Full Length Test
Electrical Engineering

Answer Keys and Explanations

1. [Ans. *] Range: 0.43 to 0.45

Total resistance of the instrument circuit

$R + r = 500\ \Omega$

Resistance of magnetizing coil, $R = 50\ \Omega$

Swamping resistance, $r = 500 - 50 = 450\ \Omega$

Inductance of voltmeter circuit, $L = 0.09$ H

$$C = \frac{L}{r^2} = \frac{0.09}{(450)^2} = 0.444\ \mu F$$

2. [Ans. B]

$V_R = 1\angle 0°$

$$V_{series} = \left(1 + j\omega - \frac{j}{\omega}\right)(1\angle 0°)$$

$$\therefore |V_R| = 1; \quad |V_{series}| = \sqrt{1 + \left(\omega - \frac{1}{\omega}\right)^2}$$

We desire the freq. ω at which $V_{series} = 2V_R$

$$\Rightarrow V_{series} = 2$$

$$\therefore 1 + \left(\omega - \frac{1}{\omega}\right)^2 = 4 \Rightarrow \left(\omega - \frac{1}{\omega}\right) = \pm\sqrt{3}$$

$$\Rightarrow \omega^2 - \sqrt{3}\omega - 1 = 0$$

$$\Rightarrow \omega = 2.189\ \text{rad/sec} \ \text{ or } \ 0.45\ \text{rad/sec}$$

B is the only correct answer among all the options.

3. **[Ans. A]**

Main winding current,

$$I_m = \frac{230}{28\angle 70°} = 8.214\angle -70° = 2.809 - j7.719\ A$$

Auxiliary winding current

$$I_a = \frac{230}{42\angle 45°} = 5.476\angle -45° = 3.872 - j3.87\ A$$

Input current at starting

$I = I_m + I_a$

$\ \ = 6.681 - j11.59$

$$\boxed{I = 13.37\angle -60°.04° A}$$

4. [Ans. *] Range: 72 to 72

$V = 300V; R = 12000\Omega$

$i = \frac{V}{R} = \frac{300}{12000} = 0.025A$

$T_d = NBIA = 100 \times 6 \times 10^{-2} \times 0.025 \times 0.04 \times 0.03$

$= 18 \times 10^{-5}$ Nm

$T_c = 25 \times 10^{-7}\theta$ Nm

At steady state: $T_c = T_d$

$\Rightarrow 25 \times 10^{-7}\theta = 18 \times 10^{-5}$

$\therefore \theta = \frac{18 \times 10^{-5}}{25 \times 10^{-7}} = 72°$

5. [Ans. *] Range: 76.3 to 76.5

The primary CT current for relay operation

$= 1.5 \times \frac{1000}{5} = 300A = I_s$

Percentage winding unprotected $= \frac{I_s \cdot R}{V} \times 100$

$= \frac{300 \times 5}{11000/\sqrt{3}} \times 100 = 23.6\ \%$

Percentage winding protected $= 100 - 23.6 = 76.4\%$

6. [Ans. A]

$h(n) = \frac{1}{2}[\delta(n) + \delta(n-2)]$

$H(z) = \frac{1}{2}[1 + z^{-2}]$

Put $z = e^{j\Omega}$

$H(e^{j\Omega}) = \frac{1}{2}[1 + e^{-2j\Omega}]$

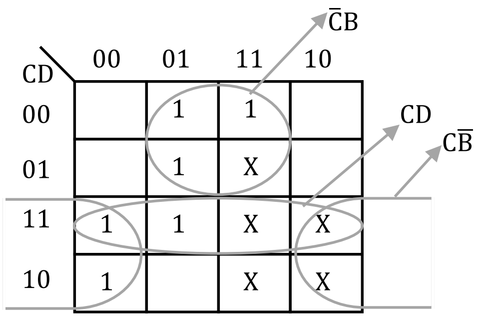
$= \frac{1}{2}e^{-j\Omega}[e^{j\Omega} + e^{-j\Omega}]$

$\Rightarrow H(e^{j\Omega}) = e^{-j\Omega}\cos\Omega$

$\therefore |H(e^{j\Omega})| = |e^{-j\Omega}||\cos\Omega|$

$= |\cos\Omega|$

7. [Ans. D]



$\therefore$ Minimised form is $\bar{C}B + CD + C\bar{B}$

8. [Ans. B]

In this given figure, 3 intersection points are given that shows, the system is stable for different value or region of k. So system is conditionally stable

9. [Ans. C]

By K.V.L

$2I_x = 2I_x + 2I_x + 2$

$2I_x = -2A$

$I_x = -1\ A$

$V = 2i_x = -2V$

10. [AAns. *] Range: 6.39 to 6.40

$f(t) = 4\sin 200t + 6\cos 200t + 2\cos(200t - 60°)$

$$= \frac{4}{\sqrt{2}}\angle 0 + \frac{6}{\sqrt{2}}\angle 90° + \frac{2}{\sqrt{2}}\angle 30°$$

$= 6.397\ \angle 50.68$

$\therefore$ RMS value $= 6.397$

11. [Ans. B]

Consider $x = \sqrt{18}$

$x^2 = 18$

$f(x) = x^2 - 18 = 0$

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$

$$x_1 = 4 - \left[\frac{(-2)}{8}\right] = 4.25$$

$$\therefore x_2 = 4.25 - \frac{(4.25)^2 - 18}{8.5} = 4.243$$

12. [Ans. A]

Green's theorem and stokes theorem convert line integral to surface integral and vice versa. Whereas Gauss's Divergence theorem converts from surface to volume and vice versa.

13. [Ans. B]

$w_1 = 14.2\text{ kW}; w_2 = -6.1\text{ kW}; E_L = 440\text{ V}$

True power $= 14.2 - 6.1 = 8.1$ kW

$P = \sqrt{3}E_L I_L \cos\phi$

$$\tan\phi = \frac{\sqrt{3}(w_1 - w_2)}{(w_1 + w_2)} = \frac{\sqrt{3} \times 20.3}{8.1} = 4.34$$

$\phi = \tan^{-1}(4.34) = 77°$

$\cos\phi = \cos 77 = 0.2249$

$\therefore P = \sqrt{3}E_L I_L \cos\phi$

$\Rightarrow 8.1 \times 1000 = \sqrt{3} \times 440 \times I_L \times 0.2249$

$\therefore I_L = 47.26\ A$

14. [Ans. C]

$$\begin{bmatrix} 4-\lambda & -2 \\ -2 & 1-\lambda \end{bmatrix} = 0$$

$(4-\lambda) \times (1-\lambda) - 4 = 0$

$\lambda^2 - 5\lambda = 0$

$\Rightarrow \lambda = 0 \text{ and } 5$

Hence, Eigenvalues are 0 and 5

15. [Ans. *] Range: 1322 to 1323

Total RMS output voltage

$$V_{or} = \frac{V_s}{2} = \frac{230}{2} = 115\text{V}$$

$$\text{Total output power} = \frac{V^2}{R}$$

$$= \frac{115^2}{10} = 1322.5 \text{ W}$$

16. [Ans. *] Range: 179.5 to 181

$$V_m = \frac{380}{\sqrt{3}} \times \sqrt{2} = 310.3\text{V}$$

$$V_{dc\,avg} = \frac{3\sqrt{3}}{2\pi} V_m \cos\alpha - V_t$$

$$= \frac{3\sqrt{3} \times 310.3}{2\pi} \cos 45° - 1.2$$

$$= 180.25\text{V}$$

17. [Ans. *] Range: 1.2 to 1.2

$$L \propto \ln\left(\frac{GMD}{GMR}\right)$$

If distance between conductors is doubled

$\therefore$ GMD is doubled

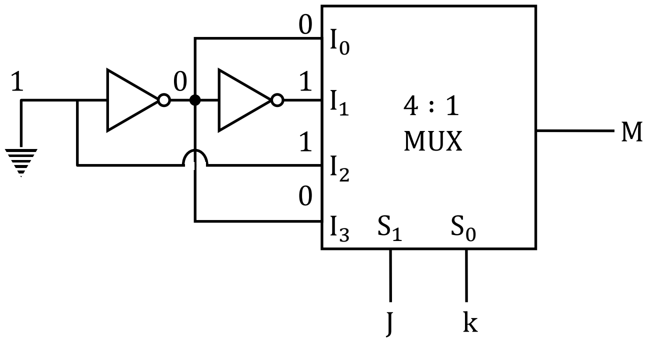
If radius is doubled $\Rightarrow$ GMR is doubled

$$\frac{L'}{L} = \frac{\ln\left(\frac{2\,GMD}{2\,GMR}\right)}{\ln\left(\frac{GMD}{GMR}\right)}$$

$\therefore L' = L$

18. [Ans. C]

19. [Ans. D]



$M = J \oplus K$

$= XOR (J, K)$

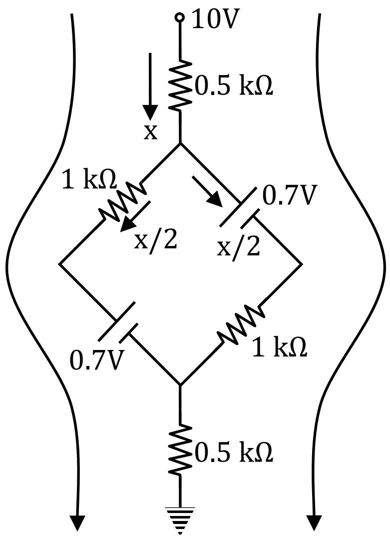
20. [Ans. A]

The circuit is a NOR gate followed by an inverter. Thus,

$Y = \overline{\overline{A + B}} = A + B$

So, it is a OR gate.

21. [Ans. *] Range: 3 to 3.2



$KVL = 10 - 0.5 \times 10^3 x - 0.7 - 10^3 (x/2) - 0.5 \times 10^3 x = 0$

$\Rightarrow 9.3 = 0.5 \times 10^3 x(1 + 1 + 1)$

$\Rightarrow 9.3 = 1.5 \times 10^3 x$

$$x = \frac{9.3}{1.5 \times 10^3} = 6.2 \text{ mA}$$

$$I = \frac{x}{2} = \frac{6.2}{2} = 3.1 \text{ mA}$$

22. [Ans. *] Range: 0.15 to 0.16

Bandwidth of series RLC circuit

$$B = \frac{R}{L}\ \text{rad\textbackslash sec}$$
$$= 1\ \text{rad\textbackslash sec}$$
$$B = \frac{1}{2\pi}\text{Hz}$$
$$= 0.159\ \text{Hz}$$

23. [Ans. *] Range: 25 to 25

Using the addition of admittances in parallel

$$Y = Y_L + Y_R + Y_C = 1 + \frac{1}{j\omega L} + j\omega c = 1 + \frac{1}{j120\pi \cdot \frac{1}{120\pi}} + j120\pi\ \frac{1}{60\pi}$$
$$= 1 + \frac{1}{j} + 2j = 1 + j$$
$$I_R = \frac{\left(\frac{1}{R}\right)}{Y} I$$
$$\text{Or, } I_R = \frac{1}{1+j} I$$
$$\text{Now, } I = \frac{10}{\sqrt{2}}\angle 0°$$
$$\therefore I_R = 5\angle -45°\ \text{A}$$
$$\therefore \text{Power dissipated} = I_R^2 R = (I_R . I_R^*)R = 25\ \text{watt}$$

24. [Ans. B]

$$L\,[f(t)] = \frac{1}{s(s-3)}$$

∴ Pole of s F(s) lie on right half of s – plane

∴ Final value theorem cannot be applied

And system is unstable

∴ Final value is unbounded

25. [Ans. C]

$$\text{Grad } u = \hat{i}\frac{\partial u}{\partial x} + \hat{j}\frac{\partial u}{\partial y} = x\,\hat{i} + \frac{2y}{3}\ \hat{j}$$
$$\text{At point } (1,3)\ |\text{Grad } u| = \sqrt{(1)^2 + \left(\frac{2}{3}\times 3\right)^2} = \sqrt{5}$$

26. [Ans. C]

27. [Ans. *] Range: 99 to 101

Average output voltage $V_O = \alpha V_s$

V_O across L is zero

$E = V_O = 0.25 \times 400 = 100V$

During T_{ON}; VOltage across $L = (V_s - E)$

$V - t$ area during T_{ON} applied to $L = (400 - 100)T_{ON} = 300\ T_{ON} V - s$

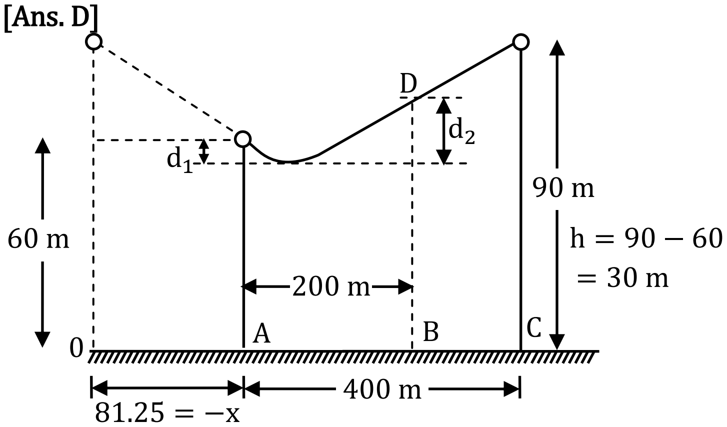
$$\int_0^{T_{ON}} V_L dt = \int_0^{T_{ON}} L\frac{di}{dt}\,dt = L(\Delta I)$$

Current excursions should be limited to 15A $\Rightarrow \Delta I = 15$

$$300\ T_{ON} = L(\Delta I) \Rightarrow T_{ON} = \frac{0.05 \times 15}{300} = 2.5\text{ ms}$$

$$f = \frac{1}{T} = \frac{\alpha}{T_{ON}} = \frac{0.25}{2.5m} = 100Hz$$

28. [Ans. D]



$$x_1 = \frac{L}{2} - \frac{Th}{WL} = \frac{400}{2} - \frac{3000 \times 30}{0.8 \times 400}$$
$$= -81.25m$$

$$OB = 81.25 + \frac{400}{2} = 281.25m$$

$$d_1 = \frac{W}{2T} \times x_1^2 = \frac{0.8}{2 \times 3000} \times (81.25)^2 = 0.88\text{ m}$$

$$d_2 = \frac{W}{2T}(OB)^2 = \frac{0.8}{2 \times 3000} \times (281.25)^2 = 10.54\text{ m}$$

$d_2 - d_1 = 10.54 - 0.88 = 9.66$ m

Clearance between P and ground = 60 + 9.66 = 69.66 m

29. [Ans. C]

For a SLG fault

$$I_{a1} = \frac{E_a}{Z_1 + Z_2 + Z_0 + 3Z_f}$$

$Z_0 = 0.1 + 3 \times 0.033 = 0.2$

$Z_1 = 0.2$ and $Z_2 = 0.1$

$$I_{a1} = \frac{1}{0.2 + 0.1 + 0.2} = 2 \text{ pu}$$

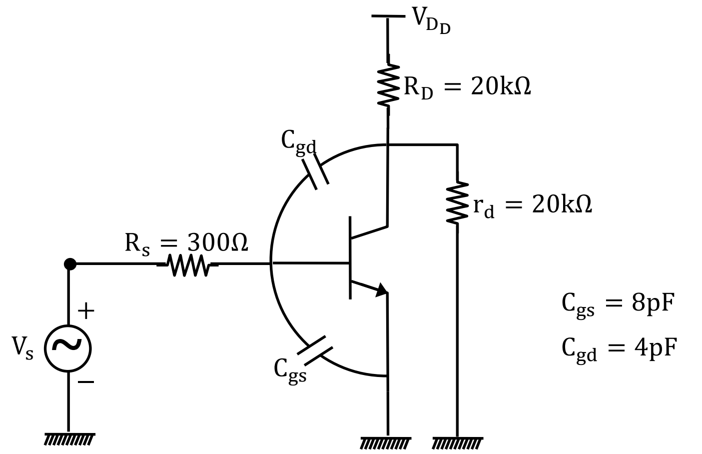
$I_a = 3I_{a1} = 6\text{pu}$

$$\text{Rated current} = \frac{\text{Rated MVA}}{\text{Rated kV}}$$

$$= \frac{25\text{MVA}}{\sqrt{3} \times 11\text{kV}} = 1.312 \text{ kA}$$

Fault current $I_a = 6 \text{ pu} = 6 \times 1.312 = 7.9 \text{ kA}$

30. [Ans. D]



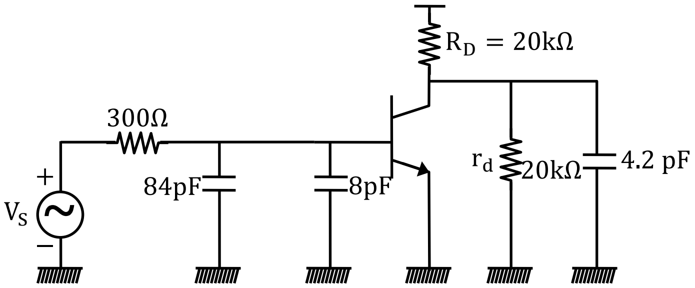
The midband gain of the circuit is

$A_V = -g_m(r_d||R_D)$

$= -2 \times 10^{-3}(20k\Omega||20k\Omega)$

$= -20$

Splitting the C_{gd} using Millers theorem we have



$C_{in} = C_{gd}(1 - Av)$

$= 4(1 + 20)$

$= 84$ pF

$$C_{out} = C_{gd}\left(1 - \frac{1}{Av}\right)$$

$$= 4\left(1 + \frac{1}{20}\right) = 4.2 \text{ pF}$$

Cut off frequency at input side

$$f_{in_{cutoff}} = \frac{1}{2\pi R_s(C_{in} + C_{gs})}$$

$$= \frac{1}{2\pi \times 300 \times 92 \times 10^{-12}} = 5.76 \text{ MHz}$$

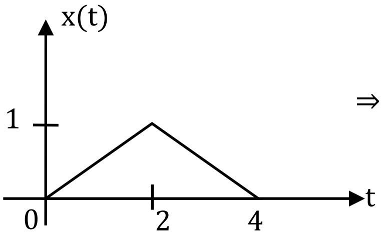
Cut off frequency at output side

$$f_{out_{cutoff}} = \frac{1}{2\pi\, C_{out}(R_D||r_d)}$$

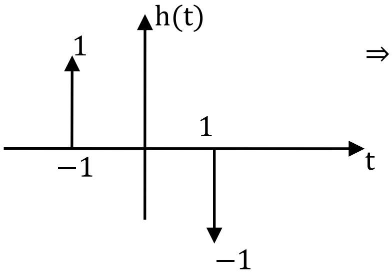
$$= \frac{1}{2\pi(4.2 \times 10^{-12}) \times 10^1 \times 10^3} = 3.7 \text{ MHz}$$

As the upper cutoff frequency is defined by the minimum of the input and output cutoff, thus 3.7 MHz is the correct answer.

31. [Ans. B]



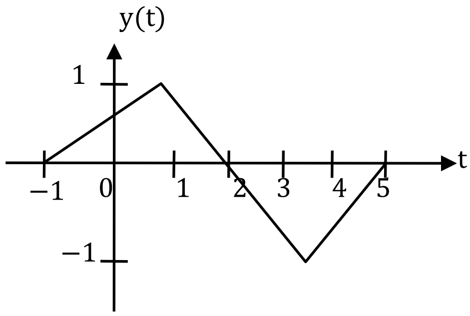
$$\Rightarrow x(n) = \left\{\underset{\uparrow}{0}, \frac{1}{2}, 1, \frac{1}{2}, 0\right\}$$



$$\Rightarrow h(n) = \{1, \underset{\uparrow}{0}, -1\}$$

h(n) \ x(n)	0	1/2	1	1/2	0
1	0	1/2	1	1/2	0
→ 0	0	0	0	0	0
−1	0	−1/2	−1	−1/2	0

$$y(n) = \left\{0, \underset{\uparrow}{\frac{1}{2}}, 1, 0, -1, -\frac{1}{2}, 0\right\} \Rightarrow$$



$$\therefore \int_{-\infty}^{\infty} y(t)dt = 0 \text{ (from the figure)}$$

32. [Ans. B]

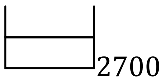
LXI B, 2100 H $B \leftarrow 21$

$C \leftarrow 00$

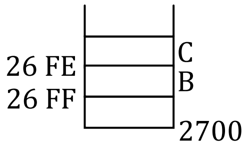
LXI D, 0200 H $D \leftarrow 02$

$E \leftarrow 00$

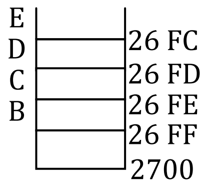
LXI SP, 2700



PUSH B



PUSH D



LXI H, 0100 $H \leftarrow 01$

$L \leftarrow 00$

XTHL $H \leftarrow 02$

$L \leftarrow 00$

DAD D

$$\begin{array}{rcc} & 02 & 00 \\ + & 02 & 00 \\ \hline & 04 & 00 \\ & \uparrow & \uparrow \\ & H & L \end{array}$$

HLT

D,E pair remains unchanged

33. [Ans. *] Range:1 to 2

R_0 facing R_E is given by $\dfrac{R_s + r_\pi}{\beta_0 + 1}$

$g_m . r_\pi = \beta_0;\ g_m = \dfrac{0.25}{25}\ \left[g_m = \dfrac{I_c}{V_T}\right]$

$r_\pi = 150 \times \dfrac{25}{0.25} = 15k\Omega$

$R_0 = \dfrac{3 + 15}{151} = 119.2\Omega$

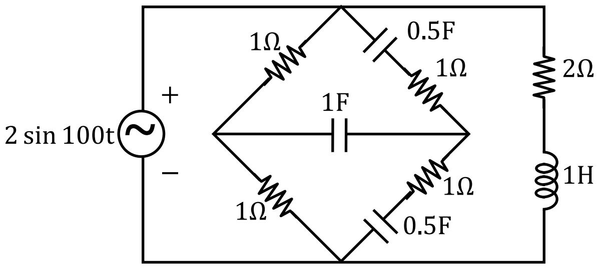
$R_0' = R_0 || R_E = 110\Omega$

$\Rightarrow \dfrac{R_0 R_E}{R_0 + R_E} = 110$ with $R_0 = 119.2\Omega$

$\Rightarrow R_E = 1.42k\Omega$

34. [Ans. B]

This circuit is drawn again for better understanding. The simplified diagram is shown below



Now from the figure it is clear that the 1 Farad capacitor is connected in a bridge network which is completely balanced. Therefore voltage on the both side of the capacitor will be same and make zero drop across the capacitor

Hence current flowing through it will be zero.

35. [Ans. A]

$z^2e^{-z} \Rightarrow (x+iy)^2e^{-(x+iy)}$

$(x^2-y^2+2xy)(e^{-x})(\cos y - i\sin y)$

$(e^{-x})[(x^2-y^2)\cos y + 2xy\sin y]$

36. [Ans. D]

$x^2 - x + I = 0$, Multiplying both sides by x^{-1}

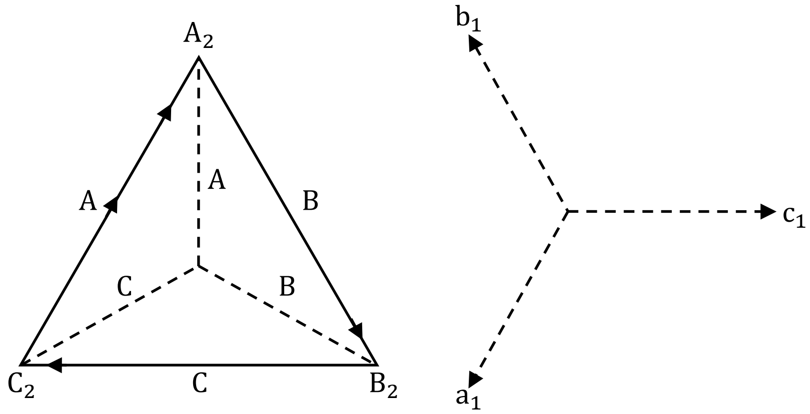
$x - I + x^{-1} = 0$

$$\therefore x^{-1} = I - x = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix} - \begin{bmatrix} b^2 & 1 \\ (b^2+b-1) & (1-b)\end{bmatrix} = \begin{bmatrix}(1-b^2) & -1 \\ (1-b-b^2) & b\end{bmatrix}$$

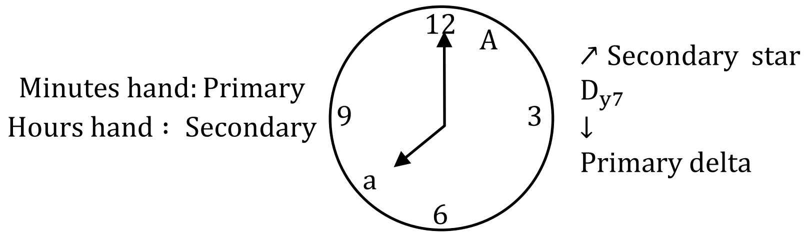
37. [Ans. A]

In order to find the displacement between the vectors there is a procedure

1. Primary is arbitrarily (directly) drawn
2. Secondary can't be drawn directly but we should draw analogously based on primary connection (it may be parallel (or) Antiparallel)
3. When dotted terminals are shown in figure we should draw Antiparallel w.r.t primary [when o/p terminal dotted on primary and o\p terminal undotted on secondary we draw antiparallel]



For to find displacement exactly convert primary Δto Y by conversion
Now take a clock and place any one winding on the clock



38. [Ans. B]

$$T_e\ \alpha \frac{sV^2}{\omega_s R_2}$$

$$T_{e(FL)} = \frac{7500 \times 60}{2\pi \times 1000 \times 0.96} = 74.6\ \text{Nm}$$

$$74.6 \alpha \frac{0.04 \times 400^2}{\omega_s R_2}$$

$$6 \alpha \frac{s \times 200^2}{\omega_s R_s}$$

$s = 0.01287$

No – load speed $= 1000(1 - 0.01287) = 987$ rpm

39. [Ans. *] Range: 100030 to 100035

$V_1 = 250V; V_2 = 92V; t = 60$ seconds

$C = 600 \times 10^{-12} F$

Since $V_2 = V_1 e^{-t/CR}$

$$\frac{t}{CR} = \log_e \frac{V_1}{V_2}$$

$$\therefore R = \frac{t}{C \log_e \frac{V_1}{V_2}} = \frac{60}{600 \times 10^{-12} \log_e \frac{250}{92}} = 100{,}033\ M\Omega$$

40. [Ans. B]

x(t) at max be '∞' and at minimum be '−∞' but |x(t)| at max be '∞' and at minimum be '0' and $e^{-\infty} = 0$ and $e^{0} = 1$

$\therefore e^{-5|x(t)|} \in [0, 1]$

∴It is strictly bounded

41. [Ans. *] Range: -0.25 to -0.25

Forward Transfer function $G(s) = \dfrac{AB}{s(s + (P + Bk_r))}$

$C.E = s^2 + s(P + B\,k_r) + AB = 0$

System is marginally stable

So $P = -Bk_r = -256$

and $-\omega_0^2 + AB = 0$

$\omega_0 = \sqrt{AB} = 64$

So, $\dfrac{\omega_0}{P} = \dfrac{-64}{256} = -\dfrac{1}{4} = -0.25$

42. **[Ans. *] Range: 8 to 8**

Given

$x[-2] = x[2] = -2$

$x[-1] = x[1] = 1$

$x[0] = 4$

Property $X(0) = \dfrac{1}{2\pi} \displaystyle\int_{-\pi}^{\pi} X(\omega)\, d\omega$

$$\frac{1}{\pi} \int_{-\pi}^{\pi} X(\omega)\ d\omega = 2x(0)$$

$$= 8$$

43. [Ans. D]

$\dot{x}_1 = -3x_1 + x_2 + (4 - 3(1))u$

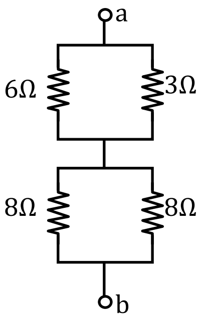
$\dot{x}_2 = -2x_1 + x_3 + (6 - 2(1))u$

$\dot{x}_3 = -x_1 + (2 - 1(1))u$

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-3 & 1 & 0\\ -2 & 0 & 1\\ -1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}1\\ 4\\ 1\end{bmatrix}[u], y = x_1$$

44. [Ans. B]

Replacing current source by open circuit and voltage source by short circuit



$R_{ab} = 6\|3 + 8\|8\Omega$

$= 6\Omega$

45. [Ans. A]

Fourier transform is Laplace transform on imaginary axis.

∴ For stability ROC must include imaginary axis.

∴ Fourier transform exists only for stable system ROC for causal signal is right of rightmost pole in s-plane

∴ All pole must lie on left half of s-plane.

46. [Ans. *] Range: 8.81 to 8.86

$$E = -\frac{dv}{dx} = -\frac{d}{dx}(10^5 x) = -10^5 V/m$$

$$\text{Energy density} = \frac{\text{Enegry}}{\text{volume}} = \frac{1}{2}\epsilon_0\ E^2$$

$$\frac{\text{Energy}}{\text{volume}} = \frac{1}{2} \times \frac{1}{36\pi} \times 10^{-9} \times (-10^5)^2$$

$$\text{Energy} = \frac{1}{2} \times \frac{1}{36\pi} \times 10^{-9} \times (-10^5)^2\ [Ad]$$

$$= \frac{1}{2} \times \frac{1}{36\pi} \times 10^{-9} \times 10^{10}[100 \times 0.2 \times 10^{-2}]$$

$$= 8.84mJ = 8.84 \times 10^{-3} J$$

47. [Ans. *] Range: 0.25 to 0.25

Let B-boy and G – Girl, C – Cricketer

$P(B) = 60\% = 0.60, P(G) = 40\% = 0.40$

$P(C/B) = 50\% = 0.50, P(C/G) = 25\% = 0.25$

$P(G/C) = ?$

By Bayes theorem

$$P(G/C) = \frac{P(G)P(C/G)}{P(G)P(C/G) + P(B)P(C/B)}$$

$$= \frac{(0.40)(0.25)}{(0.40)(0.25) + (0.60)(0.50)}$$

$$= \frac{0.1}{0.1 + 0.3} = \frac{0.1}{0.4} = 0.25$$

48. [Ans. *] Range: 24 to 24

By KCL at output node

$I_x + I_2 = 2I_x$

$I_2 = I_x$

$V_x = 4I_2 + V_2 \ldots\ldots\ldots (1)$

$\frac{V_1 - V_x}{4} = \frac{V_x}{4} + I_2 \ldots\ldots\ldots (2)$

$V_1 - V_x = V_x + 4I_2$

So,

$V_1 = 2V_x + 4I_2$

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

$= 8I_2 + 4I_2 + 2V_2$

$V_1 = 2V_2 + 12I_2$

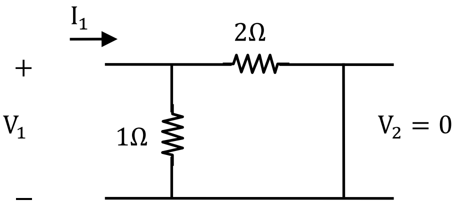
$S = 2, \quad M = 12$

$M \times S = 24$

49. [Ans. *] Range: 1.49 to 1.51

$I_1 = V_1 y_{11} + V_2 y_{12}$

$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$



$\Rightarrow y_{11} = \frac{1}{\frac{2}{3}} = \frac{3}{2} \mho$

50. [Ans. A]

$$\text{Load impedance } Z = 4 + j\left(2\pi \times 50 \times 35m - \frac{1}{2\pi \times 50 \times 155\mu}\right)$$

$$= 4 + j(10.99 - 20.53) = 10.345\angle - 67.25°$$

Diode conducts for 67.25°

Thyristor conducts for $180° - 67.25° = 112.75°$

$$\therefore \text{Conduction time} = \frac{112.75 \times \pi}{180 \times 2\pi \times 50} = 6.264 \text{ ms}$$

51. [Ans. B]

$$P_d = V_{01} \times I_{01} \cos\phi$$

$$V_{01} = \frac{4V_s}{\pi \times \sqrt{2}} \text{ Volt}$$

$$\text{and } I_{01} = \frac{200}{\sqrt{2}} \text{mA}$$

$$\therefore P_d = \frac{4 \times 220}{\pi \times \sqrt{2}} \times \frac{200}{\sqrt{2}} \cos 45° \times 10^{-3}$$

$$P_d = 19.8\text{W}$$

52. [Ans. *] Range: 0.5 to 0.53

The angle θ by which the current in pressure coil lags behind the voltage

$$\theta = \tan^{-1}\frac{\omega L_P}{r_p + R} = \tan^{-1}\left(\frac{2\pi \times 50 \times 5 \times 10^{-3}}{3000}\right)$$

$$= \tan^{-1} 0.000523$$

$$\theta = 0.02996$$

Reading of wattmeter $= VI\cos(90° \pm \theta)$ [As power factor is zero]

$$= VI\sin\theta = VI\tan\theta \quad [\because \theta \text{ is very small}]$$

$$= 100 \times 10 \times 0.000523$$

$$= 0.523 \text{ Watts}$$

$\therefore$ Error $= 0.523$ W

53. [Ans. *] Range: 0.2 to 0.3

Actual energy consumed in 12 hours = Load in kW × Time in hours

$$= 1 \times 12 = 12 \text{ kWh}$$

Revolution made by disc in 12 hours = Speed × Time

$$= 10.2 \times 12 \times 60$$

$$= 7344$$

$$\text{Energy consumption} = \frac{7344}{600} = 12.24 \text{ kWh}$$

$$\text{Error} = 12.24 - 12 = 0.24 \text{ kWh}$$

54. [Ans. *] Range: 30 to 30

$$T(s) = \frac{1}{s^3 + 6s^2 + 5s + k}$$

Routh table

s^3	1	5
s^2	6	k
s^1	$\frac{30-k}{6}$	
s^0	k	

For marginally stability

$30 - k = 0; k = 30$

55. [Ans. D]

For stable system $|sI - A| = 0$ should have roots in left half s – plane.

$$|sI - A| = \begin{vmatrix} s-x & 0 & 0 \\ 0 & s-y & -1 \\ 0 & 1 & s+2 \end{vmatrix} = (s-x)[(s-y)(s+2)+1]$$

$$= (s-x)[s^2 + s(2-y) + 1 - 2y]$$

The roots to lie in left hand plane,

$x < 0$

$2 - y > 0$

And $1 - 2y > 0$

$\therefore y < 2$ and $y < \frac{1}{2}$

$\therefore x < 0$

$y < 1/2$

56. [Ans. D]

They will chime together after the time in minutes equal to LCM of 18, 24, 32.

$18 = 2 \times 3 \times 3$

$24 = 2 \times 2 \times 2 \times 3$

$32 = 2 \times 2 \times 2 \times 2 \times 2$

$\therefore$ LCM $= 2 \times 2 \times 2 \times 3 \times 3 \times 2 \times 2 = 288$

288 min = 4 hrs 48 min.

57. [Ans. C]

According to the statement, 80% of the total runs were made by spinners. So, conclusion I does not follow. Nothing about the opening batsmen is mentioned in the statement. So, conclusion II also does not follow

58. [Ans. D]

1 km = 1000 meter

1 min = 60 second

$$\text{Average speed } = \frac{\text{Total distance}}{\text{Total time}}$$

Total distance = 12 km = 12000 meter

Total time = 6 + 6 +12 minute = 24 × 60 = 1440 seconds

$$\text{Average speed } = \frac{12000}{1440} = 8.33 \text{ m/s}$$

59. [Ans. A]

60. [Ans. C]

CEPQS - E cannot go with S.

AEPQS - C and P have to be together. E cannot go with S.

ACPRS -It satisfies all the conditions and also there are two boys in the team.

BDPRS - C and P have to be together.

Hence, C

61. [Ans. A]

$$\text{Number of males in U.P } = \left[\frac{3}{5} \text{ of } (15\% \text{ of N})\right] = \frac{3}{5} \times \frac{15}{100} \times \text{N} = \frac{9\text{N}}{100}$$

$$\text{Total population, N } = 3276000$$

$$\text{Number of males in M.P } = \left[\frac{3}{4} \text{ of } (20\% \text{ of N})\right] = \frac{3}{4} \times \frac{20}{100} \times \text{N} = \frac{15\text{N}}{100}$$

$$\text{Number of males in Goa } \left[\frac{3}{8} \text{ of } (12\% \text{ of N})\right] = \frac{3}{8} \times \frac{12}{100} \times \text{N} = \frac{4.5\text{N}}{100}$$

$$\text{Total males in these 3 states } = \frac{(9 + 15 + 4.5)\text{N}}{100} = \frac{28.5\text{N}}{100}$$

$$\text{Required \% } = \left(\frac{28.5 \times \frac{\text{N}}{100} \times 100}{\text{N}}\right)\% = 28.5\%$$

62. **[Ans. C]**

A cube is cut into 125 smaller cubes.

$\therefore$ Length of cube $= \sqrt[3]{125}$

$\therefore l = 5$ unit

Let upper face be coloured red.

Then bottom face will be coloured green, two adjacent faces are coloured yellow and blue respectively.

Two faces are uncoloured.

Number of cubes uncoloured on all faces $= (n-2)^3 = (5-2)^3 = 27$

Now there are two surfaces which are not coloured.

$\therefore$ There will be 9 cubes at centre on both the uncoloured surfaces each.

3 cubes at the common edge of both uncoloured surfaces.

$\therefore$ Total number of uncoloured cubes $= 27 + 9 + 9 + 3 = 48$

63. **[Ans. C]**

64. **[Ans. B]**

The passage clearly states the unawareness of teachers regarding population education. Thus, the teachers should be given a proper orientation on the same.

65. **[Ans. C]**

In statement I nothing is given about c. Hence it is not enough to answer the question.

In statement II nothing is mentioned about a. Hence this statement alone cannot answer the question.

Combining both the statements we get

$a : b : c = 3 : 15 : 10$

$\therefore a : c = 3 : 10$

$$\frac{a}{c} = \frac{3}{10}$$

$$\frac{a+c}{c} = \frac{3+10}{10} = \frac{13}{10}$$

$\therefore$ Question can be answered using both the statements.

Hence, C.