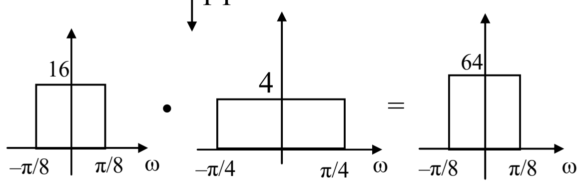
43. Ans: 5.09 Range(5 to 5.2)

Sol: $2\sin c(t/8) * \sin c(t/4)$

$$= \frac{2\sin \pi t/8}{\pi t/8} * \frac{\sin \pi t/4}{\pi t/4}$$

$\downarrow$ FT



$\downarrow$ IFT

$$x(t) = \frac{64\sin(\pi t/8)}{\pi t}$$

$$x(t)\big|_{t=4} = \frac{64\sin(\pi/2)}{4\pi} = \frac{16}{\pi}$$

44. Ans: (c)

Sol:

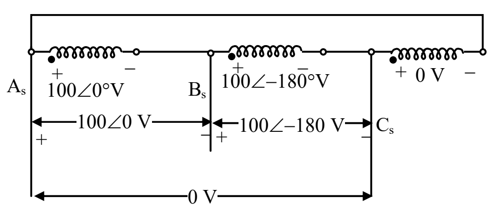


Fig. 2

Figure-2 shows the secondary side with voltages marked.

The line voltages are, $\bar{V}_{AsBs} = 100\angle 0°\,V$

$\bar{V}_{BsCs} = 100\angle -180°\,V,\ \bar{V}_{CsAs} = 0$

Their sum is zero, as it should be (by KVL)

The sequence components are

$\bar{V}_{AsBs1} = \frac{1}{3}\left(\bar{V}_{AsBs} + a\bar{V}_{BsCs}\right)$ and

$\bar{V}_{AsBs2} = \frac{1}{3}\left(\bar{V}_{AsBs} + a^2\bar{V}_{BsCs}\right)$

Since $\bar{V}_{CsAs} = 0$. Substituting numerical values,

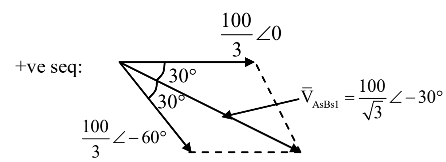
$$\bar{V}_{AsBs1} = \frac{1}{3}\left(100\angle 0 + 1\angle 120°.100\angle -180°\right)$$

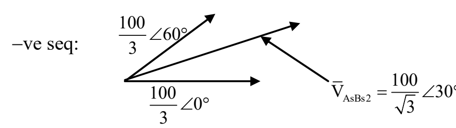
$$= \frac{1}{3}\left(100\angle 0° + 100\angle -60°\right)$$

$$\bar{V}_{AsBs2} = \frac{1}{3}\left(100\angle 0 + 1\angle 240°.100\angle -180°\right)$$

$$= \frac{1}{3}\left(100\angle 0 + 100\angle 60°\right)$$

These are evaluated in the phasor diagrams below.





45. Ans: (c)

Sol: $TF = C[sI - A]^{-1} B = \frac{1}{s^2 + 5s + 4}$

$$TF = \frac{1}{(s+1)(s+4)}$$

Poles are located on left side of s – plane

$\therefore$ System is stable

For observability:

$$N = \begin{bmatrix} C \\ CA \end{bmatrix}$$

$$CA = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & -4 \\ 1 & -5 \end{bmatrix} = \begin{bmatrix} 1 & -5 \end{bmatrix}$$

$$N = \begin{bmatrix} 0 & 1 \\ 1 & -5 \end{bmatrix}$$

|N| is not equal to zero

$\therefore$ Observable

For controllability

$$M = \begin{bmatrix} B & AB \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$AB = \begin{bmatrix} 0 & -4 \\ 1 & -5 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

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

|M| is not equal to zero

$\therefore$ Controllable

46. Ans: 3 (Range: 3 to 3)

Sol: $P(X \geq 1) = 1 - P(X = 0)$

$= 1 - n_{c_0} p^0 q^n$

$= 1 - q^n$

Here $p = \frac{1}{3}$

$\Rightarrow q = \frac{2}{3}$

$\therefore 1 - \left(\frac{2}{3}\right)^n > \frac{2}{3}$

Apply trial and error method

$\Rightarrow n = 3$

47. Ans: 50

Sol: $A\text{rect}(t/T) \leftrightarrow ATSa\left(\frac{\omega T}{2}\right)$

$$H(\omega) = 0.2Sa(0.01\omega)\, e^{-j\omega(0.01)}$$

$H(\omega) = 0$ only when

$\frac{\omega}{100} = \pm n\pi$

$\omega = \pm 100n\pi$

$f = \pm 50n$

first-null occurs at f = 50

second-null occurs at f = 100

third-null occurs at f = 150

and so on

null-to-null band width is 50Hz.

48. Ans: (c)

Sol: $y = (Ax + B)e^{-4x}$ ……..(1)

Differentiating (1) w.r.t 'x'

$y' = (Ax + B)(-4)e^{-4x} + e^{-4x}.A$

Use (1) in the above eq.

$y' = (-4)y + Ae^{-4x}$ …… (2)

Differentiating w.r.t 'x'

$y'' = -4y' + A(-4)e^{-4x}$ ….. (3)

Use (2) in (3)

$y'' = -4y' - 4(y' + 4y)$

$y'' = -8y' - 16y$

$y'' + 8y' + 16y = 0$

Is the required differential equation

49. Ans: (d)

Sol: Continuous current rating = 5 kA

Symmetrical breaking capacity = 2000 MVA

$= \sqrt{3} \times V_L \times I_{sy}$

$I_{sy} = 35$ kA

$I_{sy} = 2.55 \times I_{sy} = 89.25$ kA

50. Ans: (A)

Sol: $H_1(s) = s+1 \quad H_2(s) = \frac{1}{s+1}$

$$H(s) = H_1(s)H_2(s) = 1$$

$$Y(s) = X(s)\,H(s)$$

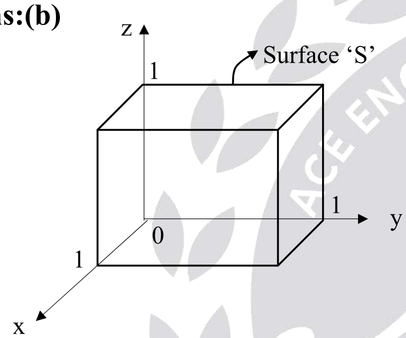
$$= \frac{2}{s+1}.1$$

Apply Inverse Laplace Transform

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

51. Ans:(b)

Sol:



Integral $\oint_S \vec{G}.d\vec{S} = \int_{vol} \nabla.\vec{G}\,dv$

$$\vec{G} = 2xy\hat{a}_x + 3\hat{a}_y + z^2y\hat{a}_z$$

$$\nabla.\vec{G} = 2y + 2zy$$

$$\nabla.\vec{G} = 2y(z+1)$$

$$I = \int_{x=0}^{1}\int_{y=0}^{1}\int_{z=0}^{1} 2y(z+1)dxdydz$$

$$= 2\frac{y^2}{2}\Bigg|_0^1 \left(\frac{z^2}{2}+z\right)\Bigg|_0^1 x\Big|_0^1$$

$$\therefore I = \frac{3}{2} \qquad (I \to \text{Integral})$$

52. Ans: 30

Sol: C. E $\Rightarrow$ $s^3 + 4s^2 + 3s + k = 0$

s^3	1	3
s^2	4	k
s^1	$\frac{12-k}{4}$	0
s^0	k	

$$k_{mar} = 12$$

$$GM = \frac{k_{mar}}{k_{operating}} = \frac{12}{0.4} = 30$$

53. Ans: (d)

Sol: At balanced condition,

$T_d = T_c$

In gravity control,

$T_c \propto \sin\theta$

$10\sqrt{2} = \sin 90°$

$? = \sin 45°$

$\therefore$ meter reading $= 10\sqrt{2} \times \frac{1}{\sqrt{2}} = 10\,V$

54. Ans: 4

Sol: If the particle moves with a constant velocity, that means its acceleration is zero. (i.e. particle experiences no net force

we have $\overline{F} = m\overline{a} = Q(\overline{E} + \overline{U} \times \overline{B})$

$$\Rightarrow 0 = Q(20\hat{a}_y + 5\hat{a}_x \times B_0\hat{a}_z)$$

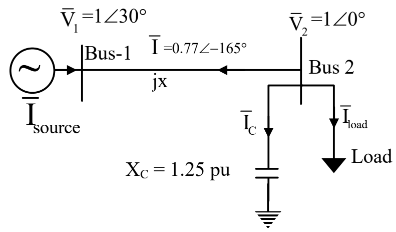
$$\Rightarrow 20\hat{a}_y - 5B_0\hat{a}_y = 0$$

$$\Rightarrow 20 = 5B_0$$

$$\Rightarrow B_0 = \frac{20}{5} = 4$$

55. Ans: (c)

Sol:



Current supplied by source

$$\bar{I}_{source} = -(\bar{I})$$

$$= (1\angle 180°)(0.77\angle -165°)$$

$$= 0.77\angle 15°$$

Power factor of source, $\cos\phi_s = \cos(30° - 15°)$

$$= 0.966 \text{ lag}$$

KCL at bus – 2

$$\bar{I} + \bar{I}_C + \bar{I}_{load} = 0$$

$$\bar{I}_{load} = -(\bar{I}_c + \bar{I})$$

$$= -\left(\frac{\bar{V}_2}{-jx_c} + 0.77\angle -165°\right)$$

$$= -\left(\frac{1\angle 0°}{-j1.25} + 0.77\angle -165°\right)$$

$$= -(0.8\angle 90° + 0.77\angle -165°)$$

$$= -[j0.8 + (0.77 \times -0.966) - j(0.77 \times 0.259)]$$

$$= 0.744 - j0.6$$

$$= 0.956\angle -38.88°$$

Pf of load, $\cos\theta_l = \cos(0 + 38.88°)$

$$= 0.778 \text{ lag}$$