



$$\begin{aligned} \text{Now, } Q_2 &= \frac{|V_2|}{X} [|V_1| \cos \delta - |V_2|] \\ &= \frac{1}{0.4} [1 \times \cos(-23.6^\circ) - 1] \\ &= -0.209 \text{ pu} \end{aligned}$$

Reactive power balance

$$Q_2 + Q_c + Q_{\text{load}} = 0$$

Where Q_{load} is reactive power injected by load

$$\text{into bus bar and } Q_c = |V_2|^2 \left| \frac{Y}{2} \right|$$

$$\begin{aligned} Q_c &= 1 \times 0.08 \\ &= 0.08 \text{ pu} \end{aligned}$$

$$-0.209 + 0.08 + Q_{\text{load}} = 0$$

$$Q_{\text{load}} = 0.129 \text{ pu}$$

37. Ans: (a)

Sol: The given circuit is Wein-bridge oscillator.

$$\text{The gain of the amplifier, } \frac{V_2}{V_1} = \left(1 + \frac{2k\Omega}{1k\Omega} \right) = 3$$

\Rightarrow Oscillations will be sustained Frequency of

$$\text{oscillation, } f = \frac{1}{2\pi RC}$$

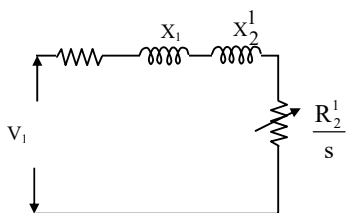
$$\text{Given : } f = 1\text{kHz, } R = 1k\Omega$$

$$C = \frac{1}{2\pi Rf} = \frac{1}{2\pi \times 10^3 \times 10^3}$$

$$\therefore C = \frac{1}{2\pi} \mu\text{F}$$

38. Ans: (c)

Sol:



$$\text{For maximum slip, } \frac{R_2^1}{s} = \sqrt{R_1^2 + (X_{01})^2}$$

$$\frac{0.08}{s} = \sqrt{(0.07)^2 + (0.67)^2}$$

$$s = 0.1187$$

39. Ans: 7.29 (Range: 7.28 to 7.30)

Sol: $f_s = 200 \text{ kHz} \Rightarrow T = 5 \mu\text{s}$

$$V_0 = \frac{V_{\text{in}}}{1-D} \Rightarrow 12 = \frac{5}{1-D} \Rightarrow D = 0.5833$$

$$\Delta I_L = \frac{V_{\text{dc}}}{L} DT = 2A$$

$$\Rightarrow \frac{5}{L} \times 0.5833 \times 5\mu = 2$$

$$\Rightarrow L = 7.29 \mu\text{H}$$

40. Ans: (b)

Sol: Let X = number of accidents between 5 P.M and 6 P.M.

For Poisson distribution,

$$\lambda = np = (1000)(0.0001) = 0.1$$

$$P(X=x) = \frac{e^{-\lambda} \lambda^x}{x!} \quad (x = 0, 1, 2, \dots)$$

Required Probability = $P(X \geq 2)$

$$= 1 - P(X < 2)$$

$$= 1 - \{P(X=0) + P(X=1)\}$$

$$= 1 - e^{-0.1} (1 + 0.1)$$

$$= 0.0045$$

41. Ans: (c)

Sol: $P_0 = 20\text{kW, } V_t = 250\text{V, } N_1 = 1000 \text{ r.p.m}$

$$\phi \alpha = \frac{I}{50+I}, r_s = 0.01\Omega, r_a = 0.015\Omega$$

$$I_{a2} = 100\text{A, } N_2 = 1050 \text{ r.p.m and } V_b = 2\text{V}$$

$$I_{a1} = \frac{20 \times 10^3}{250} = 80\text{A}$$



Now field flux $\phi_1 = \frac{80}{50+80} \times 0.94$

(since in total ampere turns, the demagnetizing ampere turns are 6%)

$$E_{a1} = 80(r_s + r_a) + V_b + V_t$$

$$= 80(0.025) + 2 + 250$$

$$= 254V$$

Now $I_{a2} = 100A$

Net field flux $\phi_2 = \frac{100}{150} \times 0.94$

We know that, $\frac{E_{a1}}{E_{a2}} = \frac{N_1 \phi_1}{N_2 \phi_2}$

$$E_{a2} = \frac{1050 \times 100 \times 0.94 \times 130}{150 \times 1000 \times 80 \times 0.94} \times 254$$

$$= 288.925$$

$$E_{a2} = 100(0.025) + V_b + V_t$$

$$V_t = E_{a2} - (100 \times 0.025) - 2$$

$$= 284.43V$$

42. Ans: (c)

Sol: $2k > 1$ & $0.01k < 1$

$$k > \frac{1}{2} \text{ \& } k < 100$$

$$\therefore \frac{1}{2} < k < 100$$

43. Ans: (c)

Sol: Given data

$$H = \frac{\text{K.E stored}}{\text{rating of the generator}}$$

$$5 = \frac{\text{K.E stored}}{100}$$

$$\text{K.E} = 500 \text{ MJ}$$

$$\text{K.E stored in 0.4 sec}$$

$$50 \times 0.4 = 20 \text{ MJ}$$

$$\text{K.E} \propto f^2$$

$$\frac{500}{520} = \left(\frac{50}{f_{\text{new}}} \right)^2$$

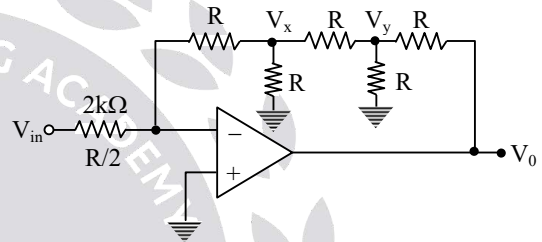
$$\frac{50}{f_{\text{new}}} = \sqrt{\frac{50}{52}}$$

$$f_{\text{new}} = 50 \sqrt{\frac{52}{50}}$$

$$= 50.99 \approx 51 \text{ Hz}$$

44. Ans: (b)

Sol: Let $R = 4k\Omega$



Applying KCL at inverting terminal,

$$\frac{V_{in} - 0}{R/2} = \frac{0 - V_x}{R} \Rightarrow V_x = -2V_{in} \dots\dots\dots (1)$$

Applying KCL at V_x ,

$$\frac{V_x}{R} + \frac{V_x}{R} + \frac{V_x - V_y}{R} = 0$$

$$\Rightarrow 3V_x - V_y = 0$$

$$\text{i.e. } 3V_x = V_y \dots\dots\dots (2)$$

Applying KCL at V_y ,

$$\frac{V_y}{R} + \frac{V_y - V_x}{R} + \frac{V_y - V_0}{R} = 0$$

$$\Rightarrow 3V_y - V_x = V_0 \dots\dots\dots (3)$$

Substituting (2) in (3),

$$3(3V_x) - V_x = V_0$$

$$8V_x = V_0 \dots\dots\dots (4)$$

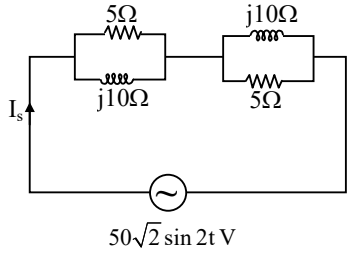
Substituting (1) in (4)

$$8(-2V_{in}) = V_0$$

$$\Rightarrow \frac{V_0}{V_{in}} = A_v = -16$$

45. Ans: (c)

Sol: If the galvanometer is short circuited then modified bridge circuit is shown below.

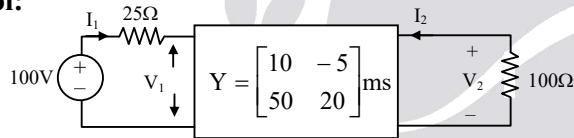


$$Z_{eq} = 2 \times \left(\frac{5 \times j10}{5 + j10} \right) = 4\sqrt{5} \angle 26.56$$

$$I_s = \frac{50 \angle 0^\circ}{4\sqrt{5} \angle 26.56} = 5.59 \angle -26.56^\circ$$

46. Ans: $V_1 = 68.6$ volts (Range: (67.5 to 69.5V))

Sol:



By applying at KVL input side

$$V_1 = 100 - 25I_1 \quad \dots\dots\dots (1)$$

$$V_2 = -100 I_2 \quad \dots\dots\dots (2)$$

From Y-parameters

$$I_1 = (10 \times 10^{-3}) V_1 - (5 \times 10^{-3}) V_2 \quad \dots\dots\dots (3)$$

$$I_2 = (50 \times 10^{-3}) V_1 + (20 \times 10^{-3}) V_2 \quad \dots\dots\dots (4)$$

By putting value of V_2 in equation (4)

$$I_2 = (50 \times 10^{-3}) V_1 + (20 \times 10^{-3}) (-100 I_2)$$

$$= (50 \times 10^{-3}) V_1 - 2I_2$$

$$3I_2 = (50 \times 10^{-3}) V_1$$

And from equation (3)

$$I_1 = (10 \times 10^{-3}) V_1 - (5 \times 10^{-3}) (-100 I_2)$$

$$= (10 \times 10^{-3}) V_1 + (5 \times 10^{-3} \times 100) \left(\frac{50 \times 10^{-3}}{3} \right) V_1$$

$$= (10 \times 10^{-3}) V_1 + \frac{25}{3} \times 10^{-3} V_1$$

$$= \frac{55}{3} \times 10^{-3} V_1$$

$$\therefore V_1 = 100 - [25 \times I_1]$$

$$V_1 = 100 - \left[25 \times \frac{55}{3} \times 10^{-3} V_1 \right]$$

$$V_1 \left[1 + 25 \times \frac{55}{3} \times 10^{-3} \right] = 100$$

$$V_1 = \frac{100}{1.458} = 68.57V$$

47. Ans: (a)

Sol: $P = V_{s1} I_{s1} \cos \phi_1 = 950$

$$\Rightarrow \text{DPF} = \cos \phi_1 = \frac{950}{120 \times 10} = 0.792$$

$$\text{IPF} = \text{DF} \times \text{DPF}$$

$$= \frac{\text{DPF}}{\sqrt{1 + (\text{THD})^2}} = \frac{0.792}{\sqrt{1 + (0.75)^2}} = 0.6336 \text{ lag}$$

48. Ans: (b)

Sol: According to the given data, state table can be prepared as follows.

Control Input	Present State		Next state		Flip-flop Input	
	Q_1	Q_0	Q_1	Q_0	T_1	T_0
y	Q_1	Q_0	Q_1	Q_0	T_1	T_0
0	0	0	1	1	1	1
0	0	1	0	0	0	1
0	1	0	0	1	1	1
0	1	1	1	0	0	1
1	0	0	0	1	0	1
1	0	1	1	0	1	1
1	1	0	1	1	0	1
1	1	1	0	0	1	1



K-map for T_1 : (in terms of present state & control inputs)

	$Q_1 Q_0$			
y	00	01	11	10
0	0	1	3	2
1	4	5	7	6

$$\Rightarrow T_1 = \bar{y}\bar{Q}_0 + yQ_0 = \bar{y} \oplus Q_0$$

49. Ans: (c)

$$\text{Sol: } V_{PO} = \frac{16 \times 10^{-9}}{4\pi\epsilon_0} \left[\frac{1}{d(PQ)} - \frac{1}{d(OQ)} \right]$$

$$= \frac{16 \times 10^{-9}}{4\pi\epsilon_0} \left[\frac{1}{\sqrt{12}} - \frac{1}{\sqrt{38}} \right] = 18.21V$$

$$V_{PO} = \frac{-\rho_L}{2\pi\epsilon_0} [\ln(d_p) - \ln(d_o)]$$

Co-ordinate of point P are (4, 1, 3). Coordinate of the foot of the perpendicular dropped from P on the line charge (2, 4, 3)

$$\therefore d_p = \sqrt{(4-2)^2 + (1-4)^2} = \sqrt{13}$$

Co-ordinate of point O are (0,0,0). Coordinate of the foot of the perpendicular dropped from O on the line charge (2,4,0)

$$\therefore d_o = \sqrt{(0-2)^2 + (0-4)^2} = \sqrt{20}$$

$$V_{PO} = -\frac{5 \times 10^{-9}}{2\pi\epsilon_0} [\ln(\sqrt{13}) - \ln(\sqrt{20})]$$

$$= 19.3852V$$

$$V_{PO} (\text{total}) = 18.21 + 19.3852 = 37.5952V$$

$$\text{Now } V_{PQ} = V_P - V_O$$

$$\Rightarrow V_p = V_{PO} + V_O = 37.5952 + 100$$

$$= 137.5952V$$

50. Ans: 23040 (23000 to 24000)

Sol: Initial load = $(P_1) = 50 \times 0.8 = 4kW$

$$P_1 = 4kW$$

$$\text{Final load } (P_2) = 3 \times 0.8 = 2.4kW$$

$$(P_2 = 2.4kW)$$

Given meter rotates 400 times in 150 seconds

\therefore Revolutions made in 1hr = r_1

$$r_1 = 400 \times \frac{60 \times 60}{150} = 9600$$

\therefore meter constant of the meter is

$$(K_1) = \frac{r_1}{P_1} = \frac{9600}{4} = 2400 \text{ rev/kWh}$$

$$\text{But meter constant } (K) \propto \frac{r}{\phi^2 R}$$

r = resistance to eddy currents

R = radius of disc

ϕ = flux of brake magnet

Given flux of brake magnet is halved

$$\therefore \phi_2 = \frac{\phi_1}{2}$$

$$\Rightarrow K_2 (\text{new meter constant}) = 4K_1$$

$$\therefore K_2 = 9600 \text{ rev/kWh}$$

\therefore revolutions the new meter will do in

$$1 \text{ hour} = 9600 \times P_2 \times 1 = 9600 \times 2.4$$

$$= 23040 \text{ rev}$$

51. Ans: 4

Sol: Using conjugate symmetry property

$$X[k] = X^* [N - k]. \text{ Here, } N = 5$$

$$X[1] = X^* [4] = 8.78 + j1.4$$

$$X[3] = X^* [2] = -1.28 + j4.39$$

$$x_0 = \frac{1}{N} \sum_{k=0}^{4} X[k]$$

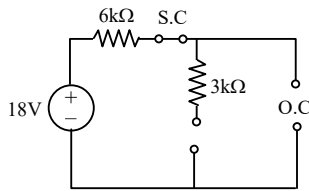
$$= \frac{1}{5} [X(0) + X(1) + X(2) + X(3) + X(4)]$$

$$= 4$$

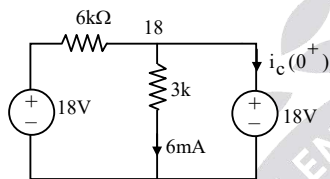


52. Ans: - 60 V/sec (No Range)

Sol: At time $t = 0^-$ switch is in open condition



So, L is short circuit, C is open circuit $i_L(0^-) = 0$



$V_c(0^+) = V_c(0^-) = 18V$

At $t = 0^+$ switch is closed

$I_c(0^+) = C \frac{dv(0^+)}{dt}$

$\frac{dv(0^+)}{dt} = \frac{i_c(0^+)}{C}$

$i_c(0^+) = -6 \times 10^{-3} A$

$\frac{dv(0^+)}{dt} = \frac{-6 \times 10^{-3}}{100 \times 10^{-6}}$

$\frac{dv(0^+)}{dt} = -60V/sec$

53. Ans: 64 (No Range)

Sol: Since $F_3 = F_1$. $F_2 = \Sigma m(4, 6, 12)$, the function F_2 must have the minterms m_4, m_6 & m_{12} . Since $F_1 = \Sigma m(0,1,2,3,4,6,10,11,12,13)$, the function F_2 may or may not have the remaining minterms viz. $m_5, m_7, m_8, m_9, m_{14}$ and m_{15} .

m_5	m_7	m_8	m_9	m_{14}	m_{15}	F_2
0	0	0	0	0	0	$\Sigma m(4,6,12)$
0	0	0	0	0	1	$\Sigma m(4,6,12,15)$
0	0	0	0	1	0	$\Sigma m(4,6,12,14)$
⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	$\Sigma m(4,5,6,7,8,9,12,14,15)$

\Rightarrow Number of possible functions for F_2 is $2^6 = 64$

54. Ans: (a)

Sol: $\frac{d^2y}{dx^2} - y = 0$

$m^2 - 1 = 0$

$\Rightarrow m = \pm 1$

$y = c_1e^x + c_2e^{-x}$

$y(0) = 2 \Rightarrow 2 = c_1 + c_2$ (1)

$y' = c_1e^x - c_2e^{-x}$

$y'(0) = 0 \Rightarrow 0 = c_1 - c_2$ (2)

Solving (1) and (2), we get $c_1 = 1$ and $c_2 = 1$

$y = e^x + e^{-x}$

$y = 2\cosh x$

55. Ans: (b)

Sol: $D = 0$, Load not change

$\Delta P_D = +ve$, so frequency decreases

$\Delta f = -ve$, so generation increases.