37. Ans: (C)

Sol: Force acting on electron

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

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

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

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

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

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

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

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

$\therefore$ v(t) = 4.39×10^{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

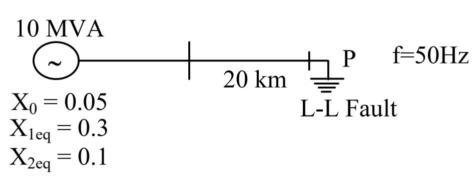
$$\cos\alpha = \frac{\pi\left(V_0 + \frac{3\omega L_s}{\pi}I_0\right)}{3V_{m\ell}}$$

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

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

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

= 14.315× 10^{-4} H/km

For 20 km length total inductance

L_{eq} = 14.315× 10^{-4}× 20

= 0.0286 H

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

= 2π× 50 × 0.0286 = 8.994Ω

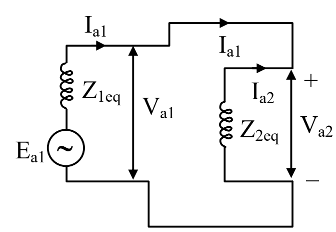
p.u. reactance of the line

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

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

LL-fault occurs at point P.

$I_f = \dfrac{-j\sqrt{3}\,E_{a1}}{X_{1eq}+X_{2eq}}$ [E_{a1} = 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)

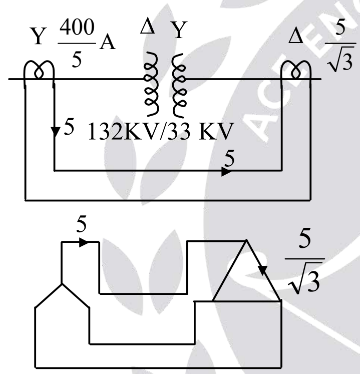
Sol: $V_{E1} = 0.7\text{V}$

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

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

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

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

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

$$Y(z) = X(z)$$
$\downarrow$ 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: $e = -N\frac{d\phi}{dt}$;

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

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

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

$\omega = 100\,\pi$,

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

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

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

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

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

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

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

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

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 $P_2(0, 0, -100)$;

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

$= -304$

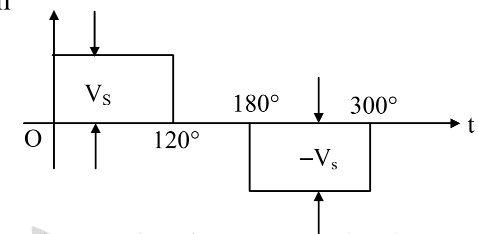
Hence we have to determine the unit vector from lower value of f (f_2 = –304) towards higher value of f (f_1 = 296). That is with positive sign

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

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

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

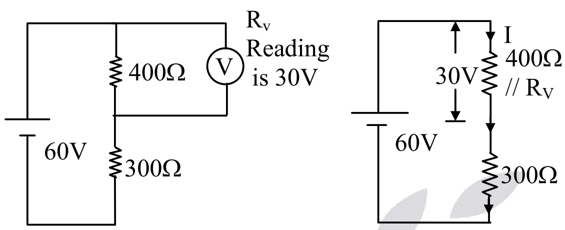
CMA ; (A) = $\overline{X}$

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 $400\Omega // R_v$

$30V = 0.1A \times 400\Omega // R_v$

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

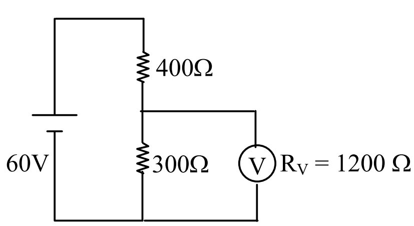
$$\Rightarrow \quad \frac{400\Omega \times R_v}{400\Omega + R_v} = 300\Omega$$

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

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

$\Rightarrow R_v = 1200\Omega$.

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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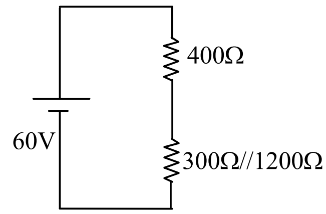


$$R_{eff} = \frac{300\Omega \times 1200\Omega}{1500\Omega} = 240\Omega$$

∴ 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), $T_{st} = 0.2366[3 \times T_{full}]$

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

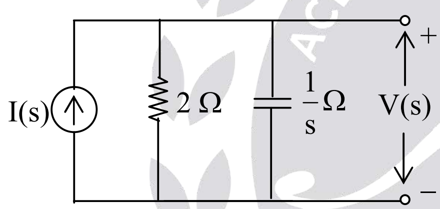
In star-delta staring

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

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

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

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

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

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

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