

$$\therefore F^1(5) = (4) (6) = 24$$

18. Ans: 4

$$\text{Sol: } G(s) = \frac{\left(1 + \frac{s}{2}\right)^2}{\left(1 + \frac{s}{8}\right)^8} = \left(\frac{1}{4}\right) \frac{\left(1 + \frac{s}{2}\right)}{\left(1 + \frac{s}{8}\right)}$$

$$\text{But } G(s) = \frac{1 + s\tau}{1 + \alpha s\tau}$$

$$\text{By comparing } \tau = \frac{1}{2}$$

$$\alpha\tau = \frac{1}{8} \Rightarrow \alpha = \frac{1}{4}$$

$$\omega_m = \frac{1}{\tau\sqrt{\alpha}} = \frac{1}{\frac{1}{2}\sqrt{\frac{1}{4}}} = 4 \text{ rad/sec}$$

19. Ans: 4 (No range)

Sol: The constant term in the characteristic equation of a matrix is equal to the determinant of a matrix

$$\therefore \det(A) = 4$$

20. Ans: (B)

$$\text{Sol: } 0.2 \ln\left(\frac{d}{r}\right) = 1 \Rightarrow \ln\left(\frac{d}{r}\right) = 5$$

$$\Rightarrow \frac{d}{r} = 148.41$$

$$\Rightarrow r = \frac{6}{148.41}$$

$$= 4.04 \text{ cm}$$

$$\text{diameter} = 2 \times 4.04 = 8.08 \text{ cm.}$$

21. Ans: (B)

Sol: For $t \geq 0^+$; KVL gives

$$E = \frac{1}{C} \int_0^t i(t) dt + (E/2)$$

$$\text{Laplace transforming, } \frac{1}{Cs} I(s) + \frac{E}{2} \frac{1}{s} = E \frac{1}{s};$$

$$\text{from which } I(s) = \frac{CE}{2}$$

$$\text{Hence } i(t) = \frac{CE}{2} \delta(t) \text{ A.}$$

22. Ans: (a)

$$\text{Sol: } \frac{\partial \omega}{\partial y} = \frac{1}{1 + \left(\frac{y}{x}\right)^2} \frac{\partial}{\partial y} \left(\frac{y}{x}\right) = \frac{x^2}{x^2 + y^2} \frac{1}{x}$$

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

$$\frac{\partial \omega}{\partial x} = \frac{1}{1 + \left(\frac{y}{x}\right)^2} \frac{\partial}{\partial x} \left(\frac{y}{x}\right) = \frac{x^2}{x^2 + y^2} \left(\frac{-y}{x^2}\right)$$

$$= \frac{-y}{x^2 + y^2}$$

23. Ans: (b)

Sol: For eigen vector, $Ax = \lambda x$

$$\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = (-2) \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$\Rightarrow x_1 + x_2 + 3x_3 = -2x_1 \rightarrow (1)$$

$$\Rightarrow x_1 + 5x_2 + x_3 = -2x_2 \rightarrow (2)$$

$$\Rightarrow 3x_1 + x_2 + x_3 = -2x_3 \rightarrow (3)$$

$$(1) \Rightarrow 3(x_1 + x_3) = -x_2 \rightarrow (4)$$

$$(2) \Rightarrow x_1 + x_3 = -7x_2 \rightarrow (5)$$

$$(3) \Rightarrow 3(x_1 + x_3) = -x_2 \rightarrow (6)$$

$$\text{From (5)} \rightarrow x_1 + x_3 - 7(3(x_1 + x_3)) = 0$$

$$\Rightarrow x_1 + x_3 = 0$$

$$\text{Suppose } x_1 = k \Rightarrow x_3 = -k$$

$$\therefore x_2 = -3(x_1 + x_3) = 0$$

$$\therefore \text{Eigen vector} \begin{bmatrix} k \\ 0 \\ -k \end{bmatrix}$$

$$\text{For } k = 1 \Rightarrow \text{eigen vector} = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$$

24. Ans: (C)

Sol: Suppose the fault involves yellow and blue phases and the ground. Taking red phase as the reference, let its phase e.m.f. be $\vec{E}_R = 1$ p.u.

$$\text{Now, } \vec{X}_1 = j 0.08 \text{ p.u.; } \vec{X}_2 = j 0.07 \text{ p.u.;$$

$$\vec{X}_0 = j 0.05 \text{ p.u.}$$

$$\text{Fault current, } \vec{I}_F = \vec{I}_Y + \vec{I}_B$$

$$= \frac{-3\vec{X}_2\vec{E}_R}{\vec{X}_1\vec{X}_2 + \vec{X}_1\vec{X}_0 + \vec{X}_2 + \vec{X}_0}$$

$$= \frac{-3 \times j0.07 \times 1}{j0.08 \times j0.07 + j0.08 \times j0.05 + j0.07 \times j0.05}$$

$$= \frac{-j 0.21}{-(56 + 40 + 35) \times 10^{-4}}$$

$$= \frac{j0.21 \times 10^4}{131} = j 16 \text{ p.u.}$$

25. Ans: (b)

Sol: Given data:

$$R_1 = 0.03 \times \frac{50}{200} = 7.5 \times 10^{-3} \text{ Hz/MW}$$

$$R_2 = 0.04 \times \frac{50}{300} = 6.667 \times 10^{-3} \text{ Hz/MW}$$

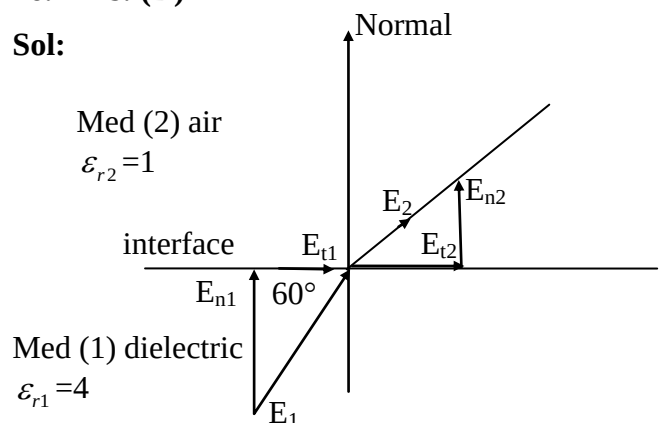
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = 283.32 \text{ MW/Hz}$$

$$\Delta f = \frac{-\Delta P_D}{D + \frac{1}{R_{eq}}} = \frac{-400}{0 + 283.32} = -1.41 \text{ Hz}$$

$$f_2 = f_1 + \Delta f = 50 - 1.41 \\ = 48.58 \text{ Hz}$$

26. Ans: (D)

Sol:



$$E_{t1} = E \cos 60^\circ = 10 \times \frac{1}{2} = 5 \text{ V/m}$$

$$E_{n1} = E \sin 60^\circ = 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3} \text{ V/m}$$

From boundary conditions

$$E_{t1} = E_{t2} \text{ \& } D_{n1} = D_{n2}$$

$$E_{t2} = E_{t1} = 5 \text{ V/m}$$

$$\epsilon_1 E_{n1} = \epsilon_2 E_{n2}$$

$$E_{n2} = \left(\frac{4}{1}\right)(5\sqrt{3})$$

$$E_{n2} = 20\sqrt{3}$$

$$E_2 = \sqrt{E_{t2}^2 + E_{n2}^2}$$

$$= \sqrt{(5)^2 + (20 \times \sqrt{3})^2}$$

$$E_2 = 35 \text{ V/m}$$

$\therefore$ The amplitude of electric field just above the surface is 35 V/m

27. Ans: 335 range (330 to 340 rpm)

Sol: Machine -1

$$400 = 40 \times 0.25 + E_1$$

$$E_1 = 390$$

$$E_1 = K_1 \times 40 \times \left(600 \times \frac{2\pi}{60} \right)$$

$$390 = K_1 \times 40 \times 20\pi$$

$$K_1 = 0.155$$

Machine -2

$$E_2 = 390 \text{ V}$$

$$E_2 = K_2 \times 40 \times \left(800 \times \frac{2\pi}{60} \right)$$

$$K_2 = \frac{390 \times 60}{32000 \times 2\pi} = 0.116$$

If the common speed is ω_m (rad/sec)

$$E_1 = K_1 \times 40 \times \omega_m$$

$$E_2 = K_2 \times 40 \times \omega_m$$

$$E_1 + E_2 = 400 - 40 \times 0.5 = 380 \text{ V}$$

$$\omega_m (40 K_1 + 40 K_2) = 380$$

$$\omega_m = \frac{380}{40(0.155) + 40(0.116)} = 35.05 \text{ rad/sec}$$

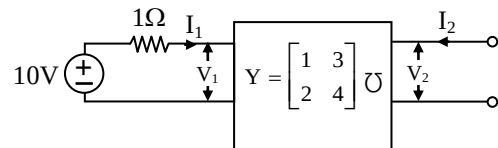
$$N = 334.7 \text{ rpm}$$

28. Ans: 25 (Range: 25 to 25)

Sol: Maximum power transferred to load resistance R_L is

$$= \frac{V_{Th}^2}{4R_{Th}}$$

Calculation of V_{Th} : (open the load resistance)



From Y-parameters

$$I_1 = V_1 + 3V_2 \dots\dots\dots(1)$$

$$I_2 = 2V_1 + 4V_2 \dots\dots\dots(2)$$

But $I_2 = 0$, so $-2V_1 = 4V_2$

$$V_1 = -2V_2 \dots\dots\dots(3)$$

And $I_1 = 10 - V_1$

From(1), $10 - V_1 = V_1 + 3V_2$

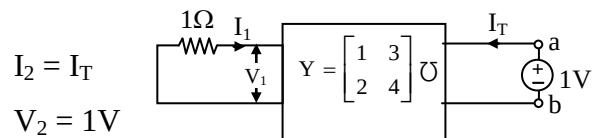
$$10 - 2V_1 = 3V_2$$

From(3), $10 - 2(-2V_2) = 3V_2$

$$V_2 = -10 \text{ V}$$

Calculation of R_{Th} : (deactivate all independent sources)

if 1V is applied across a-b then



From (1) & (2)

$$I_1 = V_1 + 3(1) \dots\dots\dots(4)$$

$$I_T = 2V_1 + 4(1) \dots\dots\dots(5)$$

But $V_1 = -I_1$, $I_1 = -V_1$

$$-V_1 = V_1 + 3$$

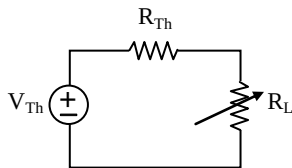
$$V_1 = \frac{-3}{2}$$

$$\text{From (5)} \quad I_T = 2 \left(\frac{-3}{2} \right) + 4$$

$$I_T = 1$$

$$R_{Th} = \frac{1}{I_T} = 1\Omega$$

$\therefore$



$$P_{\max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{100}{4 \times 1} = 25 \text{ W}$$

29. Ans: (a)

$$\begin{aligned} \text{Sol: } \frac{E(s)}{R(s)} &= \frac{1 \left\{ 1 - \left\{ \frac{2}{3} - \frac{3}{2} \right\} + \left\{ \frac{2}{3} \times \frac{-3}{2} \right\} \right\}}{1 - \left\{ \frac{2}{3} - \frac{3}{2} - 3 \right\} + \left\{ \frac{2}{3} \times \frac{-3}{2} \right\}} \\ &= \frac{1 \left\{ 1 - \frac{2}{3} + \frac{3}{2} - 2 \times 3 \times \frac{1}{2} \times \frac{1}{3} \right\}}{1 - \frac{2}{3} + \frac{3}{2} + 3 - 2 \times 3 \times \frac{1}{2} \times \frac{1}{3}} \\ &= \frac{1 + \frac{5}{6} - 1}{1 + \frac{5}{6} + 3 - 1} \\ \frac{E(s)}{R(s)} &= \frac{5}{23} \end{aligned}$$

30. Ans: 70 (No range)

$$\text{Sol: } X(e^{j\omega}) = e^{6j\omega} - 3e^{-j2\omega} + 5e^{j\omega} + 5 - 2e^{-j6\omega} - 3e^{-j4\omega}$$

Apply IDTFT

$$x(n) = \{1, 0, 0, 0, 0, 5, 5, 0, -3, 0, -3, 0, -2\}$$

$$x(4) = -3;$$

$$\sum_{n=-\infty}^{\infty} |x(n)|^2 = 1 + 25 + 25 + 9 + 9 + 4 = 50 +$$

$$18 + 5 = 73$$

$$x(4) + \sum_{n=-\infty}^{\infty} |x(n)|^2 = -3 + 73 = 70$$

31. Ans: (a)

Sol: Torque constant.

$$\phi_1 I_{a1} = \phi_2 I_{a2}$$

$$\Rightarrow I_{a2} = I_{a1} \cdot \frac{\phi_1}{\phi_2} = I_{a1} \cdot x$$

$$E_{b1} = 220 - 40 \times 0.5 = 200$$

$$E_{b2} = 200 - 40x \times 0.5$$

$$N \propto \frac{E_b}{\phi}$$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}} \times \frac{\phi_1}{\phi_2}$$

$$\Rightarrow \frac{220 - 20x}{200} \times x = 1.5$$

$$x = 9.4 \text{ or } 1.6$$

Prefer low value

$$\left[\begin{aligned} \therefore \frac{\phi_1}{\phi_2} &= \frac{1}{9.4} \\ \frac{\phi_1 - \phi_2}{\phi_1} &= \frac{8.4}{9.4} \Rightarrow \text{high reduction so not used} \end{aligned} \right]$$

$$\therefore \frac{\phi_2}{\phi_1} = \frac{1}{1.6}$$

$$\frac{\phi_1 - \phi_2}{\phi_1} = 37.5\%$$

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and many more...

TOTAL SELECTIONS in Top 10: 33

(**EE: 9, E&T: 8, ME: 9, CE: 7**) and many more...



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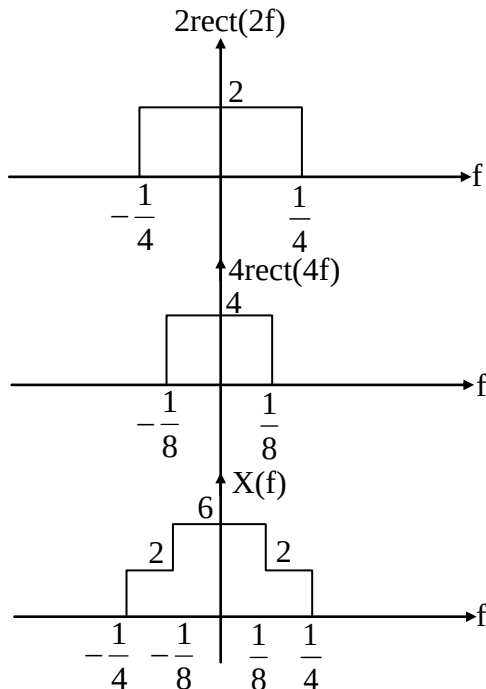
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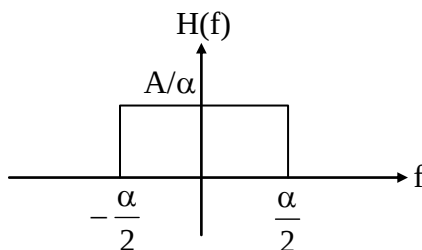
32. Ans: 1**Sol:** $\text{Sinc}(t) \leftrightarrow \text{rect}(f)$

$$\text{Sinc}(t/2) \leftrightarrow 2 \text{rect}(2f)$$

$$\text{Sinc}(t/4) \leftrightarrow 4 \text{rect}(4f)$$

Given $h(t) = A \text{Sinc}(\alpha t)$

$$H(f) = \frac{A}{\alpha} \text{rect}\left(\frac{f}{\alpha}\right)$$

 $Y(f) = X(f) \cdot H(f) = X(f)$ only when

$$\frac{-\alpha}{2} = \frac{-1}{4} \Rightarrow \alpha = \frac{1}{2}$$

$$\frac{A}{\alpha} = 1 \Rightarrow A = \alpha = \frac{1}{2}$$

$$A + \alpha = 1$$

33. Ans:(a)**Sol:** For full digit we require 7 segment

$$\text{So, } I_f = 10\text{mA} \times 7 = 70\text{mA}$$

For half digit we require 2 segment

$$\text{So, current for one half digit, } I_h = 2 \times 10\text{mA} = 20\text{mA}$$

Now for full operation,

$$I_{\text{total}} = 20\text{mA} + 3(70\text{mA}) = 230\text{mA} = 0.23\text{A}$$

34. Ans: (D)**35. Ans: 45°**

$$\text{Sol: } \left| \frac{(50)\sqrt{50}}{(j\omega_{gc} + 5)^3} \right| = 1$$

$$\left(\sqrt{\omega_{gc}^2 + 5^2} \right)^3 = 50\sqrt{50}$$

$$\omega_{gc} = 5 \text{ rad/sec}$$

$$\text{PM} = 180^\circ + \angle G(j\omega_{gc})H(j\omega_{gc})$$

$$= 180^\circ - 3 \tan^{-1} \frac{\omega_{gc}}{5} = 180 - 135 = 45^\circ$$

36. Ans: (b)**Sol:** line equation of AB is,

$$\text{Here } A = (1, 1) \quad B = (3, 2)$$

$$y - 1 = \frac{1}{2}(x - 1) \Rightarrow y = \frac{x+1}{2}$$

$$dy = \frac{dx}{2}$$

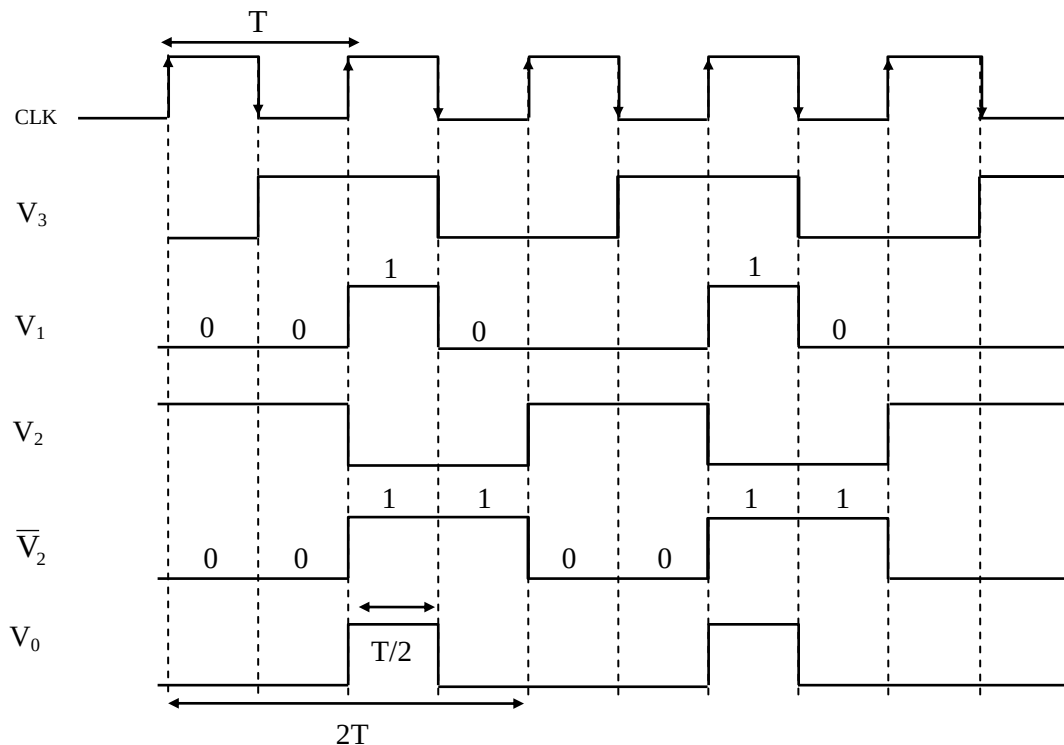
$$\therefore \int_C \text{Re } z \, dz = \int_1^3 x(dx + idy)$$

$$= \int_1^3 x \left(dx + i \frac{dx}{2} \right) = \left(1 + \frac{i}{2} \right) \left[\frac{x^2}{2} \right]_1^3$$

$$= 4 + 2i$$

37. Ans: 25 (no range)

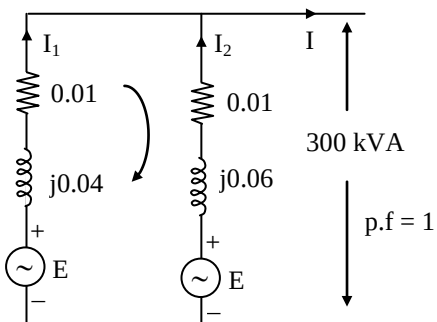
Sol:



$$\text{Duty cycle} = \frac{\frac{T}{2}}{T} \times 100 = 50\%$$

38. Ans: (c)

Sol:



Let us assume, common base kVA = 200 kVA

$$I_1 + I_2 = I$$

Apply KVL in a loop

$$E_1 - I_1 Z_1 = E_2 - I_2 Z_2$$

$$\Rightarrow I_1 Z_1 = I_2 Z_2$$

$$I_1 Z_1 = (I - I_1) Z_2$$

$$Z_1 = 0.02 + j 0.08$$

$$Z_2 = 0.01 + j 0.06$$

$$I_1 = \frac{I Z_2}{Z_1 + Z_2}$$

$$S_1 = S \left(\frac{0.01 + j0.06}{0.03 + j0.14} \right) = 300 \times 0.424 \angle 2.63$$

$$S_1 = 127.45 \text{ kVA, p.f} = 0.9989 \text{ lead}$$

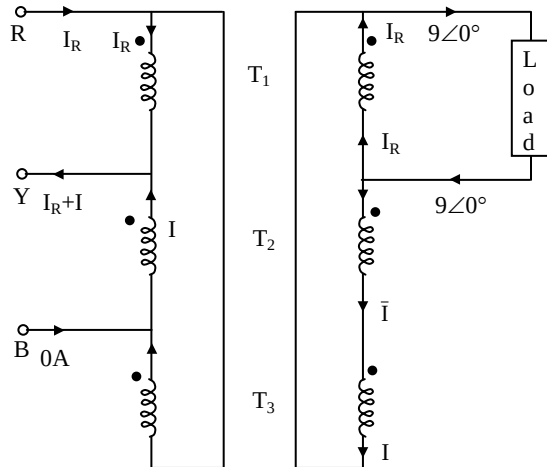
$$S_2 = S \frac{Z_1}{Z_1 + Z_2} = 300 \times \left(\frac{0.02 + j0.08}{0.03 + j0.14} \right)$$

$$S_2 = 172.68 \text{ kVA, } 0.9994 \text{ lag}$$

39. Ans: (d)

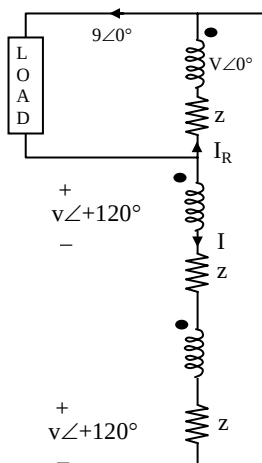
Sol: consider transformer is Ideal. (does not specify any impedances). The currents can be as shown in figure below.

Currents in all windings & lines are shown turns ratio is equal to 1 is assumed.



From the diagram, $\bar{I} + \bar{I}_R = 9\angle 0^\circ$.

The secondary side is drawn in below figure.



$$I + I_R = 9\angle 0^\circ \text{ ----- (1)}$$

Apply kVL:

$$V\angle 0^\circ + V\angle -120^\circ + V\angle 120^\circ - \bar{I}_R Z + \bar{I}(2Z) = 0$$

$$\Rightarrow 2\bar{I} - \bar{I}_R = 0$$

$$\Rightarrow \bar{I}_R = 2\bar{I}$$

From (1),

$$I = \frac{9}{3}\angle 0^\circ = 3\angle 0^\circ \text{ A}$$

40. Ans: (D)

$$\text{Sol: } \rightarrow (A) = \times \times H \oplus \times \times H = 00H$$

$$\rightarrow (HL) = 4000H$$

$$\rightarrow (SP) = 3000H$$

$$\rightarrow (A) = 35 H$$

$$\rightarrow (M) = (4000H) = 36H$$

$$\rightarrow (A) = 35H = 0011 \ 0101$$

$$(M) = 36H = 0011 \ 0110$$

$$(A) = 6BH = 0110 \ 1011$$

$$CY = 0, P = 0, AC = 0, Z = 0, S = 0$$

→ Decimal Adjust Accumulator

06H is added to lower digit since it is > 9

$$(A) = 6BH = 0110 \ 1011$$

$$= 06H = 0000 \ 0110$$

$$(A) = 71H = 0111 \ 0001$$

$$CY = 0, P = 1, AC = 1, Z = 0, S = 0$$

$$(PSW) = 0111 \ 0001 \ 0001 \ 0100 = 7114H$$

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AMAN GULIA CE



KUMAR PIYANK EE



VISHU CHANDRA CE



RTESH LALWAN EE



PURNIMA ME



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ANSHU SHARMA EE



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SUMIT SHANDOO PE

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41. Ans: (A)

Sol: Load kVA = $\frac{50}{100} = 0.5$ pu

Load voltage = $\frac{11}{12} = 0.917$ pu

Load current (I_1) =

$$\frac{0.5}{0.917} \angle -36.86^\circ = 0.545 \angle -36.86^\circ \text{ pu}$$

Base current $I = \frac{100}{\sqrt{3} \times 12} = 4.81$ kA

Generator reactance $X_g = 0.35 \times \frac{100}{60} = 0.583$

Line reactance $X_l = 12 \times \frac{100}{(66)^2} = 0.275$

$$X_{T1} = X_{T2} = 0.1 \text{ p.u.}$$

Thevenin voltage at F before fault

$$V_{TH} = 0.917 \angle 0^\circ$$

Current through breaker A due to fault

$$I_{fA} = \frac{V_{th}}{j(X_g + X_{t1} + X_\ell)}$$

$$= \frac{0.917}{j(0.583 + 0.1 + 0.275)} = 0.957 \angle -90^\circ$$

Post fault current through breaker A

$$I_{fp} = I_1 + I_{fA} = 0.957 \angle -90^\circ + 0.545 \angle -36.9^\circ$$

$$= 0.436 - j1.284 = 1.356 \text{ pu}$$

or, $I_{fp} = 1.356 \times 4.81 = 6.522$ kA

42. Ans: (c)

Sol: To obtain the loop gain, we break the positive feedback at the positive input terminal of the op-amp where the input

impedance is infinite, apply an input voltage V_i , and find its output voltage, V_0

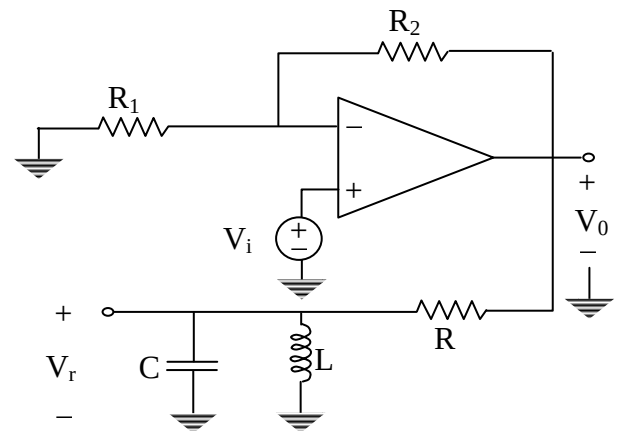


Fig. Breaking the feedback loop at the input of the op-amp

$$A(s) = \frac{V_0}{V_i} = 1 + \frac{R_2}{R_1}$$

$$\beta(s) = \frac{V_r}{V_0} = \frac{s \frac{1}{CR}}{s^2 + s \frac{1}{CR} + \frac{1}{LC}}$$

$$A(s)\beta(s) = \frac{s \frac{1}{CR} \left(1 + \frac{R_2}{R_1}\right)}{s^2 + s \frac{1}{CR} + \frac{1}{LC}}$$

$$A(j\omega)\beta(j\omega) = \frac{j \frac{\omega}{CR} \left(1 + \frac{R_2}{R_1}\right)}{\left(-\omega^2 + \frac{1}{LC}\right) + j \frac{\omega}{CR}}$$

From this expression, we see that the phase angle of $A(j\omega) \beta(j\omega)$ will be zero at the value of ω that makes the real part of denominator zero,

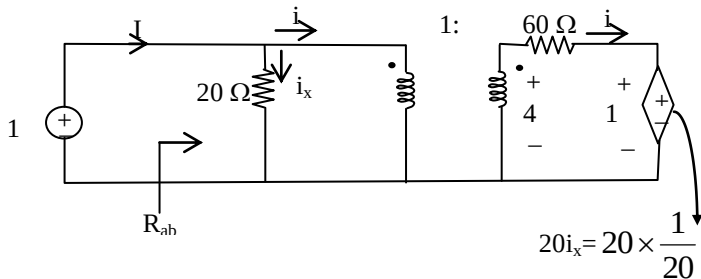
$$\omega_0 = \frac{1}{\sqrt{LC}}$$

At this frequency, the magnitude of the loop gain is given by

$$|A(j\omega_0)\beta(j\omega_0)| = 1 + \frac{R_2}{R_1} = 1 + \frac{10k}{1k} = 11$$

43 Ans: (C)

Sol:



$$i_x = 1/20$$

$$i_2 = \frac{4-1}{60} = \frac{3}{60} = \frac{1}{20}$$

$$\frac{i_1}{i_2} = 4 \Rightarrow i_1 = \frac{4}{20}$$

$$I = \frac{1}{20} + \frac{4}{20} = \frac{1}{4}$$

$$R_{ab} = 4 \Omega$$

44. Ans: (C)

Sol: Average power loss = $\frac{1}{T} \int_0^{t_1} vi dt$

$$i = -I + \frac{I}{t_1} t$$

$$v = -V + \frac{V}{t_1} t$$

$$vi = \left(-I + \frac{I}{t_1} t\right) \left(-V + \frac{V}{t_1} t\right) = VI - VI \frac{t}{t_1} - VI \frac{t}{t_1} + VI \frac{t^2}{t_1^2}$$

$$P_{av} = \frac{1}{T} \int_0^{t_1} \left(VI - 2VI \frac{t}{t_1} + VI \frac{t^2}{t_1^2} \right) dt$$

$$= \frac{VI}{T} \left[t - \frac{t^2}{2} \cdot \frac{2}{t_1} + \frac{t^3}{3} \cdot \frac{1}{t_1^2} \right]_0^{t_1}$$

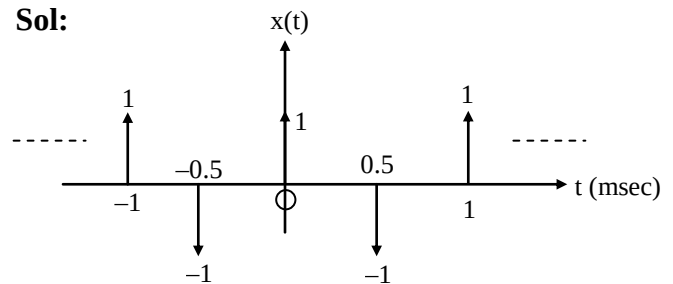
$$= \frac{VI}{T} \left[t_1 - \frac{t_1^2}{t_1} + \frac{t_1^3}{3} \cdot \frac{1}{t_1^2} \right] = \frac{VI}{T} \left[t_1 - t_1 + \frac{t_1}{3} \right]$$

$$P_{av} = \frac{VI}{T} \cdot \frac{t_1}{3} = \frac{1}{3} VI f t_1$$

$$P_{av} = \frac{1}{3} VI f t_1$$

45. Ans: (c)

Sol:



$$C_n = \frac{1}{T_0} \int_0^{T_0} x(t) e^{-jn\omega_0 t} dt$$

$$C_n = \frac{1}{1 \times 10^{-3}} \left[\int_0^{0.5 \times 10^{-3}} x(t) e^{-jn\omega_0 t} dt + \int_{0.5 \times 10^{-3}}^{1 \times 10^{-3}} x(t) e^{-jn\omega_0 t} dt \right]$$

$$C_n = 10^3 \left[1 - e^{-jn\omega_0 (0.5 \times 10^{-3})} \right]$$

$$C_n = 10^3 \left[1 - e^{-jn \left(\frac{2\pi}{1 \times 10^{-3}} \right) (0.5 \times 10^{-3})} \right]$$

$$C_n = 10^3 \left[1 - e^{-jn\pi} \right] = 1000 \left[1 - (-1)^n \right]$$

Fourier transform of periodic signal is $X(\omega)$

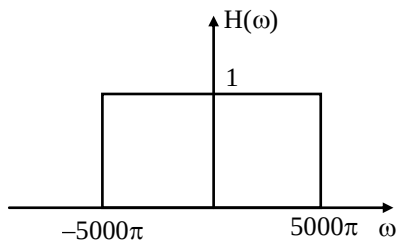
$$= 2\pi \sum_{n=-\infty}^{\infty} C_n \delta(\omega - n\omega_s)$$

$$X(\omega) = 2000\pi \sum_{n=-\infty}^{\infty} \left[1 - (-1)^n \right] \delta(\omega - 2000n\pi)$$

$$X(\omega) = 2000\pi[\dots 2\delta(\omega+2000\pi) + 2\delta(\omega-2000\pi) + \dots]$$

$$X(\omega) = 4000\pi[\delta(\omega+2000\pi) + \delta(\omega-2000\pi) + \dots]$$

$$X(\omega) = 4000[\cos(2000\pi t) + \cos(6000\pi t) + \dots]$$



The output of low pass filter is $y(t) = 4000 \cos(2000\pi t)$

46. Ans: 3.73, (Range 3.4 to 3.9)

Sol: P.F = 0.707

$$\phi = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^\circ$$

Power consumed by load = 5 kW

$$W_1 = V_L I_L \cos(30^\circ - \phi)$$

$$W_2 = V_L I_L \cos(30^\circ + \phi)$$

$$P_T = \sqrt{3} V_L I_L \cos \phi = 5000$$

$$V_L I_L = \frac{5K}{\sqrt{3} \times 0.707} = 4083.099$$

$$W_1 = 4083.099 \cos(30^\circ - 45^\circ) = 3.94 \text{ kW}$$

$$W_2 = 4083.099 \cos(30^\circ + 45^\circ) = 1.056 \text{ kW}$$

$$\frac{W_1}{W_2} = \frac{3.94}{1.056} = 3.73$$

47. Ans: (c)

Sol: Given $v = y + e^{-x} \cos y$

$$\Rightarrow v_x = -e^{-x} \cos(y) \quad \text{and}$$

$$v_y = 1 - e^{-x} \sin(y)$$

Consider $du = (u_x) dx + (u_y) dy$

$$= (v_y) dx + (-v_x) dy$$

$$\Rightarrow du = (1 - e^{-x} \sin y) dx + (e^{-x} \cos y) dy$$

$$\Rightarrow \int du = \int (1 - e^{-x} \sin y) dx + \int 0 dy + k$$

$$\Rightarrow u = x + e^{-x} \sin y + k$$

Now, the required analytic function $f(z)$ is given by $f(z) = u + iv$

$$\Rightarrow f(z) = (x + e^{-x} \sin y + k)$$

$$+ i(y + e^{-x} \cos y)$$

$$\therefore f(z) = z + ie^{-z} + k$$

48. Ans: (b)

Sol: Low voltage side of the main transformers windings are connected in delta.

$\therefore$ Voltage per phase = (line voltage) = 11,000V.

Current transformers on low voltage side are connected in star and the ratio is 250/5. Hence, 5A current will flow through the pilot and hence the primary side (HV) CT secondary current will be $\left(\frac{5}{\sqrt{3}}\right)$ amps.

On the high voltage side of the transformer, the main windings are connected in star.

$$\therefore \text{Phase voltage} = \frac{66,000}{\sqrt{3}} = 38105.25 \text{ V.}$$

The ratio of the main transformer

$$= \frac{38106.25}{11,000} = 3.46.$$

$$\therefore \text{Primary line current, } I_1 = \frac{I_2}{(3.46 \times \sqrt{3})}$$

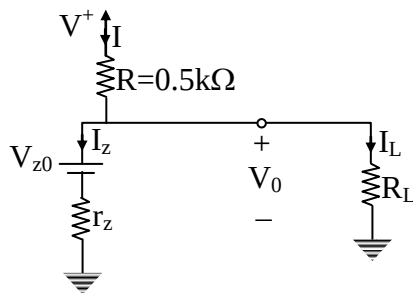
If $I_2 = 250 \text{ A}$, $I_1 = \frac{250}{3.46 \times \sqrt{3}}$

High voltage side current transformer ratio

i.e., the ratio is $= \frac{250}{3.46\sqrt{3}} : \frac{5}{\sqrt{3}} = 72.25 : 5$

49. Ans: 6.83V (6.75 to 6.9)

Sol:



$$V_z = V_{z0} + r_z I_z$$

$$6.8 = V_{z0} + (20\Omega \times 5\text{mA})$$

$$\Rightarrow V_{z0} = 6.7\text{V} \quad (1)$$

With no load connected, the current through the zener is given by

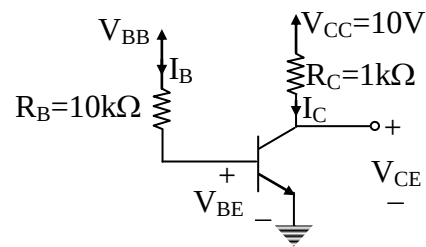
$$I_z = I = \frac{V^+ - V_{z0}}{R + r_z} = \frac{10 - 6.7}{0.5\text{k} + 0.02\text{k}}$$

$$I_z = 6.35\text{mA} \quad (2)$$

$$\begin{aligned} \rightarrow V_0 = V_{z0} + I_z r_z &= 6.7 + (6.35 \times 0.02) \\ &= 6.83\text{V} \end{aligned}$$

50. Ans: (d)

Sol:



i) Operating at the edge of saturation is obtained with $V_{CE} = 0.3\text{V}$. Thus

$$I_C = \frac{10 - 0.3}{1\text{k}\Omega} = 9.7\text{mA}$$

Since, at the edge of saturation, I_C and I_B are still related by β ,

$$I_B = \frac{9.7\text{mA}}{50} = 0.194\text{mA}$$

$$V_{BB} = (0.194 \times 10) + 0.7 = 2.64\text{V}$$

ii) To operate deep in saturation,

$$V_{CE} = V_{CEsat} \approx 0.2\text{V}$$

$$I_C = \frac{10 - 0.2}{1\text{k}\Omega} = 9.8\text{mA}$$

$$I_B = \frac{I_C}{\beta_{\text{forced}}} = \frac{9.8}{10} = 0.98\text{mA}$$

$$V_{BB} = (0.98 \times 10) + 0.7 = 10.5\text{V}$$

51. Ans: (C)

Sol: $s \omega(s) = -\omega(s) + i_a(s)$

$$\Rightarrow \omega(s) [s+1] = i_a(s) \Rightarrow \omega(s) = \frac{i_a(s)}{s+1} \quad \dots\dots (1)$$

$$s i_a(s) = -\omega(s) - 10 i_a(s) + 10 U(s)$$

$$i_a(s) [s+10] + \omega(s) = 10 U(s)$$

$$i_a(s) \left[s+10 + \frac{1}{s+1} \right] = 10 U(s) \quad [\because \text{eq (1)}]$$

$$\Rightarrow \frac{i_a(s)}{U(s)} = \frac{10(s+1)}{s^2 + 11s + 11}$$

52. Ans: 71.56° (70° to 73°)

$$\text{Sol: } \frac{30\angle 0^\circ + \bar{V}_{NS}}{-j30} + \frac{30\angle -120^\circ + \bar{V}_{NS}}{30} + \frac{30\angle 120^\circ + \bar{V}_{NS}}{30} = 0$$

$$\bar{V}_{NS} \left[\frac{1}{15} + j\frac{1}{30} \right] = -30[1\angle -120^\circ + 1\angle 120^\circ + j1]$$

$$= -30[-1\angle 0^\circ + j1] = 1 - j1$$

$$\bar{V}_{NS} = \frac{30(1-j1)}{\frac{1}{15} + j\frac{1}{30}} \quad \angle \bar{V}_{NS} = -45^\circ - \tan^{-1} \frac{1}{2} = 71.56^\circ$$

53. Ans: (C)

$$\text{Sol: } \Rightarrow V_0 = DV_s \quad K_{cr} = (1-D) = 0.5$$

$$K = \frac{2FL}{R} \quad 50 = D \times 100$$

$$D = 0.5 \quad \text{for } D_{cc}, K < K_{cr}$$

$$L_c = \frac{0.5 \times 10}{2 \times 2K} = 1.25 \text{ mH}$$

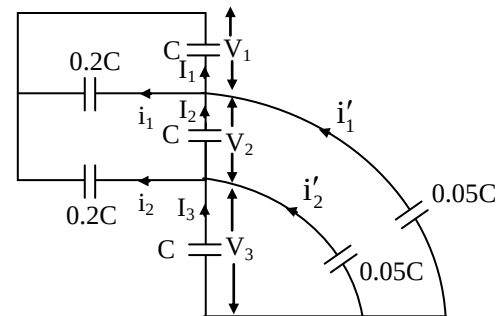
$$\frac{2fL}{R} < (1-D)$$

$$\frac{2 \times 2000 \times L}{10} < 0.5$$

$$L < 1.25 \text{ mH.}$$

54. Ans: 82.07 (Range: 81 to 83)

Sol:



$$I_2 = I_1 + i_1 - i'_1$$

$$V_2 \omega C = V_1 \omega C + V_1 \omega (0.2C) - (V_3 + V_2) 0.05C$$

$$V_2 = V_1 + 0.2V_1 - 0.05V_3 - 0.05V_2$$

$$1.05V_2 = 1.2V_1 - 0.05V_3 \dots\dots\dots (1)$$

$$\text{Similarly } I_3 = I_2 + i_2 - i'_2$$

$$V_3 \omega C = V_2 \omega C + (V_1 + V_2) (0.2C) - V_3 (0.05C)$$

$$V_3 = V_2 + 0.2V_1 + 0.2V_2 - 0.05V_3$$

$$1.05V_3 = 0.2V_1 + 1.2V_2 \dots\dots\dots (2)$$

$$21(0.05V_3 = 1.2V_1 - 1.05V_2)$$

$$1.05V_3 = 25.2V_1 - 22.05V_2$$

$$1.05V_3 = 0.2V_1 + 1.2V_2$$

$$1.05V_3 = 25.2V_1 - 22.05V_2$$

$$25V_1 = 23.25V_2$$

$$V_2 = 1.075V_1$$

$$V_3 = 1.419V_1$$

String efficiency

$$= \frac{V_1 + V_2 + V_3}{3V_3} = \frac{V_1 + 1.075V_1 + 1.419V_1}{3 \times 1.419V_1}$$

$$= 82.07\%$$

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55. Ans: 13.85 (Range: 13 to 14)

Sol: Data given : A Y – connected alternator

$$V_L = 400\text{V}, f = 50\text{Hz}, P = 4$$

Open circuit test :

$$V_{oc} = 400 \text{ V (rms – line to line)}$$

$$\text{at } I_f = 2.5\text{A}$$

Short circuit test :

$$I_{sc} = 10\text{A (rms – phase current)}$$

$$I_f = 1.5\text{A}$$

The synchronous impedance,

$$Z_s = \frac{\text{O.C. voltage}}{\text{S.C. current}}$$

Field current is same both for o.c voltage & s.c current .

$$\text{At } I_f = 1.5 \text{ A} \Rightarrow I_{sc} = 10 \text{ A}$$

$$\text{At } I_f = 2.5 \text{ A} \Rightarrow I_{sc} = \frac{10 \times 2.5}{1.5} = 16.67 \text{ A}$$

$\therefore$ SCC is linear

Synchronous Impedance / phase at rated voltage is

$$Z_s = \frac{E_{oc}}{I_{sc}}$$

$$I_f \text{ is at } E_{oc} = V_{\text{rated}} \text{ i.e., } I_f = 2.5 \text{ A}$$

$$\therefore Z_s = \frac{400 / \sqrt{3}}{16.67} = 13.85 \Omega$$