Offline GATE Mock – 4 _ Solutions

General Aptitude (GA)

One Mark Solutions:

01. Ans: (A)

(ACTION AND PURPOSE) One slices a cake before eating; one carves a turkey before cooking.

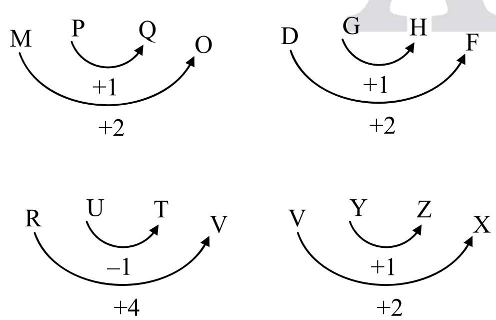
02. Ans: (C)

03. Ans: (A)

Apparent mean visible, easy to see or understand while Ambiguous mean no clear stated or defined.

04. Ans: (C)

Sol:



∴ RUTV is different Ans is **(C)**

05. Ans: (B)

Sol: Clearly, thirteenth result

= (sum of 25 results) – (sum of 24 results)

= (18×25) – [(14×12)+(17×12)]

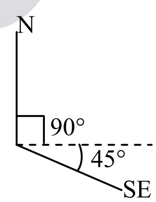
= 450 – (168+204) = 450 – 372 = 78

Two Mark Solutions:

06. Ans: (C)

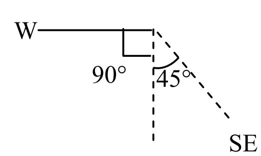
07. Ans: (C)

Sol: If south–East becomes north, it suggests that there is a movement of 135° in anti-clockwise direction.



Similarly, when North-East becomes west

∴ When west moves 135° in anti-clock wise direction, it becomes south–East



08. Ans: (B)

Sol: Dist covered by a wheel in 1 rev

= Circumference of the wheel

$= 2\pi r$

$= 2\times\frac{22}{7}\times 1.5$

No. of rev made $= \frac{\text{total distance covered}}{\text{distance in 1 Revolution}}$

$= \frac{5280}{2\times\frac{22}{7}\times 1.5} \Rightarrow \frac{5280\times 7}{66} \Rightarrow 560$

$\therefore$ Time taken to cover the distance $= \frac{560}{28}$

= 20 min

09. Ans: (C)

Sol: Among all given alternatives, divisible by 3 is 48 only

for R $\Rightarrow \frac{48}{3}=16 \Rightarrow 48-16=32+4=36$

for r S $\Rightarrow \frac{36}{4} = 9 \Rightarrow 36\text{-}9= 27+3=30$

for T $\Rightarrow \frac{30}{2}=15 \Rightarrow 30\text{-}15 = 15+2=17$

$\therefore$ Ans 48

10. Ans: (B)

Specific section (EE)

One mark Solutions:

01. Ans: (C)

Sol: The given signal is finite duration both sided signal, so ROC is $0<|z|<\infty$

02. Ans: (c)

Sol: Given $\frac{dy}{dx} = \left[\frac{y}{x}\right] + \tan\left(\frac{y}{x}\right)$

It is Homogeneous DE

Put $\frac{y}{x} = v \Rightarrow y = vx$

$\Rightarrow \frac{dy}{dx} = v + x\frac{dy}{dx}$

$\frac{dy}{dx} = \left(\frac{y}{x}\right) + \tan\left(\frac{y}{x}\right)$

$\Rightarrow v + x\frac{dv}{dx} = v + \tan(v)$

$\Rightarrow \quad x\frac{dv}{dx} = \tan v$

$\Rightarrow \int \cot v\, dv = \int \frac{dx}{x}$

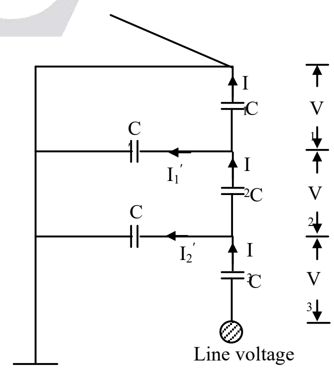
$\Rightarrow \log(\sin v) = \log x + \log c$

$\Rightarrow \log(\sin v) = \log(cx)$

$\therefore \sin\left(\frac{y}{x}\right) = cx$ is required solution

03. Ans: (A)

Sol: Capacitance Distribution Network



Top unit, V_1 = 7kV

Middle unit, V_2 = 10kV

$$\frac{\text{Pin to earth capacitance}}{\text{Self capacitance}} = K$$

$V_2 = (1+K)V_1$

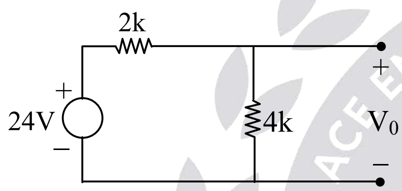
$10 = (1+K) \times 7$

$1 + K = \frac{10}{7}$

$K = \frac{10}{7} - 1 = 0.42$

04. Ans: (D)

Sol: Calculate the terminal voltage



$= \frac{24(4)}{2+4} = 16\text{V}$

$V_0 < (V_z + V_{DON})$, therefore no current flows through zener, $I_L = \frac{V_0}{4k} = \frac{16}{4k} = 4\text{mA}$

05. Ans: (D)

Sol: Ripple factor, $R.F = \frac{\sqrt{V_{or}^2 - V_0^2}}{V_0}$

$$R.F = \frac{\sqrt{\alpha V_s^2 - \alpha^2 V_s^2}}{\alpha V_s}$$

$$R.F = \sqrt{\frac{1}{\alpha} - 1} = \sqrt{(1-\alpha)/\alpha}$$

06. Ans: 8.66

Sol: $\% \text{ Reg} = \frac{V_{sc}}{E_2} \times \cos(\phi_{sc} - \phi) \times 100$

$$= \frac{220}{2200} \times \cos(75 - 45^\circ) \times 100 = 8.66\%$$

07. Ans: (D)

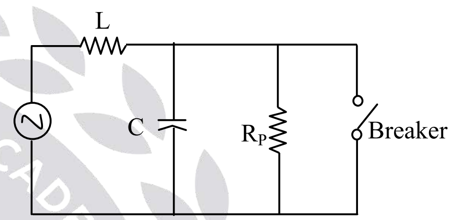
Sol: Unstable system, hence error is unbounded

$$CE = 1 + \frac{9}{s^2(s+3)} = 0$$

$s^3+3s^2+9 = 0$ system is unstable and hence steady state error = ∞.

08. Ans: (B)

Sol:



The value of resistance R_P needed for critical damping of restriking voltage is

$$R_P = \frac{1}{2}\sqrt{\frac{L}{C}} \Rightarrow R_P = \frac{1}{2}\sqrt{\frac{1}{0.01 \times 10^{-6}}}$$

$$R_P = \frac{1}{2} \times 10^4 \Rightarrow R_P = 5000\,\Omega = 5\text{ k}\Omega$$

09. Ans: (D)

Sol: Let Q_n be the present state and Q_{n+1} be next state of given X – Y flip-flop.

X	Y	Q_n	Q_{n+1}
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

Solving from K-map

X \ YQ_n	00	01	11	10
0	1	1	1	1
1	1		1	

Characteristic equation of X – Y flip-flop is

$$Q_{n+1} = \overline{Y}\,\overline{Q}_n + \overline{X}Q_n$$

Characteristic equation of a J – K flip-flop is given by

$$Q_{n+1} = J\overline{Q}_n + \overline{K}Q_n$$

By comparing

$J = \overline{Y}, K = X$

10. Ans: (B)

Sol: efficiency $\eta = \frac{P_{out}}{P_{in}}$

$P_{in} = \frac{P_{out}}{\eta} = \frac{7.46\times10^3}{0.85} = 8.77$ kW

Motor line current, $I_L = \frac{P_{in}}{V} = \frac{8.77\times10^3}{440}$

$= 19.93$ A

$I_{sh} = \frac{V}{R_{sh}} = \frac{440}{200} = 2.2A$

Armature current, $I_a = I_L - I_{sh} = 19.93 - 2.2 = 17.73A$

$E_a = V - I_aR_a = 440 - 17.73\times0.6 = 429.36V$

11. Ans: (A)

In graph theory,

- Every f-loop consists of only one link in its representation
- Every f-cutset consists of only one twig in its representation
- Tree connects all the nodes without any closed loop
- In a complete graph, between any pair of nodes only one branch is connected for all the combinations.

12. Ans: 1

13. Ans: (B)

Sol: The probability density function of X is

$$f(x) = \begin{bmatrix} \frac{1}{30}, & 0 < x < 30 \\ 0\ , & \text{otherwise} \end{bmatrix}$$

$$P(5 < X < 10) = \int_5^{10} f(x)\,dx = \int_5^{10} \frac{1}{30}dx = \frac{1}{6}$$

14. Ans: 0.93 (Range: 0.9 – 0.95)

Sol: Required probability = P $(A\cup B\cup C)$

$= P(A) + P(B) + P(C) - P(A\cap B) - P(B\cap C) - P(A\cap C) + P(A\cap B\cap C)$

$= 0.8 + 0.5 + 0.3 - (0.8)(0.5) - (0.5)(0.3) - (0.8)(0.3) + (0.8)(0.5)(0.3)$

$= 0.93.$

15. Ans: (A)

Sol: S = 2000 MW; P = 1000 MW

H = 5 MW/MVA; R = 2.4 Hz/pu MW

$$B = \frac{\frac{1}{100}\times1000}{\frac{1}{100}\times50} = \frac{10}{0.5} = 20$$

Damping coefficient 'B' in pu MW/Hz

$$= \left(\frac{\partial P_D}{\partial f}\right)/P_r = \frac{20}{2000}$$

$= 0.01$ pu MW/Hz

16. Ans: (A)

Sol: If A and B are independent, then

$P(A\cap B) = P(A) . P(B)$

$\Rightarrow P(A\cap B) = (0.4) . P(B)$ ………. (1)

By addition theorem,

$P(A\cup B) = P(A) + P(B) – P(A\cap B)$

$\Rightarrow 0.6 = (0.4) + P(B) – P(A\cap B)$ ………. (2)

From (1), and (2),

$0.6 = 0.4 + P(B) – (0.4) P(B)$

$\Rightarrow P(B) = \frac{1}{3}$

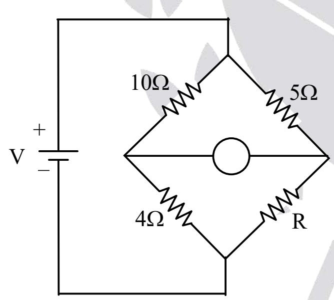
17. Ans: (C)

Sol: Both diodes are RB

$I_D = \frac{15}{8k+3k} = \frac{15}{11}$ mA

18. Ans: (A)

Sol: By using wheatstone bridge principle



$10\times R = 20 \Rightarrow R = 2\ \Omega$

19. Ans: (B)

20. Ans: 1.14 Ω [Range 1.1 to 1.2]

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

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

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

$= 182.4$ V

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

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

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

21. Ans: (C)

Sol: Stoke's theorem is

$\oint_\ell \overline{H}.d\overline{\ell} = \int_s J.ds$

Converts form closed line to open surface.

22. Ans: (A)

Sol: Root locus diagram starts at poles are at s = 0, s = −20 and s = ∞ and ends/terminates at s = −10, s = −10 and s = −100.

23. Ans: (D)

Sol: The given D.E

$4y'''+4y''+y' = 0$

$\Rightarrow 4D^3 + 4D^2 + D = 0$

$\Rightarrow D(2D + 1)^2 = 0$

$D = 0, \frac{-1}{2}, \frac{-1}{2}$

$\therefore y_c = C_1 + (C_2 + C_3x)e^{-1/2}x$

24. Ans: (D)

Sol: $I_{LV} = 10 \times 2 = 20$ A

(transformation ratio = 2)

$Z = 0.15 + j0.37 = 0.399\angle 67^o$

$I_0 = \frac{200}{600} - \frac{j200}{300} = 0.33 – j0.67$

$I = I_1' + I_0 = 20\angle -36.86 + 0.33 –j0.67$

$= 20.65\angle -37.8$

25. Ans: 1

Sol: Here, $i_L(0^-) = 0A = i_L(0^+)$

$V_C(0^-) = 0V = V_C(0^+)$

By KVL in s-Domain ⇒

$$\frac{10}{s} = 2I(s) + 1s\,I(s) + \frac{2}{s}I(s)$$

$$= I(s)\left(2 + s + \frac{2}{s}\right)$$

$$\Rightarrow \frac{10}{s} = I(s)\frac{(2s + s^2 + 2)}{s}$$

$$\Rightarrow I(s) = \frac{10}{s^2 + 2s + 2}$$

So, the characteristic equation is

$s^2 + 2s + 2 = 0$

by comparing with $s^2 + 2\xi\omega_n s + \omega_n^2 = 0$

$\Rightarrow 2\xi\omega_n = 2 \Rightarrow \xi\omega_n = 1$

$$\Rightarrow \tau = \frac{1}{\xi\omega_n}\sec = \frac{1}{1} = 1\sec$$

Two Marks Solutions:

26. Ans: (A)

Sol: Let the output from the upper first level multiplexer is f_a and form the lower first level multiplexer is f_b

$f_a = \overline{w}x + w\overline{x},$

$f_b = \overline{w}x + wx = x$

$f = f_a\overline{y}\,\overline{z} + f_b y\overline{z} + yz = (\overline{w}x + w\overline{x})\overline{y}\,\overline{z} + xy\overline{z} + yz$

$= \overline{w}x\overline{y}\,\overline{z} + w\overline{x}\,\overline{y}\,\overline{z} + xy + yz$

27. Ans: (C)

Sol: Given data:

$R_1 = 1500\Omega$, $C_1 = 0.03$

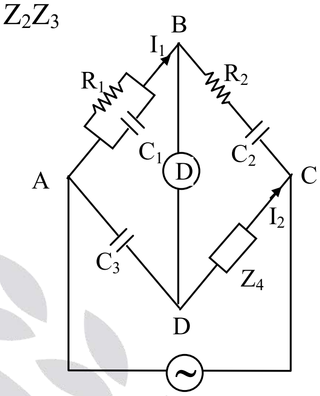
$R_2 = 1876\ \Omega$ in series with $C_2 = 0.03\ \mu F$

CD = unknown

DA = $C_3 = 0.5\ \mu F$

We don't know the value of 'Z', but it is a combination of R, L (or) R, C.

$Z_1Z_4 = Z_2Z_3$



$$\left(\frac{R_1}{1 + j\omega C_1R_1}\right)Z_4 = \left(R_2 + \frac{1}{j\omega C_2}\right)\frac{1}{j\omega C_3}$$

$$Z_4 = \left(\frac{R_2}{j\omega C_3} - \frac{1}{\omega^2 C_2C_3}\right)\left(\frac{1 + j\omega C_1R_1}{R_1}\right)$$

$$= \frac{R_2}{jR_1\omega C_3} + \frac{C_1}{j\omega C_2C_3} + \frac{R_2C_1}{C_3} - \frac{1}{\omega^2 C_2C_3R_1}$$

Substitute all values.

$Z_4 = 112.559 - j716.3$

Z_4 is a combination of R and C

$$\frac{1}{\omega C_4} = 716.3$$

$$C_4 = \frac{1}{716.3 \times 2\pi \times 10^3} = 0.222\mu F$$

28. Ans: (C)

Sol: 2000H : LXI SP, 2724H ; (SP) = 2724H

2003H : CALL 2006H ;

(TOS) ←(PC),(SP)↓↓

(TOS) = 2006H

(SP) = 2722H

2006H : POP H ; (HL) ←(TOS), (SP)↑↑

(HL) = 2006H

(SP) = 2724 H

2007H : INR H ; (H) ← (H) + 1

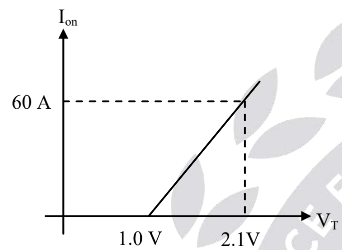
(H) = 21

Thus (HL) = 2106H & (SP) = 2724H

29. Ans:(C)

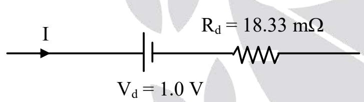
Sol: Given that

$$\nu_T = 1 + \frac{2.1-1}{60} i_a = 1 + 0.0183\ i_a$$

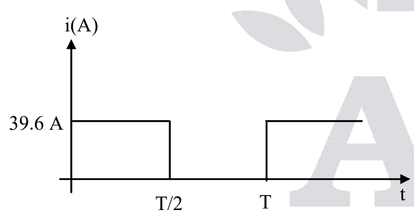


$$R_d = \frac{2.1-1.0}{60} = 18.33 m\Omega$$

The diode is represented as follows



A level current of 39.6 A for one half cycle.



$$I_{avg} = 39.6 \times \frac{T/2}{T} = \frac{39.6}{2} = 19.8 A$$

$$I_{rms} = 39.6\sqrt{\frac{\frac{T}{2}}{T}} = \frac{39.6}{\sqrt{2}}$$

I_{rms} = 28 A

Mean power loss

$= 19.8 \times 1 + 28^2 \times 18.33 \times 10^{-3}$

= 34.17 W

30. Ans: (D)

31. Ans: (421.39) Range: (417 to 424)

Sol: $|\overline{E}| = \dfrac{k}{\rho}$

$$W_E = \frac{\varepsilon_0}{2}\int |\overline{E}|^2\ d\nu$$

$$= \frac{\varepsilon_0}{2}\int_2^3\int_0^{\pi/2}\int_5^7 \frac{k^2}{\rho^2} \times \rho\ d\rho\ d\phi\ dz$$

$$= \frac{\varepsilon_0}{2} \times k^2 \times [\ln\rho]_2^3 [\phi]_0^{\pi/2} [z]_5^7$$

$$= k^2 \times \frac{10^{-9}}{36\pi \times 2} \times \ln\left(\frac{3}{2}\right) \times \frac{\pi}{2} \times 2$$

$$= k^2 \times \frac{10^{-9}}{72} \times \ln\left(\frac{3}{2}\right)$$

$W_E = 1\mu J = 10^{-6}$

$$\Rightarrow k^2 \times \frac{10^{-9}}{72} \times \ln\left(\frac{3}{2}\right) = 10^{-6}$$

$$\Rightarrow k^2 = \frac{72}{10^{-3} \times \ln\left(\frac{3}{2}\right)} = 177573.84$$

$\Rightarrow k = 421.39$

32. Ans : (A)

Sol: $A = 0.96\angle 1^\circ$ $B = 100\angle 80^\circ\ \Omega$; $\delta = 30°$

$|V_{SL}| = |V_{rL}| = 110$ kV

$V_s = AV_r + BI_r$

Receiving end voltage,

$$V_{rph} = \frac{110kV}{\sqrt{3}}\angle 0^\circ \text{(reference)}$$

Sending end voltage,

$$V_{sph} = \frac{110kV}{\sqrt{3}}\angle 30^\circ$$

From ABCD equations,

$V_{sph} = AV_{rph} + BI_{rph}$

$$I_{rph} = \frac{V_{sph} - AV_{rph}}{B}$$

$$I_{rph} = \frac{\frac{110k}{\sqrt{3}}\angle 30^\circ - (0.96\angle 1^\circ)\left(\frac{110k}{\sqrt{3}}\angle 0^\circ\right)}{100\angle 80^\circ}$$

$I_{rph} = 312.63\angle 20.98°$ A

Receiving end current magnitude $|I_{rph}|$

= 312.63A

Receiving end power factor $\cos\phi_r$

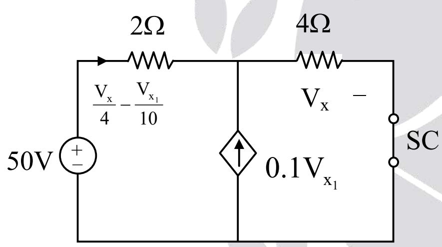
= cos (angle between V_{rph} & I_{rph})

= cos (0 –20.98) = 0.933 leading

33. Ans: –38.5 (Range –37 to –39)

Sol: By superposition theorem

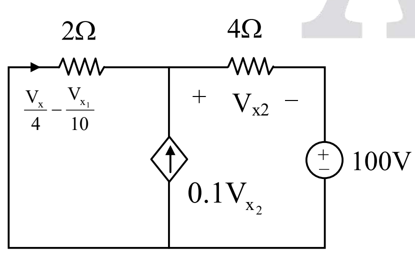
Take 50V (100V – short circuit)



$$50 = \frac{V_{x_1}}{2} - \frac{V_{x_1}}{5} + V_{x_1}$$

V_{x_1} = 38.5 Volts

Take 100V (50V – short circuit)



$$\frac{V_{x_2}}{2} - \frac{V_{x_2}}{5} + V_{x_2} + 100 = 0$$

$$5V_{x_2} - 2V_{x_2} + 10V_{x_2} + 1000 = 0$$

$$13V_{x_2} = -1000$$

$$V_{x_2} = -77$$

By superposition theorem = $V_x = V_{x_1} + V_{x_2}$

= 38.5 – 77

= –38.5V

34. Ans: δ_{cr} = 70.336 (68 to 72)

Sol: $\delta = 30°$, $P_{m2} = 0.5$, $P_{m3} = 1.5$, $P_s = 1.0$

$\delta_{0(rad)} = 0.52$

$$\delta_{max} = 180 - \sin^{-1}\left(\frac{P_s}{P_{m3}}\right)$$

$$= 180 - \sin^{-1}\left(\frac{1.0}{1.5}\right)$$

δ_{max} = 180 – 41.80 = 138.18

$$\delta_{max} = 138.18 \times \frac{\pi}{180} = 2.41$$

$$\delta_c = \cos^{-1}\left[\frac{1.0(2.41-0.523)+1.5\cos 138.18 - 0.5\cos 30^\circ}{1.5-0.5}\right]$$

$$= \cos^{-1}\left[\frac{1.00\times 1.887 + 1.5\times -0.7452 - 0.5\times\frac{\sqrt{3}}{2}}{1}\right]$$

$$= \cos^{-1}[1.887 + (-1.1175) - 0.433]$$

$= \cos^{-1}$ [1.887 – 1.5505]

$= \cos^{-1}$ [0.3365] = 70.336°.

35. Ans:6

Sol: Loops are L_1 = gh, L_2 = ab, L_3 = dc, L_4 = ef, L_5 = ebch and L_6 = gdaf.

36. Ans: (B)

Sol: $e^{-|t|} \leftrightarrow \frac{2}{1+\omega^2}$

$$\frac{2}{1+t^2} \leftrightarrow 2\pi e^{-|\omega|}$$

$$\frac{1}{1+t^2} \leftrightarrow \pi e^{-|\omega|}$$

37. Ans: (C)

Sol: Force acting on electron

$$\overline{F} = -e\overline{E} = -1.6\times10^{-19}(-2.5\times10^{6}\,\hat{a}_z)$$

$$= 4\times10^{-13}\,\hat{a}_z \text{ N}$$

$$F = ma = m\frac{dv}{dt}$$

$$\Rightarrow dv = \frac{Fdt}{m}$$

$$v = \int \frac{F}{m}dt + C$$

$$= \int \frac{4\times10^{-13}}{9.11\times10^{-31}}dt + C$$

$$= 4.39\times10^{17}\,t + C$$

We have at t= 0, v = 0, so that c = 0

$\therefore$ $v(t) = 4.39\times10^{17}\,t$ m/sec

38. Ans: (C)

Sol: Given that

3-ϕ V_s = 230 V, L_s = 4 mH: 3

I_0 = 10 A

Given V_0= –210 V

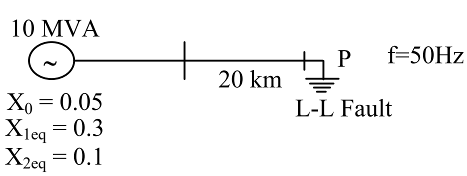
$$\cos\alpha = \frac{\pi\left(V_0 + \frac{3\omega L_s}{\pi}I_0\right)}{3V_{m\ell}}$$

$$\cos\alpha = \frac{\pi(-210+12)}{3\times\sqrt{2}\times230} = -0.6375$$

α = 129.60°

39. Ans: – 2.886 (Range: – 2.6 to –3.0)

Sol:



$$GMD = \sqrt[3]{5\times5\times5} = 5$$

Self GMD = $0.7788\times0.5\times10^{-2}$

$= 3.894\times10^{-3}$m

$$L = 2\times10^{-4}\, ln\left(\frac{5}{3.894\times10^{-3}}\right)$$

$= 14.315\times10^{-4}$ H/km

For 20 km length total inductance

$L_{eq} = 14.315\times10^{-4}\times20$

$= 0.0286$ H

$X_{eq} = 2\pi fL_{eq}$

$= 2\pi\times50\times0.0286 = 8.994\Omega$

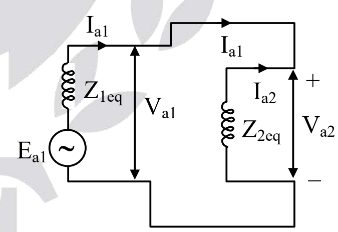
p.u. reactance of the line

$$= 8.994\times\frac{10\times10^{6}}{(30\,kV)^2} = j\,0.1 \text{ p.u.}$$

Transmission line $X_{1eq} = X_{2eq}$ = j 0.1 p.u.

LL-fault occurs at point P.

$$I_f = \frac{-j\sqrt{3}\,E_{a1}}{X_{1eq}+X_{2eq}} \quad [E_{a1} = \text{prefault voltage}]$$



$$I_f = \frac{-j\sqrt{3}\times1.0}{(j0.3+j0.1)+(j0.1+j0.1)}$$

I_f = –2.886 p.u.

40. Ans: 4

Sol: For the source free RC – circuit and with the given connection,

$$V_{C_1}(\infty) = V_{C_2}(\infty) = \frac{V_1C_1+V_2C_2}{C_1+C_2}\text{ Volts}$$

Where $V_1 = V_{C_1}(0)$ and $V_2 = V_{C_2}(0)$

$$\Rightarrow V_{C_1}(\infty) = V_{C_2}(\infty) = \frac{10.2 + 0.3}{2+3} \text{Volts}$$
$$= 4\text{V}$$

41. Ans: (D)

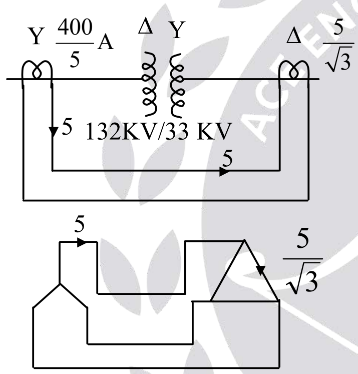
Sol: $V_{E1} = 0.7\text{V}$

$V_{E2} = V_{E1} - 0.7 = 0.7 - 0.7 = 0\text{V}$

42. Ans : 554.25 (Range :553 to 556)

Sol: The current transformer is connected opposite connection

i.e., Δ-side winding Y connection current transformer is taken to avoid phase angle.



The primary rating of current transformer is obtained by

$400 \times 132 = 33 \times x$

$\Rightarrow x = 1600$ A

The phase current of secondary side of HV CT = 5A

∴ The pilot current = 5A = Line current

∴ The phase current of Δ connected current transformer = $\frac{5}{\sqrt{3}}$ A.

∴ The current transformer ratio on LT side

$$= \frac{1600}{5/\sqrt{3}} = \frac{1600\sqrt{3}}{5} = 320\sqrt{3} = 554.25$$

Shortcut: The current in pilot wire and always taken as line current and current transformer rating is taken as phase currents.

43. Ans: (C)

Sol: $y(n) = x(n)*h_1(n)*h_2(n)$

$Y(z) = X(z)\, H_1(z)\, H_2(z)$

$$H_1(z) = \frac{1}{1-0.5z^{-1}}$$

$$H_2(z) = 1 - 0.5z^{-1}$$

$$Y(z) = X(z)$$
$$\downarrow \text{IZT}$$
$$y(n) = x(n)$$

44. Ans: (B)

Sol: The PM of a system is approximately equals to 100ξ

$40° = 100\xi$

$\therefore \xi = 0.4$

45. Ans: (A)

Sol: $e = -N\frac{d\phi}{dt}$;

$$\phi = \frac{-1}{N}\int e\,dt$$

$$= \frac{-1}{200}\int (200\sin\omega t - 50\sin 3\omega t)dt$$

$$\phi = \frac{1}{200}\left[\frac{200}{\omega}\cos\omega t - \frac{50}{3\omega}\cos 3\omega t\right] \text{Wb}$$

$\omega = 100\,\pi$,

$$\phi = \frac{1000}{200}\left[\frac{200}{100\pi}\cos\omega t - \frac{50}{300\pi}\cos 3\omega t\right] \text{mWb}$$

$$\phi = 5\left[\frac{2}{\pi}\cos\omega t - \frac{1}{6\pi}\cos 3\omega t\right] \text{mWb}$$

$= \frac{5}{\pi}\left[2\cos\omega t - \frac{1}{6}\cos 3\omega t\right]$

$W_e \propto \phi^2 f^2$

$W_1 = K[(2)^2 \times \omega^2 + (1/6)^2 \times 9\omega^2]$

$= K[4.25\ \omega^2]$

$W_2 = K(2^2\omega^2) = K \times 4\omega^2$

% Reduction $= \frac{4.25-4}{4.25} = 5.88\%$

46. Ans: (D)

Sol: Let f = 4x – 2y +3z –4;

Then $\hat{a}_x = \pm\frac{\overline{\nabla} f}{|\overline{\nabla} f|}$ gives possible unit vector which are perpendicular to f.

The unit vector with negative sign gives the unit vector which is directed from higher value of f toward, the lower value of f. the unit vector with positive sign gives the unit vector which is directed from lower value of f towards the higher value of f.

We have to determine $\overline{a_{21}}$

In region 1, at $P_1(0, 0, 100)$;

$f_1 = 4\times0 - 2\times0 + 3\times100 - 4$

$= 296$

In region 2, at $P_2(0, 0, -100)$;

$f_2 = 4\times0 - 2\times0 + 3\times-100 - 4$

$= -304$

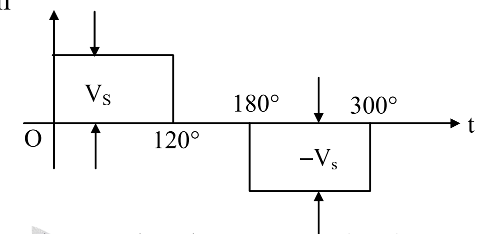
Hence we have to determine the unit vector from lower value of f (f_2 = –304) towards higher value of f (f_1 = 296). That is with positive sign

$$\hat{a}_n = \frac{\overline{\nabla} f}{|\overline{\nabla} f|} = \frac{4\hat{a}_x - 2\hat{a}_y + 3\hat{a}_z}{\sqrt{(4)^2+(-2)^2+(3)^2}}$$

$$= 0.74\hat{a}_x - 0.37\hat{a}_y + 0.55\hat{a}_z$$

47. Ans: 200 (200 to 200)

Sol: In 180° conduction mode the voltage wave form



So, peak to peak voltage = $V_s - (-V_s)$

$= 2V_s$

$= 2\times 100$

48. Ans: (B)

Sol: $\frac{V_0}{V_{in}} = \frac{+g_m R_c}{2} = \left(\frac{I_{CDC}}{v_t}\right).\frac{R_c}{2} = \frac{1mA}{Q5m}\left(\frac{2K}{2}\right)$

$= \frac{1000}{25} = 40$

49. Ans: (C)

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

= 9kW + 2kW + 0.8kW

P_{in} = 11.8kW.

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

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

50. Ans: (B)

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

MVI A,X ; (A) = X

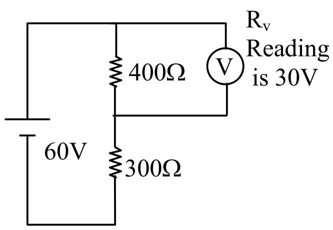
CMA ; (A) = $\overline{X}$

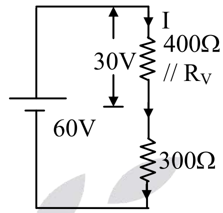
ADI 01H ; $(A) = \overline{X}+1$

51. Ans: 22.5 (Range: 22 to 23)

Sol: Say, the voltmeter resistance is R_v.

When the voltmeter is connected across 400Ω, the reading of the voltmeter is the voltage across parallel combination of 400Ω & R_v.





The voltage across 300Ω is 30V.

$V_{300\Omega} = 60V - 30V = 30V$

$$I = \frac{30V}{300\Omega} = 0.1A$$

Reading of voltmeter = 'V' across 400Ω//R_v

30V = 0.1A × 400Ω//R_v

$$\Rightarrow \quad 400\Omega \,//\, R_v = \frac{30V}{0.1A}$$

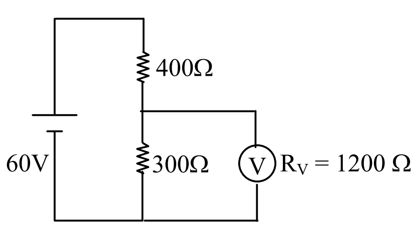
$$\Rightarrow \quad \frac{400\Omega \times R_v}{400\Omega + R_v} = 300\Omega$$

$400\Omega \times R_v = 400\Omega \times 300\Omega + 300\Omega \times R_v$

$100\Omega \times R_v = 400\Omega \times 300\Omega$

$\Rightarrow R_v = 1200\Omega$.

Now, the same voltmeter (with R_v of 1200Ω) is connected across 300Ω. As such, the reading of voltmeter is the voltage across parallel combination of 300Ω & 1200Ω.



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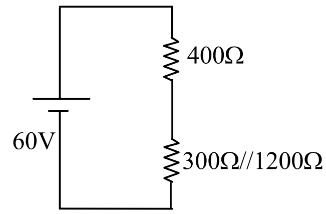


$$R_{eff} = \frac{300\Omega \times 1200\Omega}{1500\Omega} = 240\Omega$$

∴ Reading of voltmeter

$$= 60V \times \frac{240\Omega}{400\Omega + 240\Omega}$$

$$= 60V \times \frac{240\Omega}{640\Omega} = 22.5V$$

Voltmeter indicates 22.5V.

52. Ans: (B)

Sol: The given matrix is upper triangular. The eigen values of A are same as the diagonal elements of A.

∴ Eigen values are λ = 2, 2, 2

The eigen vectors for λ = 2 are given by

$$[A - 2I]X = 0 \text{ where } X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

⇒ y = 0, and z = 0

∴ Any non zero vector with y and z components as 0, is an eigen vector of A.

53. Ans: (A)

Sol: $S_m = \frac{R_2}{X_2} = \frac{0.3}{2.5} = 0.12$

$$\frac{T_{st}}{T_{max}} = \frac{2S_m}{S_m^2+1} = \frac{2\times 0.12}{(0.12)^2+1} = 0.2366 \text{......(1)}$$

Given $T_{max} = 3T_{Full}$

from (1), $T_{st} = 0.2366[3 \times T_{full}]$

$T_{st} = 3 \times 0.2366\ T_{full}$

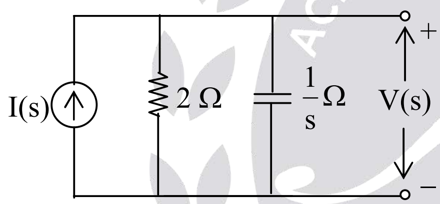
In star-delta staring

$$T_{st} = \frac{1}{3}T_{full} = \frac{1}{3}\times 3\times 0.2366$$

$$\frac{T_{st}}{T_{full}} = 0.2366$$

54. Ans: (A)

Sol: The transform circuit is shown in below



$$V(s) = \frac{I(s)}{Y(s)}$$

$Y(s) = s + 0.5$

For step response, $i(t) = 1\ u(t)$, $I(s) = \frac{1}{s}$

$$V(s) = \frac{1}{s(s+0.5)} = \frac{A}{s} + \frac{B}{s+0.5} = \frac{2}{s} - \frac{2}{s+0.5}$$

$v(t) = 2\ [1 - e^{-0.5\ t}]\ u(t)$

55. Ans: (D)

Sol: $$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

$$y(t) = \begin{bmatrix}1 & 3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

$$A = \begin{bmatrix}0 & 1\\ 1 & 1\end{bmatrix} B = \begin{bmatrix}0\\ 1\end{bmatrix} C = \begin{bmatrix}1 & 3\end{bmatrix}$$

T.F = C $[SI - A]^{-1}$ B

$$[SI - A] = \begin{bmatrix}s & -1\\ -1 & s-1\end{bmatrix}$$

$$[SI - A]^{-1} = \frac{\begin{bmatrix}s-1 & 1\\ 1 & s\end{bmatrix}}{s^2-s-1}$$

$$C[SI - A]^{-1}B = \frac{\begin{bmatrix}1 & 3\end{bmatrix}\begin{bmatrix}s-1 & 1\\ 1 & s\end{bmatrix}\begin{bmatrix}0\\ 1\end{bmatrix}}{s^2-s-1}$$

$$= \frac{\begin{bmatrix}1 & 3\end{bmatrix}\begin{bmatrix}1\\ s\end{bmatrix}}{s^2-s-1} = \frac{1+3s}{s^2-s-1}$$