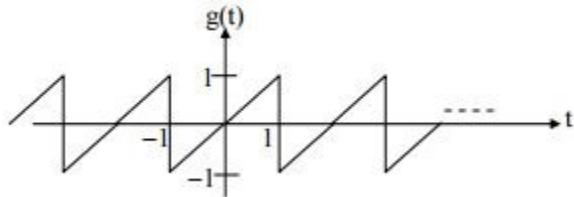


1. Ans. A.

Given

$$\begin{cases} t - \lfloor t \rfloor, & t \geq 0 \\ t - \lceil t \rceil, & \text{otherwise} \end{cases}$$

If we plot the above signal, we get

The above signal shows odd symmetry, so calculate b_n ?

$$T = 2 \Rightarrow \omega_0 = \pi$$

$$b_n = \frac{2}{T} \int_0^T g(t) \sin \omega_0 t dt = \frac{4}{T} \int_0^{T/2} g(t) \sin \omega_0 t dt$$

$$= \frac{4}{2} \int_0^1 t \sin \pi t dt$$

$$= 2 \left[\frac{-t \cos n\pi t}{n\pi} + \frac{\sin(n\pi t)}{(n\pi)^2} \right]_0^1$$

$$= 2 \left[\frac{-\cos n\pi}{n\pi} \right] = \frac{-2(-1)^n}{\pi n}$$

Coefficient of II harmonic is

$$b_2 = \frac{-2}{2\pi} = \frac{-1}{\pi} = -0.3183$$

2. Ans. A.

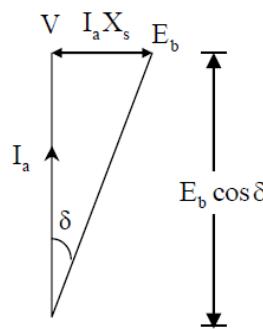
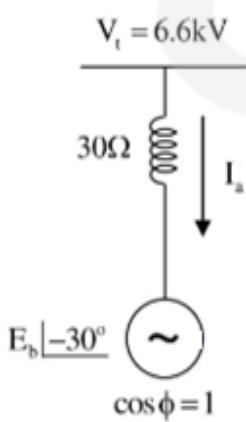
$$P_{\text{instantaneous}} = V_a i_a + V_b i_b$$

$$= 2200 \sin(100\pi t) 10 \sin(100\pi t) + 2200 \cos(100\pi t) 10 \cos(100\pi t)$$

$$= 2200 \sin^2(100\pi t) + 2200 \cos^2(100\pi t) W$$

$$= 2200 W$$

3. Ans. A.



$$E_b \cos \delta = V$$

$$E_b = \frac{V}{\cos \delta} = \frac{6600 / \sqrt{3}}{\cos 30^\circ}$$

$$E_b = 4400 \text{ volts}$$

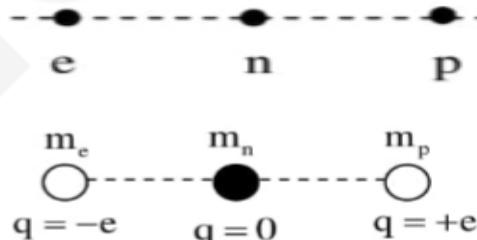
$$P = 3 \cdot \frac{E_b \cdot V}{X_s} \sin \delta = 3 \cdot \frac{4400 \times 3810.51}{30} = \sin 30^\circ$$

$$P = 838.31 \text{ KW}$$

4. Ans. D.

$$\lim_{z \rightarrow i} \frac{z^2 + 1}{z^3 + 2z - iz^2 + 2} = \lim_{z \rightarrow i} \frac{z + 1}{z^2 + 2} = \frac{2i}{-1+2} = 2i$$

5. Ans. D.



The Gravitational force of alteration between any two particles shown above is made much negligible when compared to columbic force of alteration between electron and proton. Force of alteration

$$F = \frac{-e^2}{4\pi \epsilon_0 r^2}, \text{ acceleration } q = \frac{F}{M}; q_e \gg q_p \quad \text{Due to this}$$

force, the electron as well as the proton will move towards each other since $m_e \ll M$, the speed and acceleration of the electron will be much greater than that of proton. This causes electron to collide with the neutron faster when compared to proton.

6. Ans. A.

$$z(t) = x(t) * Y(t) \\ \Rightarrow z(s) = x(s) \cdot y(s)$$

Converting into Laplace transform and applying time scaling property.

$$z(ct) \leftrightarrow \frac{1}{c} z(s/c)$$

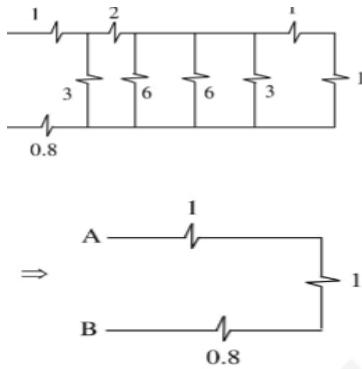
$$\begin{aligned}
 &= \frac{1}{c} \times (s/c) y(s/c) \\
 &= c \frac{1}{c} \times (s/c) \frac{1}{c} y(s/c) \\
 z(ct) &= c \cdot x(ct) * y(ct)
 \end{aligned}$$

7. Ans. B.

$$\begin{aligned}
 Y_{11} &= y_{10} + y_{12} + y_{13} = -j12 = -(jq^1 + jr^1) \\
 \therefore q^1 + r^1 &= +12 \\
 Y_{22} &= -j15 = y_{20} + y_{21} + y_{23} = -(jq^1 + jp^1) \\
 \therefore p^1 + q^1 &= +15 \\
 Y_{33} &= -j7 = Y_{30} + y_{31} + y_{32} = -(jq^1 + jp^1) \\
 \therefore p^1 + r^1 &= +7 \\
 p^1 &= +5, q^1 = +10, r^1 = +2 \text{ (admittances)} \\
 P &= +0.2 = +0.1, R = +0.5 \text{ (reactance's)}
 \end{aligned}$$

8. Ans. A.

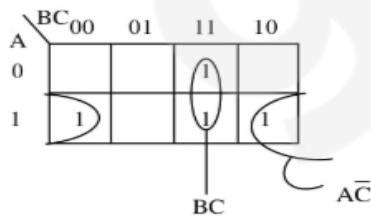
The Ckt will become



$$R_{AB} = 1 + 1.2 + 0.8 = 3\Omega$$

9. Ans. A.

$$AB + \bar{A}\bar{C} + BC$$


 $\Rightarrow BC + A\bar{C}$

10. Ans. A.

$$P = VI \cos \phi$$

$$\cos \phi = \frac{P}{V \cdot I} = \frac{555 \pm 2\%}{(220 \pm 1\%)(5 \pm 1\%)} = \frac{555 \pm 2\%}{1100 \pm 2\%} = 0.504 \pm 4\%$$

11. Ans. D.

$$\frac{V_o(s)}{V_i(s)} = \frac{1-s}{1+s} = H(s)$$

$$H(\omega) = 1 - 2 \tan^{-1} \omega, \text{ if } \omega = 0, f = 0 \\ \text{if } \omega = \infty, f = -\pi$$

$$V_0(t) = V_{\sin} (\omega t - 2 \tan^{-1}(\omega))$$

12. Ans. C.

By the properties of Eigen values and Eigen vectors,

another eigen vector of A is $\begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$ The eigen vectors

corresponding to distinct eigen values of a real symmetric matrix are orthogonal i.e., pair wise dot product is zero.

13. Ans. D.

MOSFET → Majority carrier device (NMOS, PMOS)
 Diode → both majority & minority carrier device
 Transistor, pnp
 IGBT → input is MOSFET, Output is BJT

14. Ans. B.

$$PM = 180 + \angle DG_{\omega=\omega_{gc}}$$

$$G(s) = \frac{Ke^{-s}}{s}$$

$$\text{For } \omega_{gc} \Rightarrow |G(s)| \Rightarrow \frac{K}{\omega} = 1$$

$$\omega_{gc} = K \Rightarrow \angle G(s) = -\omega \times \frac{180}{\pi} - 90^\circ$$

$$30^\circ = 180^\circ - K \times \frac{180}{\pi} - 90^\circ$$

$$K \frac{180}{\pi} = 60 \Rightarrow K = \frac{\pi}{3} = 1.047$$

15. Ans. A.

Flux always chooses less reluctance path. So flux tried to flow inside the conductor and closer to the axis of the cylinder.

16. Ans. A.

$$\iint_R xy^2 dx dy = \iint_{R_1} xy^2 dx dy + \iint_{R^2} xy^2 dx dy$$

$$\int_{x=1}^5 \int_{y=0}^2 xy^2 dx dy + \int_{x=1}^5 \int_{y=2}^{2x} xy^2 dx = \left(\frac{x^2}{2} \right)_1^5 \left(\frac{y^3}{3} \right)_0^2$$

$$+ \int_1^5 x \left(\frac{y^3}{3} \right)_2^{2x} dx$$

$$\begin{aligned}
 &= (12) \left(\frac{8}{3} \right) + \frac{1}{3} \int_1^5 x(8x^3 - 8) dx = 32 + \frac{1}{3} \left[8 \left(\frac{x^5}{2} \right)_1^5 - 8 \left(\frac{x^5}{2} \right)_1^5 \right] \\
 &= 32 + \frac{1}{3} \left(\frac{24992}{5} \right) - 32 = \frac{24992}{15}
 \end{aligned}$$

OR

$$\begin{aligned}
 \iint_R xy^2 dxdy &= \int_{x=1}^5 \left(\int_{y=0}^{2x} xy^2 dy \right) dx \\
 &= \int_1^5 x \left(\frac{y^3}{3} \right)_{y=0}^{2x} dx = \frac{8}{3} \int_1^5 x(x^3) dx \\
 &= \frac{8}{3} \left(\frac{x^5}{5} \right)_1^5 = \frac{5}{15} (3124) = \frac{24992}{15} \\
 \therefore C \iint_R xy^2 dxdy &= \frac{24992}{15} \times 10^4 \times 6 = \frac{2}{5} \times 2.4992 = 0.9968 \approx
 \end{aligned}$$

17. Ans. D.

$$\text{Given } y[n] = (1 + (-1)^n)x[n]$$

For time invariance

$$y'[n] = (1 + (-1)^n)x(n - n_0) \rightarrow (1)$$

$$y(n - n_0) = (1 + (-1)^{n-n_0})x(n - n_0) \rightarrow (2)$$

Since (1) is not equal to (2)

System is time variant

For inverse system

For each unique $x[n]$, there should be unique $y[n]$

if

$$x[n] = \delta[n-1]$$

$$y[n] = [1 + (-1)^n]\delta[n-1]$$

$$\Rightarrow y[1] = 0$$

$$x[n] \neq \delta[n-1]$$

$$y[n] = [1 + (-1)^n]2\delta(n-1)$$

$$y(1) = 0$$

For two different inputs, we have same output. Thus, one to one mapping is not possible. Hence the systems are non-invertible

18. Ans. A.

The delay line should be inverted in VDP (Y-channel) only.

19. Ans. A.

$$V_{dc} = 600V$$

$$R_L = 20\Omega/\text{ph}$$

$$\text{RMS value of phase voltage } (V_p) = 0.4082V_{dc} = 244.92V$$

$$\text{Load power} = \frac{3V_{ph}^2}{R} = \frac{3 \times 244.92^2}{20} = 8.99\text{kW}$$

20. Ans. D.

$$\text{Given } CE = s^3 + ks^2 + (k+2)s + 3 = 0$$

For stable

$$k(k+2) > 3$$

$$k^2 + 2k - 3 > 0$$

$$(k-1)(k+3) > 0$$

$$k > -1 \cap k > -3$$

$$k > 1$$

(OR)

$$\begin{array}{ccc}
 s^3 & 1 & k+2 \\
 s^2 & k & 3 \\
 s & \frac{k(k+2)}{k} - 3 & 0 \\
 s^0 & 3
 \end{array}$$

$$k > 0 \cap (k+3)(k-1) > 0$$

$$k > 0 \cap k > 1 \cap k > 3 \Rightarrow k > 1$$

21. Ans. C.

$$N_s = \frac{120 \times 60}{4} = 1800 \text{ rpm}$$

Rotor speed should be greater than syn. speed, to inductance generator mode

$$S = \frac{N_r - N_s}{N_s} \quad \left[f_r = sf \Rightarrow s = \frac{f_r}{f} = \frac{5}{60} = \frac{1}{12} \right]$$

$$\Rightarrow N_r = N_s(1+S)$$

$$N_r = 1800 \left(1 + \frac{1}{12} \right) = 1950$$

22. Ans. B.

$$\text{For half wave Rectifier } V_{dc} = \frac{V_m}{\pi}$$

$$V_1 = V_{dc} \text{ for +ve pulse}$$

$$+V_{dc} \text{ for -ve pulse} = \frac{\pi}{2\pi} + \left(\frac{-\pi}{\pi} \right) = \frac{1}{2} - 1 = -0.5V$$

$$V_2 = \left(\frac{\pi}{2\pi} \right) + 0 = 0.5V$$

23. Ans. A.

Total no of buses=10

Given G_1 =slack bus, G_2 =generator/PQ bus

$\therefore G_3, G_4$ are PV buses

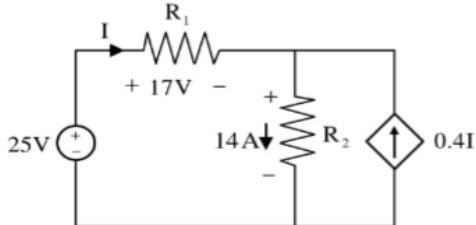
PQ buses $\rightarrow L_1, L_2, L_4, L_5$ (4)

Voltage controlled PV buses $\rightarrow L_3, L_4$ (2)

Minimum no of nonlinear equation to be solved =
 $2 \times 10 - 2 - 4 = 14$

24. Ans. A.

KCL



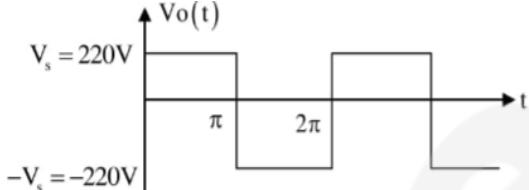
$$I + 0.4I = 14$$

$$\Rightarrow 1.4I = 14$$

$$\Rightarrow I = 10\text{A}$$

The power supplied by 25 V = $25 \times 10 = 250\text{W}$

25. Ans. A.



$$V_o(t) = \frac{4V_s}{\pi} \left[\sin \omega t + \frac{1}{3} \sin 3\omega t + \frac{1}{5} \sin 5\omega t \right]$$

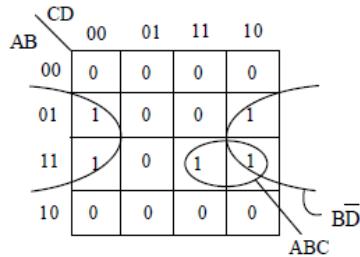
$$= \sum_{n=1,3,5}^{\infty} \frac{4V_s}{n\pi} \sin(n\omega t)$$

$$V_{on} = \frac{4}{\sqrt{2}} \frac{V_s}{n\pi}$$

$$V_{ol} = \frac{4}{\sqrt{2}} \times \frac{V_s}{n\pi} = 0.9V_s$$

$$= 0.9 \times 220 = 198.069\text{V}$$

26. Ans. D.



27. Ans. A.

$$E_{b1} = 220 - 30(0.5) = 205\text{volts}$$

$$E_{b2} = 220 - I_{a2}(0.5 + R_x)$$

Given $T\alpha N^2$ and $\phi\alpha I_R$

$$T\phi I_a^2 \alpha N^2$$

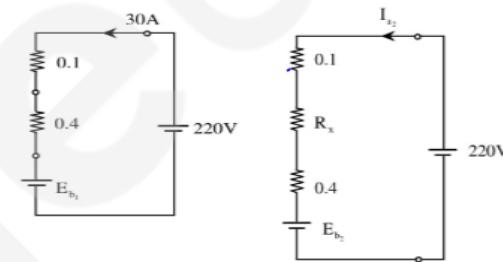
$$\frac{N_2}{N_1} = \frac{I_{a2}}{I_{a1}} \Rightarrow I_{a2} = 0.5 I_{a1} = 15\text{amp}$$

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

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

$$\frac{0.5N_1}{N_1} = \frac{220 - 15(0.5 + R_x)}{205} \times \frac{30}{15}$$

$$\Rightarrow R_x = 10.75\Omega$$



28. Ans. D.

Given

$$\begin{bmatrix} \vdots & 1 & 2 \\ \vdots & 2 & 0 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u(t)$$

$$x(t) = Ax + Bu$$

$$\text{Transfer function} = C[SI - A]^{-1} B + D$$

Here $D = 0$

$$C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

$$A = \begin{bmatrix} 1 & 2 \\ 2 & 0 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

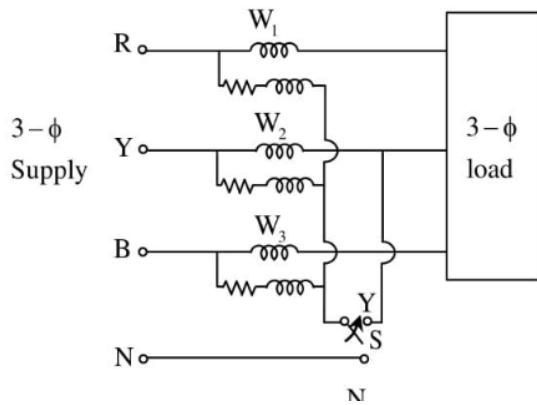
$$T/F = [1 \ 0] \begin{bmatrix} S-1 & -2 \\ -2 & S \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$= [1 \ 0] \frac{\begin{bmatrix} S & 2 \\ 2 & s-1 \end{bmatrix} \begin{bmatrix} 1 \\ 2 \end{bmatrix}}{s^2 - s - 4}$$

$$= [1 \ 0] \frac{\begin{bmatrix} s+4 \\ 2+2s-2 \end{bmatrix}}{s^2 - s - 4}$$

$$\Rightarrow T/F = \frac{s+4}{s^2-s-4}$$

29. Ans. D.



If the switch is connected to Neutral, then each wattmeter will read $1-\phi$ power.

$$W_1 + W_2 + W_3 = 3V_{ph} \cos \phi = 1732.05$$

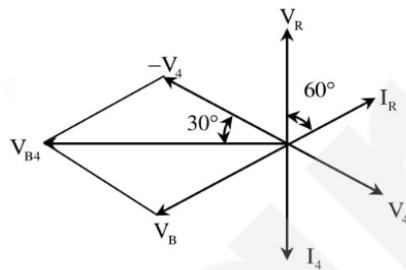
$$\Rightarrow \cos \phi = 0.5 \text{ lagg.} \Rightarrow \phi = 60^\circ$$

Given that, load drawing Apparent power of 3464 VA.

$$\sqrt{3}V_L I_L = 3464$$

$$I_L = \frac{3464}{\sqrt{3} \times 400} = 5A$$

If the switch connected to "Y", then $W_2 = 0$



$$W_1 = V_{pc} I_{cc} \cos(V_{pc} & I_{cc}) = V_{Ry} I_R \cos(V_{Ry} & I_R)$$

$$= 400 \times 5 \cos(90^\circ) = 0W$$

$$W_3 = V_{By} I_B \cos(V_{By} & I_B) = 400 \times 5 \times \cos 30^\circ$$

$$= 1732 \text{ watts}$$

30. Ans. D.

We can write V_1, I_1 in terms of $V_3 + I_3$

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} \begin{bmatrix} A_2 & B_2 \\ C_2 & D_2 \end{bmatrix} \begin{bmatrix} V_3 \\ I_3 \end{bmatrix}$$

$$\Rightarrow V_1 = (A_1 A_2 + B_1 C_2) V_3 + (A_1 B_2 + B_1 D_2) I_3$$

$$\Rightarrow C_1 = (C_1 A_2 + D_1 C_2) V_3 + (C_1 B_2 + D_1 D_2) I_3$$

To find V_{th} (or) $V_{oc} I_3 = 0$

$$V_1 = (A_1 A_2 + B_1 C_2) V_{th}$$

$$\Rightarrow V_{th} = V_{oc} = \frac{V_1}{A_1 A_2 + B_1 C_2}$$

To find $I_{sc} V_3 = 0$

$$V_1 = (A_1 B_2 + B_1 D_2) I_{sc} \Rightarrow I_{sc} = \frac{V_1}{A_1 B_2 + B_1 D_2}$$

$$\text{To find } R_{th} R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2 + B_1 C_2}$$

31. Ans. A.

$$R = \frac{V_T}{I_{C2}} \ln \left(\frac{I_{C1}}{I_{C2}} \right);$$

$$I_{C1} = 1 \text{ mA}; I_{C2} = 1 \mu\text{A}$$

$$R = \frac{25 \times 10^{-3}}{1 \times 10^{-6}} \ln \left[\frac{1 \times 10^{-3}}{1 \times 10^{-6}} \right] = 172.7 \text{ k}\Omega$$

32. Ans. A.

Average reduction in output voltage due to L_s

$$\Delta V_o = 4f_s L_s I_o = 4 \times 50 \times (10 \times 10^{-3}) \times 14 = 28 \text{ V}$$

$$\Delta V_o = \frac{V_m}{\pi} [\cos \alpha - \cos(\alpha + \mu)]$$

for a diode, $\alpha = 0$

$$\therefore \Delta V_o = \frac{V_m}{\pi} [1 - \cos \mu]$$

$$28 = \frac{220\sqrt{2}}{\pi} [1 - \cos \mu] \Rightarrow \mu = 44.17^\circ$$

\therefore conduction angle of diode $180 + \mu = 224.17^\circ$

33. Ans. A.

D.E $\frac{dy}{dt} + \frac{5t}{t^2 - 81} y = \frac{\sin(t)}{t^2 - 81}$ is a first order linear eq.

$$F = e^{\int \frac{5t}{t^2 - 81} dt} = e^{\frac{5}{2} \ln(t^2 - 81)} = (t^2 - 81)^{5/2}$$

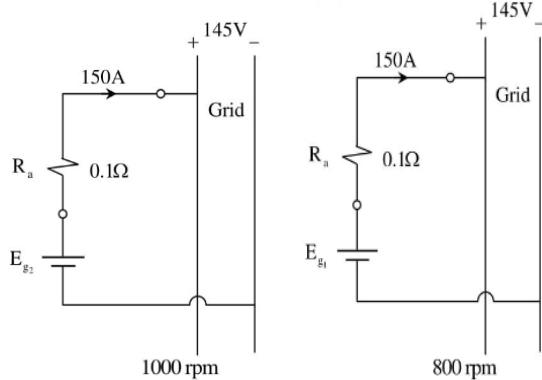
$$\therefore \text{Solution is } y(t^2 - 81)^{5/2} = \int \frac{\sin t}{t^2 - 81} (t^2 - 81)^{5/2}$$

$$= \int (t^2 - 81)^{3/2} \sin t dt + C$$

$$\Rightarrow y = \frac{\int (t^2 - 81)^{3/2} \sin t dt}{(t^2 - 81)^{5/2}} + \frac{C}{(t^2 - 81)^{5/2}}$$

If $t \neq -9, 9$ then the solution exists. Options (b), (c), (d) contain either -9 or 9 or both. So answer is option A

34. Ans. A.



$$E_{g1} = 150 \times 0.1 = 145$$

$$E_{g2} - I_{a2} \times 0.1 = 145$$

$$E_{g1} = 160 \text{ V}$$

$$200 - 145 = I_{a2} \times 0.1 \Rightarrow \frac{55}{0.1} = I_{a2}$$

No ∞E_g (\because I_{a2} is finite)

$$I_{a2} = 550 \text{ amps}$$

$$\frac{N_2}{N_1} = \frac{E_{g2}}{E_{g1}}$$

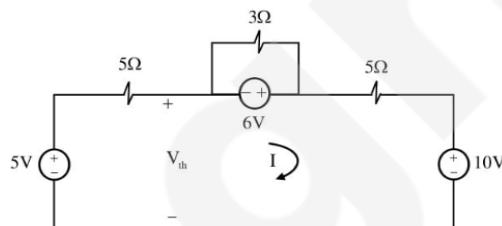
$$E_{g1} = \frac{1000}{800} \times 160 = 200 \text{ volts}$$

35. Ans. A.

To find V_{th}

$$I = \frac{5+6+10}{10} = \frac{21}{10} = 2.1 \text{ A}$$

$$V_{th} = 5 - 5 \times 2.1 = -5.5 \text{ V}$$

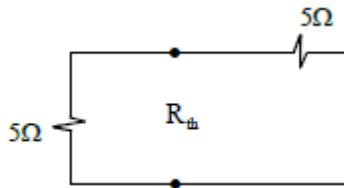


To find R_{th}

$$\Rightarrow R_{th} = \frac{5 \times 5}{5 + 5} = 2.5 \Omega$$

The maximum power transferred to

$$R = \frac{V_{th}^2}{4R_{th}} = \frac{5.5^2}{4 \times 2.5} = 3.025 \text{ W}$$



36. Ans. B.

Given causal LTI system

$$\frac{d^2y}{dt^2} + \frac{7dy(t)}{dt} + 10y(t) = ux(t) + \frac{5dx(t)}{dt}$$

$$\Rightarrow s^2y(s) + 7sy(s) + 10y(s) = u x(s) + 5sx(s)$$

$$\Rightarrow \frac{Y(s)}{X(s)} = \frac{4 + 5s}{s^2 + 7s + 10} \Rightarrow H(s) = \frac{5s + 4}{(s + 2)(s + 5)}$$

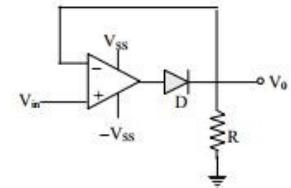
Inverse Laplace transform will give $h(t)$ (impulse response)

$$H(s) = \frac{-2}{s + 2} + \frac{7}{s + 5}$$

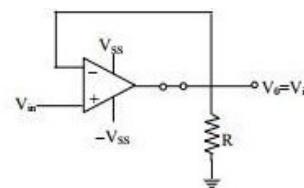
$$h(t) = -2e^{-2t}u(t) + 7e^{-5t}u(t)$$

37. Ans. A.

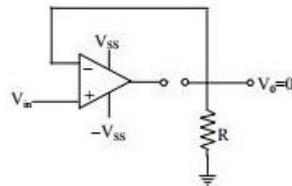
The given circuit is redrawn as



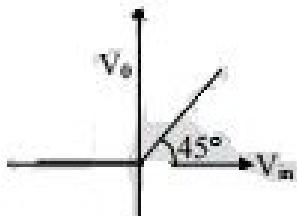
When $V_{in} > 0$, Diode is ON, then replaced by SC



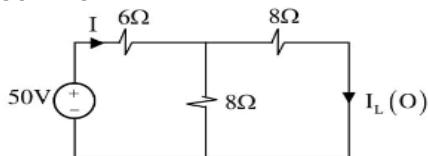
When $V_{in} < 0$, Diode OFF, then replaced by OC



The output characteristic is shown below.



38. Ans. A.

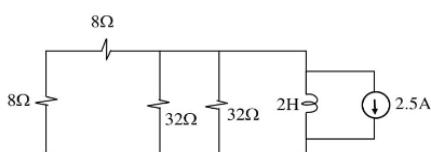


at $t=0^-$

$$I = \frac{50}{6+4} = 5A$$

$$I(0^-) = \frac{5}{2} = 2.5A$$

For $t \geq 0$



$$T = \frac{L}{R_{\text{eq}}} = \frac{2}{8} = \frac{1}{4}$$

$$I_L(\infty) = 0 \text{ (bc}_3 \text{ it is a source free ckt)}$$

$$i_L(t) = I_L(\infty) + [I_L(0) - I_L(\infty)]e^{-t/T} = 2.5e^{-4t}$$

39. Ans. C.

When the line 1-3 is removed

$$z_{13} = 0.05 = z_{31}$$

$$y_{13} = \frac{1}{0.05} = -j20$$

$$y_{13} = y_{31} = 0$$

$$\frac{y'_{13}}{2} - \text{Half Line shunt susceptance} = j0.05$$

$$y_{11}(\text{new}) = y_{11}(\text{old}) - y_{13} - \frac{y'_{13}}{2} = -j39.9$$

$$-(-j20) - j0.05 = -j19.95$$

$$y_{33}(\text{new}) = y_{33}(\text{old}) - y_{13} - \frac{y'_{13}}{2} = -j39.9$$

$$-(-j20) - j0.05 = -j19.95$$

Modified Bus admittance matrix:

$$Y_{\text{Bus(new)}} = \begin{bmatrix} -j19.95 & j20 & 0 \\ j20 & -j39.9 & j20 \\ 0 & j20 & -j19.95 \end{bmatrix}_{\text{pu}}$$

40. Ans. A.

$$\left. \frac{Y(s)}{U_1(s)} \right|_{U_2(s)=0}$$

By Mason's gain formula

$$\frac{Y(s)}{U_1(s)} = \frac{P_1 \Delta_1}{1 - [L_1 + L_2]}$$

$$\text{Here } P_1 = \frac{1}{k^2} \cdot \frac{k^2}{LJ}$$

$$\Delta_1 = 1$$

$$L_1 = -\frac{R}{L} \frac{1}{s}$$

$$L_2 = \frac{1}{LJ} \cdot \frac{1}{s^2} (K_2) K_1$$

$$\frac{Y(s)}{U_1(s)} = \frac{\frac{1}{s^2} \cdot \frac{k_1}{LJ}}{1 + \frac{R}{L} \cdot \frac{1}{s} + \frac{1}{LJ} \cdot \frac{1}{s^2} K_2 K_1}$$

$$T/F = \frac{K_1}{s^2 LJ + s RJ + K_1 K_2}$$

41. Ans. A.

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

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

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

Apply Inverse L.T

$$y(t) = u(t) - 2e^{-t}u(t)$$

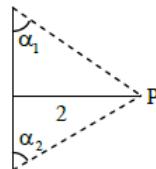
$$y(1.5) = 1 - 2e^{-1.5} = 1 - 0.44626$$

$$y(1.5) = 0.5537$$

42. Ans. A.

For a finite length conductor B at a point P

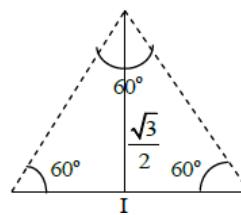
$$B = \frac{\mu_0 I}{4\pi r} (\cos \alpha_1 + \cos \alpha_2)$$



For a given hexagon 4 for a side

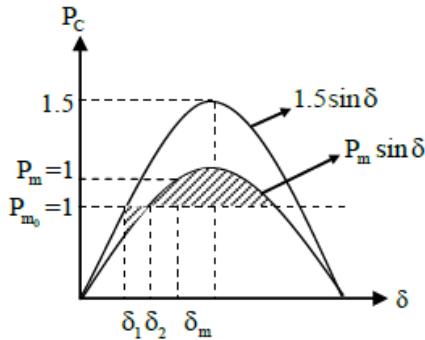
$$r = \frac{\sqrt{3}}{2}$$

$$\alpha_1 = \alpha_2 = 60^\circ$$



$$\begin{aligned} \text{Total flux density } B &= 6 \times \frac{\mu_0 I}{4\pi} (\cos\alpha_1 \cos\alpha_2) \\ &= 6 \times \frac{4\pi \times 10^{-7} \times 1}{4\pi \times \sqrt{3}/2} (\cos 60^\circ + \cos 60^\circ) \\ &= 6.9 \times 10^{-7} \text{ Tesla} \end{aligned}$$

43. Ans. A.

Given $\delta_m = 1022 \text{ rad} = 69.958^\circ$

$$\begin{aligned} \delta_1 &= \sin^{-1}\left(\frac{P_m}{1.5}\right) \\ &= \sin^{-1}\left(\frac{1}{1.5}\right) = 41.81^\circ = 0.729 \text{ rad} \end{aligned}$$

Using equal area criterion

A1=A2

$$\int_{\delta_1}^{\delta_m} (P_{m0} - P_m \sin \delta) d\delta = \int_{\delta_2}^{\delta_m} (P_{max} \sin \delta - P_m) d\delta$$

By solving above integration

$$\begin{aligned} P_{max} &= \frac{P_{m0}(\delta_m - \delta_1)}{\cos \delta_1 - \cos \delta_m} = \frac{1(1.221 - 0.7297)}{\cos(41.81) - \cos(69.95)} \\ &= 1.22 \text{ pu} \end{aligned}$$

44. Ans. A.

$$\tan^{-1}\left(\frac{X_m}{R_m}\right) = -\tan^{-1}\left(\frac{X_a - X_e}{R_a}\right) = 90^\circ$$

$$\tan^{-1}\left(\frac{15.75}{12.5}\right) - \tan^{-1}\left(\frac{12.75 - X_e}{24.5}\right) = 90^\circ$$

$$51.562^\circ - \tan^{-1}\left(\frac{12.75 - X_e}{24.5}\right) = 90^\circ$$

$$\Rightarrow -\tan^{-1}\left(\frac{12.75 - X_e}{24.5}\right) = 38.43^\circ$$

$$\frac{12.75 - X_e}{24.5} = -0.793 \Rightarrow -X_e = 32.194 \Omega$$

$$X_e = \frac{1}{2\pi \times 50 \times 32.194} = 98.87 \mu F$$

45. Ans. A.

Not matching with IIT key

Sol. $Lf^1(1) = Lt_{x \rightarrow 1} \frac{f(x) - f(1)}{x - 1} = Lt_{x \rightarrow 1} \frac{e^x - (a+b)}{x - 1}$ does not

exists, for any values of a and b

 $\therefore f(x)$ is not differentiable at $x=1$, for any values of a and b.

46. Ans. A.

The poles of $H(z)$ are $P_k = \frac{1}{\sqrt{2}} \exp\left(\frac{j(2k-1)\pi}{4}\right) k = 1, 2, 3, 4$

$$P_1 = \frac{1}{\sqrt{2}} e^{\frac{j\pi}{4}} = \frac{1}{2} + \frac{j}{2} = \frac{1+j}{2}$$

$$P_2 = \frac{1}{\sqrt{2}} e^{\frac{j3\pi}{4}} = \frac{-1}{2} + \frac{j}{2}$$

$$P_3 = \frac{1}{\sqrt{2}} e^{\frac{j5\pi}{4}} = -\frac{1}{2} - \frac{j}{2}$$

$$P_4 = \frac{1}{\sqrt{2}} e^{\frac{j7\pi}{4}} = \frac{1}{2} - \frac{j}{2}$$

$$H(z) = \frac{kz^4}{(z - P_1)(z - P_2)(z - P_3)(z - P_4)} = \frac{kz^4}{z^4 + \frac{1}{4}}$$

Given $H(1) = 5/4$

$$\frac{5}{4} = \frac{k}{5/4}$$

$$k = \frac{25}{16}$$

$$H(z) = \frac{\frac{25}{16}z^4}{z^4 + \frac{1}{4}}$$

Given $g(x) = (j)^4 n(x)$

$$G(t) = H(z/j)$$

$$G(z) = \frac{\frac{25}{16} \left(\frac{z}{j}\right)^4}{\left(\frac{z}{j}\right)^4 + \frac{1}{4}} = \frac{\frac{25}{16} z^4}{z^4 + \frac{1}{4}}$$

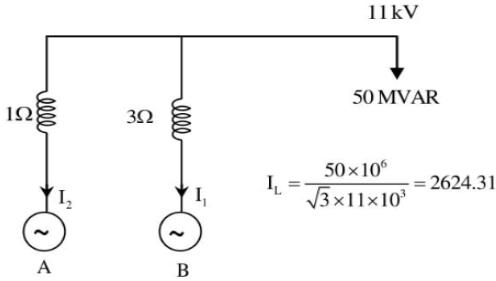
$$G(z) = \frac{25}{16} - \frac{25}{64} z^{-4} + \frac{25}{256} z^{-8} + \dots$$

47. Ans. A.

$$a=1, b=2 \text{ and } \frac{b-a}{2^n} < 0.001 \text{ using bisection method}$$

$\Rightarrow 2^n > 1000 \Rightarrow n=10$ is the minimum number of iterations.

48. Ans. A.



Sol. → syn. Condensers

→ current's supplied both the machines are same

$$\therefore I_1 = I_2 = \frac{2624.31}{2} = 1312.159 \text{ Amps}$$

As the two motors, supplying reactive power only, the phasor diagram will be

$$E + jI_a X_s = V_1$$

$$E = V - jI_a X_s$$

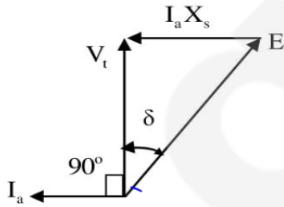
Consider magnitudes $\Rightarrow E^2 = (V - I_a X_s)^2$

$$E = \sqrt{(V - I_a X_s)^2}$$

$$E_A = \sqrt{(6350.85 - 1312.159 \times 1)^2} = 5038.7$$

$$E_B = \sqrt{(6350.85 - 1312.159 \times 3)^2} = 2414.14$$

$$\frac{I_{fA}}{I_{fB}} = \frac{E_A}{E_B} = \frac{5038.7}{2414.14} = 2.086$$



49. Ans. A.

$$I_f = \frac{3E_f}{Z_0 + Z_1 + Z_2 + 3Z_n}$$

$$3.75 = \frac{3 \times 1}{0.1 + 0.2 + 0.2 + 3Z_n}$$

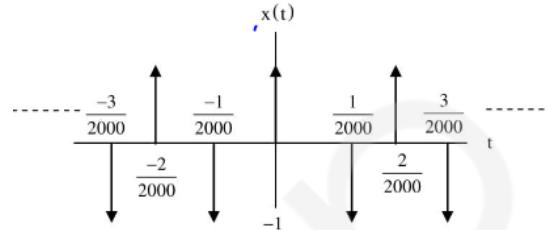
$$Z_n = 0.1 \text{ P.U}$$

50. Ans. C.

Given $x(t)$ is a periodic signal for which Fourier transform $X(\omega)$ is to be calculated

$$X(\omega) = 2\pi \sum_{n=-\infty}^{\infty} D_n (\omega - n\omega_0)$$

D_n exponential Fourier series coefficient for $x(t)$



Define $x(t)$ over one period

$$x(t) = \delta(t) - \delta\left(t - \frac{1}{2000}\right)$$

$$\text{Where as } T_0 = \frac{1}{1000} \text{ sec; } \omega_0 = 2000\pi \text{ rad/sec}$$

$$\therefore D_n = \frac{1}{T_0} [1 - e^{-jn\omega_0 t_0}] ; t_0 = \frac{1}{2000}$$

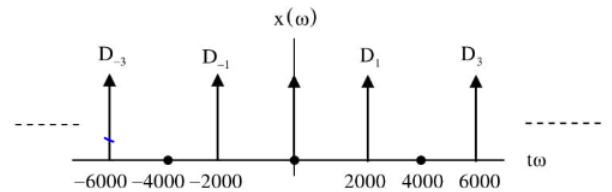
$$D_n = 1000 [1 - e^{-j\pi n}] \Rightarrow D_n = [1 - (-1)^n] 1000$$

At $n = 0, 2, 4, \dots, D_n = 0$

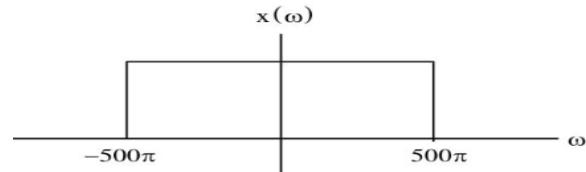
$$\text{i.e., } D_n = \begin{cases} 0 & \text{for even values of } n \\ 2000 & \text{for odd values of } n \end{cases}$$

$$\therefore X(\omega) = 2\pi [D_0 + D_1] \delta(\omega - 2000\pi)$$

$$+ D_{-1} \delta(\omega + 2000\pi) + D_{-2} \delta(\omega - 4000\pi) + D_2 \delta(\omega + 4000\pi)$$



Given $X(\omega)$ is



Thus the filtered output is

$$y(\omega) = 2\pi [D_1 \delta(\omega - 2000\pi) + D_{-1} \delta(\omega + 2000\pi)]$$

$$\therefore \omega = 2000$$

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

$$\therefore y(t) = 4000 \cos(2000\pi t)$$

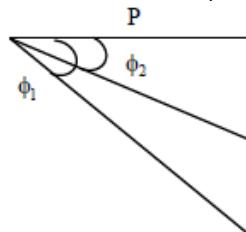
51. Ans. B.

V_1	V_2	Q_1	Q_2	V_{out}	Logic level
0	0	OFF	OFF	5V	1
0	1	OFF	ON	0V	0
1	0	ON	OFF	0V	0
1	1	ON	ON	0V	0

So, this logic level o/p is showing the functionality of NOR-gate.

52. Ans. B.

Under worst case,



$$P_{max} = 2kW$$

$$Q_{max} = 2kVAR$$

$$\phi_l = \tan^{-1} \frac{Q}{P} = 45^\circ$$

$$\cos 45 = 0.7071 \text{lag}$$

53. Ans. A.

$$V_{dc} = 32V$$

$$V_o = 48V$$

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

$$\frac{48}{32} = \frac{D}{1-D}$$

$$\frac{3}{2} = \frac{D}{1-D}$$

$$3-3D=2D$$

$$3=5D \Rightarrow D=\frac{3}{5}$$

$$\frac{2}{5} \leq D \leq \frac{3}{5}$$

$$V_{dc} = 72V$$

$$V_o = 48V$$

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

$$\frac{2}{3} = \frac{D}{1-D}$$

$$3D=2-2D$$

$$5D=2$$

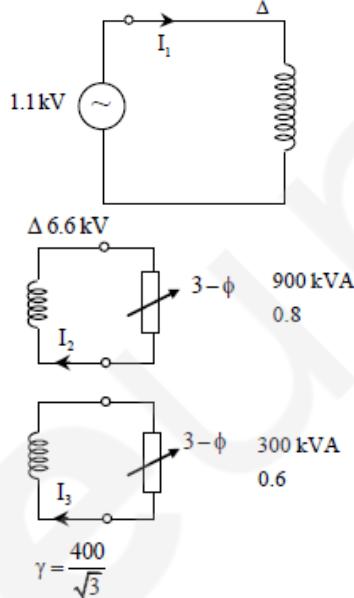
$$D=\frac{2}{5}$$

54. Ans. A.

3- ϕ , 3-winding T/F

$\Delta/\Delta/Y$

per phase representation



$$I_2 = \frac{900 \times 10^3}{\sqrt{3} \times 6.6 \times 10^3} = 78.73 \text{ Amps}$$

$$I_{ph} = \frac{I_2}{\sqrt{3}} = 45.45 \angle -36.87^\circ$$

$$I'_2 = K I_2 = \frac{6.6 \times 10^3}{1.1 \times 10^3} \times 45.45 \Rightarrow I'_2 = 272.7 \angle -36.87^\circ$$

$$I'_3 = \frac{300 \times 10^3}{\sqrt{3} \times 400} = 433.01 \text{ Amp}$$

$$I''_3 = \frac{300 \times 10^3}{\sqrt{3} \times 400} = 433.01 \angle -53.13^\circ$$

$$I'_3 = \frac{400/\sqrt{3}}{1.1 \times 10^3} \times 433.01 \Rightarrow I''_3 = 90.91 \angle -53.13^\circ$$

$$I_1 = I'_2 + I''_3 \Rightarrow I_1 = 360.87 \angle -40.91$$

$$\Rightarrow I_1 = \sqrt{3} I_1 = 625.05 \angle 40.91$$

55. Ans. B.

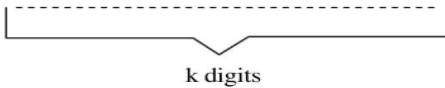
curve 'C' is $y = x \Rightarrow dy = dx$

$$\begin{aligned} \therefore I &= \int_0^1 (x^2 + i(x)^2) (dx + idx) = (1+i)^2 \int_0^1 x^2 dx \\ &= (2i) \left(\frac{x^3}{3} \right)_0^1 = \frac{2}{3}i \end{aligned}$$

56. Ans. D.

'besides' means in addition to.

57. Ans. C.



Each digit can be filled in 7 ways as 0, 5 and 9 is not allowed, so each of these places can be filled by 1, 2, 3, 4, 6, 7, 8.

So required probability is $\left(\frac{7}{10}\right)^k$ or 0.7^k .

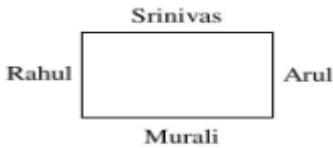
58. Ans. D.

Factorization of 162 is $2 \times 3 \times 3 \times 3$ $y \times 162$ is a perfect cube $y \times 2 \times 3 \times 3 \times 3 \times 3 =$ Perfect cube For perfect cube 2's & 3's are two more required each.

59. Ans. C.

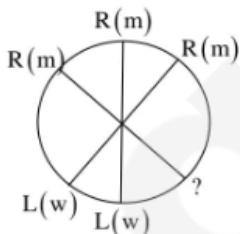
If the main clause is in the past the past tense, the subordinate clause also should be in the past tense.

60. Ans. C.



61. Ans. A.

Out of six people, 3 place definitely occupied by right handed people as atleast 2 women are there so these two will sit adjacently. Now as only one seat is left it will be occupied by a left handed man because on right side of this seat is sitting an right handed man.



Therefore, answer should be 2 women.

62. Ans. B.

If $x > y$

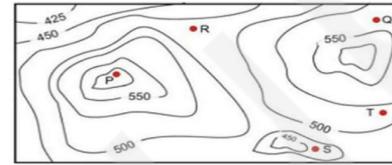
$$\text{Exp} = \frac{x+y-(x-y)}{2} = y_{\min}$$

If $x < y$

$$\text{Exp} = \frac{x+y-(x-y)}{2} = x_{\min}$$

\therefore The expression $\frac{(x+y)-|x-y|}{2}$ is equal to minimum of x & y

63. Ans. C.



The given contour is a hill station, the peak point of this hill station is P, it is under a contour of 550. At floods, the water level is 525m. So the village of R, S and T are under a contour of 500. Therefore these villages are submerged.

64. Ans. D.

As there are 4 people A,G,N,S and 4 colors so without any restriction total ways have to be $4 \times 4 = 16$

Now, Arun \rightarrow dislikes Red and

Shweta \rightarrow dislikes white

So $16 - 2 = 14$ ways

65. Ans. B.

To refer is to reach an opinion. The right opinion of the author is 'History is viewed through the filter of nationalism' so (B) is the right opinion of the author. The key words in the statement are 'history and nationalist imagination'.
