Q.27 Let $S = \sum_{n=0}^{\infty} n\alpha^n$ where $|\alpha| < 1$. The value of α in the range $0 < \alpha < 1$, such that $S = 2\alpha$ is __________.

Ans. (0.29)

The Z-transform of

$$a^n u(n) \longrightarrow \frac{1}{(1 - aZ^{-1})} \quad \text{and} \quad na^n u(n) \longrightarrow \frac{aZ^{-1}}{(1 - aZ^{-1})^2}$$

so
$$\frac{aZ^{-1}}{(1 - aZ^{-1})^2} = \sum_{n=0}^{\infty} n a^n Z^{-n}$$

If we put $Z = 1$ in above equation we get

$$\frac{a}{(1-a)^2} = \sum_{n=0}^{\infty} n a^n$$

Since
$$\sum_{n=0}^{\infty} n a^n = 2a = \frac{a}{(1-a)^2}$$

so
$$2 = \frac{1}{(1-a)^2}$$

$\Rightarrow$
$$a = 0.29$$

End of Solution

Q.28 Let the eigenvalues of a 2 × 2 matrix A be 1, –2 with eigenvectors x_1 and x_2 respectively. Then the eigenvalues and eigenvectors of the matrix $A^2 - 3A + 4I$ would, respectively, be

(a) 2, 14; x_1, x_2
(b) 2, 14; $x_1 + x_2$, $x_1 - x_2$
(c) 2, 0; x_1, x_2
(d) 2, 0; $x_1 + x_2$, $x_1 - x_2$

Ans. (a)

Eigen values of $A^2 - 3A + 4I$ are

$$= (1)^2 - 3(1) + 4 \text{ and } (-2)^2 - 3(-2) + 4$$
$$= 2, 14$$

Note: $A^2X = \lambda^2 X$

$\Rightarrow$ X is eigen vector for A^2 corresponding to eighen value λ^2

X_1 and X_2 are $e\ v$ of A corresponding to 1, –2

Then X_1 and X_2 are e.v of $A^2 - 3 + 4I$ corresponding to 2, 14

End of Solution

Q.29 Let A be a 4 × 3 real matrix with rank 2. Which one of the following statement is TRUE?

(a) Rank of A^TA is less than 2.
(b) Rank of A^TA is equal to 2.
(c) Rank of A^TA is greater than 2.
(d) Rank of $A^T A$ can be any number between 1 and 3.

Ans. **(b)**

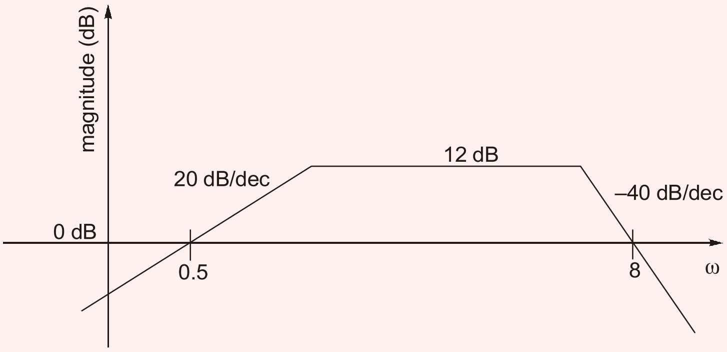
Result

$$\text{Rank}\ (A^T A) = \text{Rank}\ (A)$$

End of Solution

Q.30 Consider the following asymptotic Bode magnitude plot (ω is in rad/s).

Which one of the following transfer functions is best represented by the above Bode magnitude plot?



(a) $\dfrac{2s}{(1+0.5s)(1+0.25s)^2}$

(b) $\dfrac{4(1+0.25s)}{s(1+0.25s)}$

(c) $\dfrac{2s}{(1+2s)(1+4s)}$

(c) $\dfrac{4s}{(1+2s)(1+4s)^2}$

Ans. **(a)**

From the given Bode plot, it is evident that there are 3 (three) poles in the transfer function, out of which there are double poles at corner frequency near but less than ω = 8 rad/sec and one pole is near but greater than ω = 0.5 rad/sec. As the initial slope is positive and +20 dB/dec. Therefore one zero exist at $s = 0$. So from all the given options, option (a) satisfies all the conditions. Therefore option a is correct.

End of Solution

Q.31 Consider the following state-space representation of a linear time-invariant system.

$$\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} x(t),\ y(t) = c^T x(t), c = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

The value of $y(t)$ for $t = \log_e 2$ is ________.

Ans. **(6)**

$\because$ $$\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} x(t); \text{ and } x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$\because$ $$\phi(t) = \mathcal{L}^{-1}[sI - A]^{-1}$$

$$= \mathcal{L}^{-1}\left\{\begin{bmatrix} s-1 & 0 \\ 0 & s-2 \end{bmatrix}^{-1}\right\} = \mathcal{L}^{-1}\left\{\begin{bmatrix} \frac{1}{s-1} & 0 \\ 0 & \frac{1}{s-2} \end{bmatrix}\right\}$$

$$= \begin{bmatrix} e^t & 0 \\ 0 & e^{2t} \end{bmatrix}$$

$\therefore$ $$x(t) = \phi(t) \cdot x(0) = \begin{bmatrix} e^t & 0 \\ 0 & e^{2t} \end{bmatrix}\begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$x(t) = \begin{bmatrix} e^t \\ e^{2t} \end{bmatrix}$$

Now $$y(t) = e^t + e^{2t}$$

$$\text{at } t = \log_e 2$$

$$y(t) = e^{\log_e 2} + e^{2\log_e 2}$$

$$= 2 + 4 = 6$$

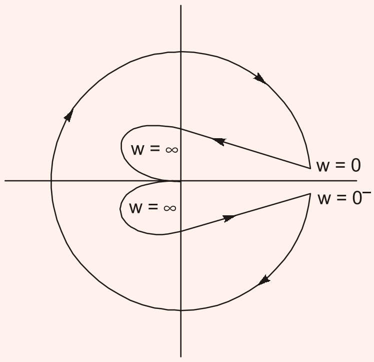
End of Solution

Q.32 Loop transfer function of a feedback system is $G(s)H(s) = \dfrac{s+3}{s^2(s-3)}$. Take the Nyquist contour in the clockwise direction. Then, the Nyquist plot of $G(s)H(s)$ encircles $-1 + j0$

(a) once in clockwise direction
(b) twice in clockwise direction
(c) once in anticlockwise direction
(d) twice in anticlockwise direction

Ans. **(a)**

Nyquist plot of $G(s)\,H(s) = \dfrac{s+3}{s^2(s-3)}$ is as shown below:



From the Nyquist plot G(s)H(s) encircle –1 + j0 once in clockwise direction.

End of Solution

Q.33 Given the following polynomial equation

$$s^3 + 5.5s^2 + 8.5s + 3 = 0,$$

the number of roots of the polynomial, which have real parts strictly less than –1, is ________.

Ans. **(2)**

$$s^3 + 5.5s^2 + 8.5\,s + 3 = 0$$

Putting $s = s_1 - 1$

$$(s_1 - 1)^3 + 5.5\,(s_1 - 1)^2 + (8.5)\,(s_1 - 1) + 3 = 0$$

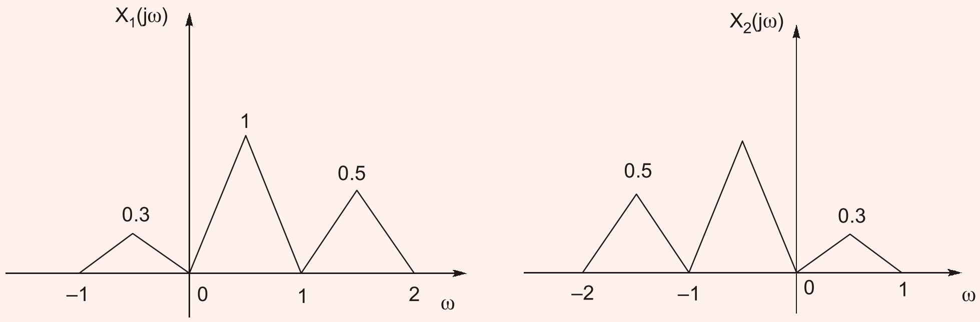
$$s_1^3 + 2.5s_1^2 + 0.5s_1 - 1 = 1$$

s_1^3	1	0.5
s_1^2	2.5	–1
s_1	0.9	0
s_1^0	–1	

As there is one sign change hence, two roots of given polynomial will lie to the left of s = –1.

End of Solution

Q.34 Suppose $x_1(t)$ and $x_2(t)$ have the Fourier transforms as shown below.



Which one of the following statements is TRUE?

(a) $x_1(t)$ and $x_2(t)$ are complex and $x_1(t)x_2(t)$ is also complex with nonzero imaginary part

(b) $x_1(t)$ and $x_2(t)$ are real and $x_1(t)x_2(t)$ is also real

(c) $x_1(t)$ and $x_2(t)$ are complex but $x_1(t)x_2(t)$ is real

(d) $x_1(t)$ and $x_2(t)$ are imaginary but $x_1(t)x_2(t)$ is real

Ans. (c)

By observing $X_1(j\omega)$ and $X_2(j\omega)$ we can say that they are not conjugate symmetric.

Since the fourier transform is not conjugate symmetric the signal will not be real

so $x_1(t)$, $x_2(t)$ are not real

Now the fourier transform of $x_1(t) \cdot x_2(t)$ will be $\frac{1}{2\pi} X_1(j\omega) * X_2(j\omega)$ and by looking at $X_1(j\omega)$ and $X_2(j\omega)$ we can say that $X_1(j\omega) * X_2(j\omega)$ will be conjugate symmetric and thus $x_1(t) \cdot x_2(t)$ will be real.

End of Solution

Q.35 The output of a continuous-time, linear time-invariant system is denoted by $T\{x(t)\}$ where $x(t)$ is the input signal. A signal $z(t)$ is called eigen-signal of the system T, when $T\{z(t)\} = y\, z(t)$, where y is a complex number, in general, and is called an eigenvalue of T. Suppose the impulse response of the system T is real and even. Which of the following statements is TRUE?

(a) $\cos(t)$ is an eigen-signal but $\sin(t)$ is not

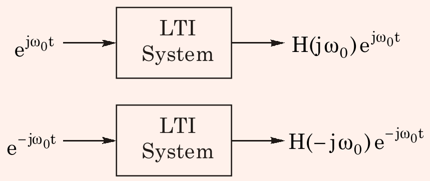
(b) $\cos(t)$ and $\sin(t)$ are both eigen-signals but with different eigenvalues

(c) $\sin(t)$ is an eigen-signal but $\cos(t)$ is not

(d) $\cos(t)$ and $\sin(t)$ are both eigen-signals with identical eigenvalues

Ans. (d)

Given that impulse response is real and even, Thus H(jω) will also be real and even.



Since $H(j\omega)$ is real and even thus $H(j\omega_0) = H(-j\omega_0)$

Now cos(t) is input i.e. $\frac{e^{jt}+e^{-jt}}{2}$ is input

Output will be $\frac{H(j1)e^{jt}+H(-j1)e^{-jt}}{2} = H(j1)\left[\frac{e^{jt}+e^{-jt}}{2}\right] = H(j1)\cos(t)$

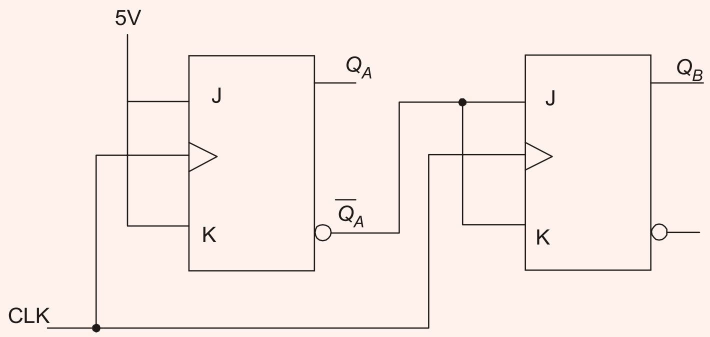
If sin(t) is input i.e. $\frac{e^{jt}-e^{-jt}}{2}$ is input

Output will be $\frac{H(j1)e^{jt}-H(-j1)e^{-jt}}{2j} = H(j1)\left[\frac{e^{jt}-e^{-jt}}{2j}\right] = H(j1)\sin t$

So sin(t) and cos(t) are eigen signals with same eigen values.

End of Solution

Q.36 The current state $Q_A\,Q_B$ of a two JK flip-flop system is 00. Assume that the clock rise-time is much smaller than the delay of the JK flip-flop. The next state of the system is



(a) 00
(b) 01
(c) 11
(d) 10

Ans. **(c)**

From the figure we get

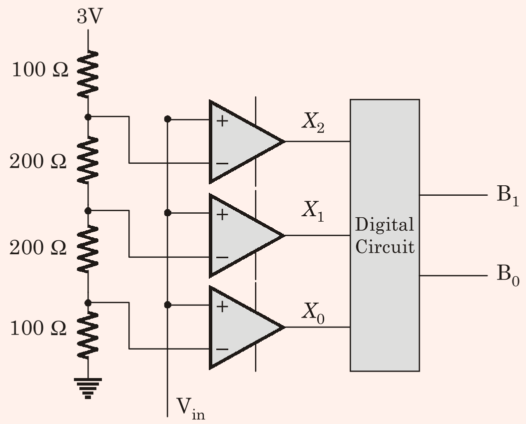
$$J_A = K_A = 1$$

$$J_B = K_B = \overline{Q_A}$$

Clock	$J_A K_A$	$J_B K_B$	$Q_A Q_B$
0	11	11	00
1			11

So next state will be 11

Q.37 A 2-bit flash Analog to Digital Converter (ADC) is given below. The input is $0 < V_{IN} < 3$ Volts. The expression for the LSB of the output B_0 as a Boolean function of X_2, X_1 and X_0 is



(a) $X_0\left[\overline{X_2 \oplus X_1}\right]$

(b) $\bar{X}_0\left[\overline{X_2 \oplus X_1}\right]$

(c) $X_0\left[X_2 \oplus X_1\right]$

(d) $\bar{X}_0\left[X_2 \oplus X_1\right]$

Ans. **(a)**

The input to digital circuit is

X_2, X_1, X_0 and output is $B_1 B_0$

X_2	X_1	X_0	B_1	B_0
0	0	0	0	0
0	0	1	0	1
0	1	1	1	0
1	1	1	1	1

$B_0 = X_2$ \ X_1X_0

X_2 \ X_1X_0	00	01	11	11
0	0	(1)	0	X
1	X	X	(1)	X

$$B_0 = \bar{X}_2\bar{X}_1X_0 + X_2X_1X_0$$

$$= X_0(\bar{X}_2\bar{X}_1 + X_2\,X_1)$$

$$= X_0(\overline{X_2 \oplus X_1})$$

End of Solution

Q.38 Two electric charges q and $-2q$ are placed at (0,0) and (6,0) on the x-y plane. The equation of the zero equipotential curve in the x-y plane is

(a) $x = -2$
(b) $y = 2$
(c) $x^2 + y^2 = 2$
(d) $(x + 2)^2 + y^2 = 16$

Ans. **(d)**

Charge, Q is located at (0, 0) and -2θ is located at (6, 0).
To find V at any point (x, y)

$$V_Q = \frac{Q}{4\pi \in \sqrt{x^2 + y^2}}$$

$$V_{-2Q} = \frac{-2Q}{4\pi \in \left(\sqrt{(x-6)^2 + y^2}\right)}$$

$$V_{total} = 0 = \frac{Q}{4\pi \in \left(\sqrt{x^2 + y^2}\right)} + \frac{-2Q}{4\pi \in \left(\sqrt{(x-6)^2 + y^2}\right)}$$

$$\sqrt{(x-6)^2 + y^2} = 2\left(\sqrt{x^2 + y^2}\right)$$

$$x^2 + 36 - 12x + y^2 = 4x^2 + 4y^2$$

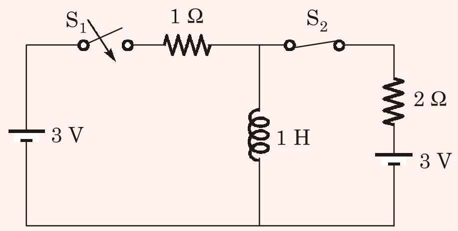
$$3x^2 + 3y^2 + 12x = 36$$

$$x^2 + y^2 + 4x = 12$$

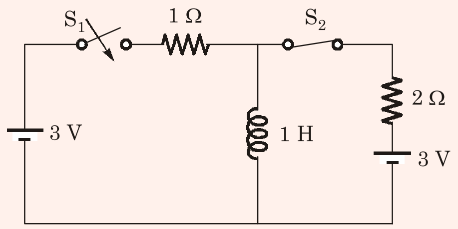
$$(x + 2)^2 + y^2 = 16$$

End of Solution

Q.39 In the circuit shown, switch S_2 has been closed for a long time. At time $t = 0$ switch S_1 is closed. At $t = 0^+$, the rate of change of current through the inductor, in amperes per second, is ________.

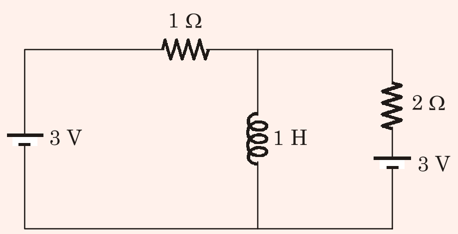


Ans. **(2)**



at $t = 0^-$,

at $t = 0^+$,



KCL at node A,

$$\frac{V_A - 3}{1} + \frac{3}{2} + \frac{V_A - 3}{2} = 0$$

$$2(V_A - 3) + 3 + (V_A - 3) = 0$$

$$3\,V_A = 6, \quad V_A = 2$$

$$V_A = L\frac{di(0^+)}{dt} = 2$$

$$\frac{di(0^+)}{dt} = \frac{2}{L} = \frac{2}{1} = 2 \text{ A/sec}$$

End of Solution

Q.40 A three-phase cable is supplying 800 kW and 600 kVAr to an inductive load. It is intended to supply an additional resistive load of 100 kW through the same cable without increasing the heat dissipation in the cable, by providing a three-phase bank of capacitors connected in star across the load. Given the line voltage is 3.3 kV, 50 Hz, the capacitance per phase of the bank, expressed in microfarads, is ________.

Ans. **(47.96)**

$$\text{KVA}_1 = \sqrt{800^2 + 600^2} = 1000 \text{ KVA}$$

Without excessive heat dissipation means current should be constant (i.e.) KVA erating must be constant.

In second case Active power, P = 800 + 100 = 900 KW

$$\text{Reactive power in second case } Q_2 = \sqrt{1000^2 - 900^2} = 435.889 \text{ KVAR}$$

Reactive power supplied by the three phase bank = 600 – 435.889

= 164.11 KVAR

$$Q_{bank}/\text{ph} = \frac{164.11}{3} = 54.7 \text{ KVAR}$$

$$V/\text{ph} = \frac{3.3}{\sqrt{3}} = 1.9052 \text{ KV}$$

$$Qc/\text{ph} = \frac{(V/\text{ph})^2}{X_C}$$

$$X_C = \frac{(1.9052 \times 10^3)^2}{54.7 \times 10^3} = 66.36\ \Omega$$

$$C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \times 50 \times 66.36} = 47.96\ \mu\text{F}$$

End of Solution

Q.41 A 30 MVA, 3-phase, 50 Hz, 13.8 kV, star-connected synchronous generator has positive, negative and zero sequence reactances, 15%, 15% and 5% respectively. A reactance (X_n) is connected between the neutral of the generator and ground. A double line to ground fault takes place involving phases '*b*' and '*c*', with a fault impedance of j0.1 p.u. The value of X_n (in p.u.) that will limit the positive sequence generator current to 4270 A is ________.

Ans. (1.07)

$$\text{Base current } I_B = \frac{30\times10^3}{\sqrt{3}\times13.8} = 1255.109 \text{ A}$$

$$I_f = 4270 \text{ A}$$

$$I_{p.u.} = \frac{4270}{1255.109} = 3.402 \text{ p.u.}$$

$$I_{g1} = \frac{E_a}{X_1 + (X_2 || X_0)}$$

where

$$X_0 = X_0 + 3\,(Z_n + Z_f)$$

$$X_0 = 3Z_n + 0.35$$

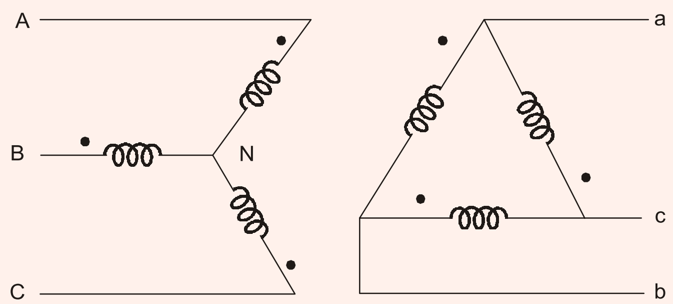
$$3.402 = \frac{1.0}{0.15 + \dfrac{0.15\times(3Z_n + 0.35)}{0.15 + 3Z_n + 0.35}}$$

by solving the equation $Z_n = 1.07$ p.u.

End of Solution

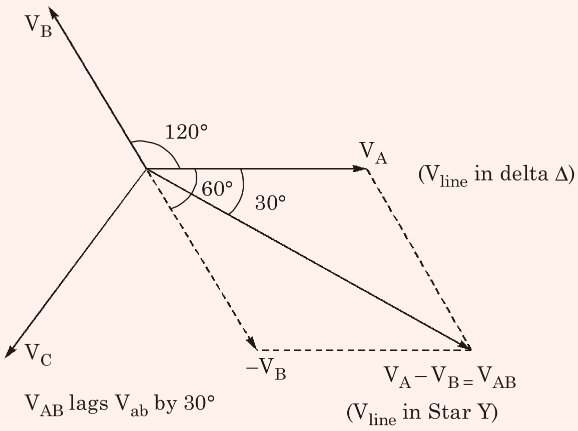
Q.42 If the star side of the star-delta transformer shown in the figure is excited by a negative sequence voltage, then

(a) V_{AB} leads V_{ab} by 60°
(b) V_{AB} lags V_{ab} by 60°
(c) V_{AB} leads V_{ab} by 30°
(d) V_{AB} lags V_{ab} by 30°



Ans. **(d)**

According to negative sequence phasors.



End of Solution

Q.43 A single-phase thyristor-bridge rectifier is fed from a 230 V, 50 Hz, single-phase AC mains. If it is delivering a constant DC current of 10 A, at firing angle of 30°, then value of the power factor at AC mains is

(a) 0.87
(b) 0.9
(c) 0.78
(d) 0.45

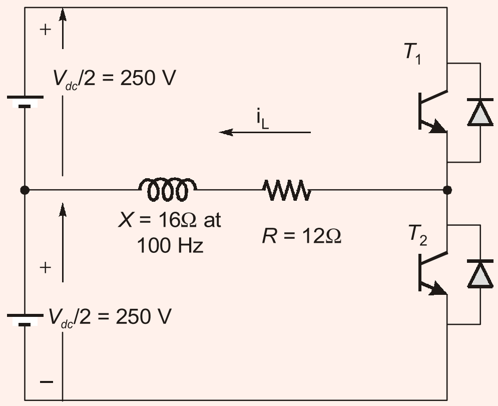
Ans. **(c)**

$$\text{Input power factor} = \text{power factor at ac mains} = \text{C.D.F.} \times \text{D.F.}$$

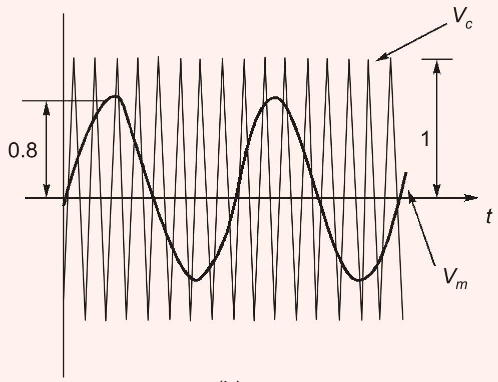
$$= \frac{2\sqrt{2}}{\pi}\cos\alpha = \frac{2\sqrt{2}}{\pi}\cos 30° = 0.78$$

End of Solution

Q.44 The switches T1 and T2 in Figure (a) are switched in a complementary fashion with sinusoidal pulse width modulation technique. The modulating voltage $v_m(t) = 0.8 \sin(200\pi t)$ V and the triangular carrier voltage (v_c) are as shown in Figure (b). The carrier frequency is 5 kHz. The peak value of the 100 Hz component of the load current (i_L), in ampere is ________.



(a)



(b)

Ans. **(10)**

$$m_a = 0.8$$

$$(V_{01})_{peak} = m_a \frac{V_d}{2} \qquad [m_a \le 1]$$

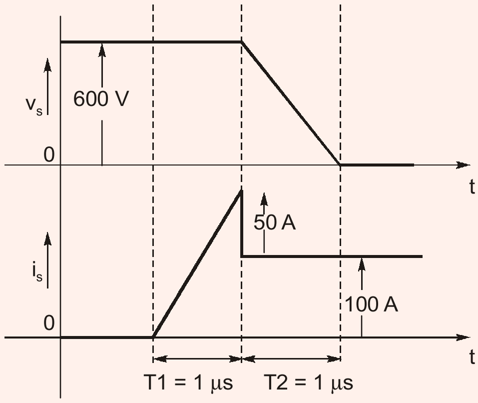
$$= 0.8 \times 250 = 200 \text{ V}$$

$$(I_{01})_{peak} = \frac{(V_{01})_{peak}}{Z_1} = \frac{200}{\sqrt{R^2 + (\omega L)^2}} = \frac{200}{\sqrt{12^2 + 16^2}}$$

$$= 10 \text{ A}$$

End of Solution

Q.45 The voltage (v_s) across and the current (i_s) through a semiconductor switch during a turn-ON transition are shown in figure. The energy dissipated during the turn-ON transition, in mJ, is



Ans. **(75)**

$$\text{Energy} = \int_0^{T_1} V \cdot i\,dt + \int_0^{T_2} v \cdot i\,dt$$

$$= V\left[\frac{1}{2} I T_1\right] + I\left[\frac{1}{2} V T_2\right]$$

$$= 600\left[\frac{150}{2} \times 1 \times 10^{-6}\right] + 100\left[\frac{1}{2} \times 600 \times 1 \times 10^{-6}\right]$$

$$\text{Energy} = 75 \text{ mJ}$$

End of Solution

Q.46 A single-phase 400 V, 50 Hz transformer has an iron loss of 5000 W at the rated condition. When operated at 200 V, 25 Hz, the iron loss is 2000 W. When operated at 416 V, 52 Hz, the value of the hysteresis loss divided by the eddy current loss is __________.

Ans. **(1.44)**

400 V, 50 Hz transformer,

$$Pi = 5000 \text{ Watt}$$

When,

200 V, 25 Hz ⇒ Pi = 2000 Watt

416 V, 52 Hz ⇒ $\frac{P_h}{P_e} = ?$

$$Pi = P_h + P_e$$

$$P_h \propto f B_m^{\,x}$$

$$P_e \propto f^2 B_m^{\,2}$$

as in the problem

$$\frac{V}{f} = \frac{400}{50} = \frac{200}{25} = \frac{416}{52}$$
$$= 8 = \text{constant}$$
$$P_h = Af$$

and
$$P_e = Bf^2$$

From given data,

$$2000 = (P_{25Hz})_i = A(25) + B(25)^2 \quad ...(i)$$
$$5000 = (P_{50\text{ Hz}})_i = A(50) + B(50)^2 \quad ...(ii)$$

Solving (i) and (ii)

$A = 60,\ B = 0.8$

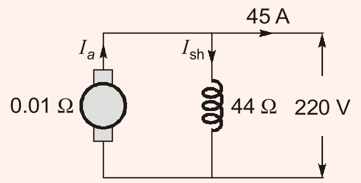
$$(P_h)_{52\text{ Hz}} = Af = 60 \times 52 = 3120 \text{ Watt}$$
$$(P_e)_{52\text{ Hz}} = Bf^2 = 0.8 \times (52)^2 = 2163.2 \text{ Watt}$$

$$\frac{(P_h)_{52Hz}}{(P_e)_{52Hz}} = \frac{3120}{2163.2}$$
$$= 1.4423$$

End of Solution

Q.47 A DC shunt generator delivers 45 A at a terminal voltage of 220 V. The armature and the shunt field resistances are 0.01 Ω and 44 Ω respectively. The stray losses are 375 W. The percentage efficiency of the DC generator is __________.

Ans. **(86.84)**



Stay losses = 375 Watt

Total copper losses
$$= I_a^2R_a + I_{sh}^2R_{sh}$$
$$= 50^2 \times (0.01) + (5)^2 \times 44$$
$$= 1125 \text{ Watt}$$

$$\eta = \frac{\text{O/p}}{\text{O/p + losses}} = \frac{220 \times 45}{220 \times 45 + (1125) + 375}$$
$$= 0.86842 \text{ or } 86.84\%$$

End of Solution

Q.48 A three-phase, 50 Hz salient-pole synchronous motor has a per-phase direct-axis reactance (X_d) of 0.8 pu and a per-phase quadrature-axis reactance (X_q) of 0.6 pu. Resistance of the machine is negligible. It is drawing full-load current at 0.8 pf (leading). When the terminal voltage is 1 pu, per-phase induced voltage, in pu, is __________.

Ans. **(1.606)**

Synchronous motor at leading p.f.

$$X_d = 0.8, \quad \phi = 36.86$$

$$X_q = 0.6, \ R_q = 0$$

$$\tan\psi = \frac{V\sin\phi + I_a \cdot X_a}{V\cos\phi}$$

$$\psi = 56.30$$

For synchronous motor at leading p.f.

$$\psi = \phi + \delta$$

$$\Rightarrow \quad \delta = 19.70°$$

Now,

$$E = V\cos\delta + I_d X_d$$

$$I_d = I_a \sin\phi = 0.831$$

$$E = (1)\cos(19.7) + (0.831)(0.8) = 1.606$$

End of Solution

Q.49 A single-phase, 22 kVA, 2200 V/ 220 V, 50 Hz, distribution transformer is to be connected as an auto-transformer to get an output voltage of 2420 V. Its maximum kVA rating as an autotransformer is

(a) 22
(b) 24.2
(c) 242
(d) 2420

Ans. **(c)**

22 KVA, 2200 V/220 V, 50 Hz

Distribution transformer is to be connected as on auto transformer to get an output voltage of 2420 V.

$(\text{kVA})_{\text{maximum}}$ as an auto transformer = ?

as voltage rating = is 2420 i.e. (2200 + 220) V

additive polarity,

$$(\text{kVA})_{\text{auto}} = (a_{\text{2winding}} + 1) \times \text{kVA}_{\text{2winding}}$$

where,

$$a_{\text{2winding}} = \frac{2200}{220} = 10$$

$$(\text{kVA})\text{auto} = (10 + 1) \times 22 = 242$$

End of Solution

Q.50 A single-phase full-bridge voltage source inverter (VSI) is fed from a 300 V battery. A pulse of 120° duration is used to trigger the appropriate devices in each half-cycle. The rms value of the fundamental component of the output voltage, in volts, is

(a) 234
(b) 245
(c) 300
(d) 331

Ans. **(a)**

$$V_{01\,(rms)} = \frac{2\sqrt{2}}{\pi}V_s \cdot \sin d$$

Pulse width where 2d = 120°

$$d = 60°$$

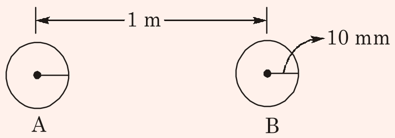
$$V_{01\,(rms)} = \frac{2\sqrt{2}}{\pi}V_s \cdot \sin 60° = \frac{2\sqrt{2}}{\pi}V_s\frac{\sqrt{3}}{2} = 234 \text{ V}$$

End of Solution

Q.51 A single-phase transmission line has two conductors each of 10 mm radius. These are fixed at a center-to-center distance of 1 m in a horizontal plane. This is now converted to a three-phase transmission line by introducing a third conductor of the same radius. This conductor is fixed at an equal distance *D* from the two single-phase conductors. The three-phase line is fully transposed. The positive sequence inductance per phase of the three-phase system is to be 5% more than that of the inductance per conductor of the single-phase system. The distance *D*, in meters, is __________.

Ans. **(1.427)**

In first case

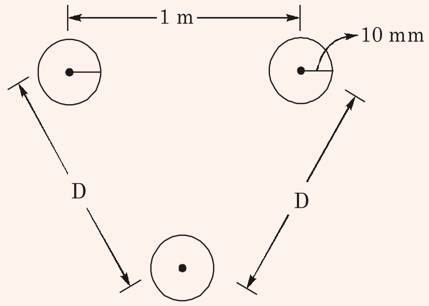


$$L_1 = 2 \times 10^{-7} \ln \frac{D}{r} = 2\times10^{-7}\ln\left(\frac{100}{0.7788}\right)$$

$$L_1 = 0.97\ \mu\text{H/m}$$

$$L_2 = 1.05 \times 0.97 = 1.0185\ \mu\text{H/m}$$

$$L_2 = 2\times10^{-7}\ln\left(\frac{\sqrt[3]{D^2\times100}}{0.7788}\right)$$



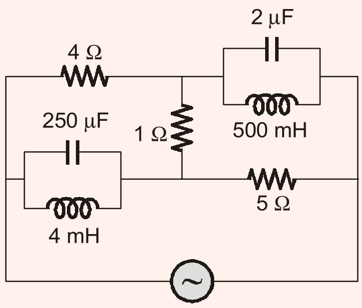
$$\ln\left(\frac{\sqrt[3]{D^2\times 100}}{0.7788}\right) = \frac{1.0185\times 10^{-6}}{2\times 10^{-7}} = 5.0925$$

$$e^{5.0925} = \frac{\sqrt[3]{100\,D^2}}{0.7788}$$

$$D = 142.7 \text{ cm} = 1.427 \text{ m}$$

End of Solution

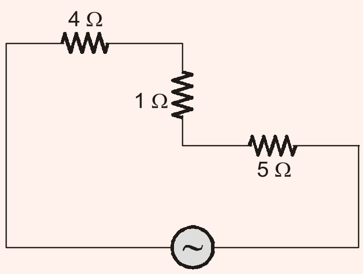
Q.52 In the circuit shown below, the supply voltage is 10 sin (1000t) volts. The peak value of the steady state current through the 1 Ω resistor, in amperes, is __________.



Ans. **(1)**

If we observe the parallel LC combination we get that at ω = 1000 rad/sec the parallel LC is at resonance thus it is open circuited.

The circuit given in question can be redrawn as



So, $$I = \frac{10\sin 1000t}{10} = \sin 100t$$

So peak value is 1 Amp.

End of Solution

Q.53 A dc voltage with ripple is given by $v(t) = [100 + 10\sin(\omega t) - 5\sin(3\omega)t)]$ volts. Measurements of this voltage $v(t)$, made by moving-coil and moving-iron voltmeters, show readings of V_1 and V_2 respectively. The value of $V_2 - V_1$, in volts, is ________.

Ans. **(0.312)**

$$V(t) = 100 + 10\sin(\omega t) - 5\sin(3\omega t) \text{ volt}$$

moving coil,

$$V_1 = V_{avg.} = 100 \text{ V}$$

moving iron,

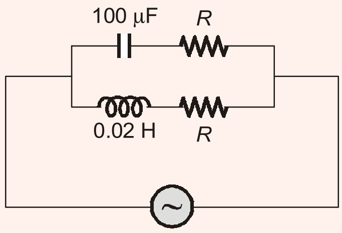
$$V_2 = V_{rms} = \sqrt{100^2 + \frac{1}{2}\left(10^2 + 5^2\right)}$$

$$= 100.312$$

$$V_2 - V_1 = 0.312$$

End of Solution

Q.54 The circuit below is excited by a sinusoidal source. The value of R, in Ω, for which the admittance of the circuit becomes a pure conductance at all frequencies is ________.



Ans. **(14.14)**

The resonant frequency for the circuit is

$$\omega_0 = \frac{1}{\sqrt{LC}}\sqrt{\frac{R_L^2 - L/C}{R_C^2 - L/C}}$$

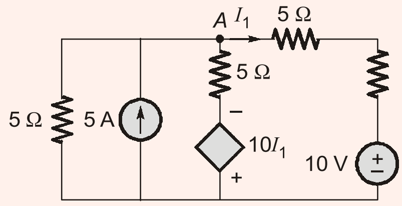
Since $(R_L = R_C = R)$

So the circuit will have zero real part of admittance when, $R = \sqrt{\frac{L}{C}}$

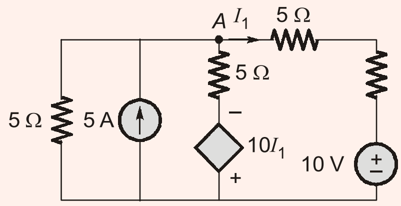
So, $$R = \sqrt{\frac{0.02}{100\ \mu\text{F}}} = 14.14\ \Omega$$

End of Solution

Q.55 In the circuit shown below, the node voltage V_A is ________ V.



Ans. **(11.42)**



Applying KCL at node A, we get

$$\frac{V_A}{5} + \frac{V_A - 10}{10} + \frac{V_A + 10\,I_1}{5} = 5$$

So, $2\,V_A + V_A - 10 + 2\,V_A + 20\,I_1 = 5$

$$5\,V_A + 20\,I_1 = 60$$

Since, $$I_1 = \frac{V_A - 10}{10}$$

So, $$5\,V_A + 2\,V_A - 20 = 60$$

$$7\,V_A = 80$$

$$V_A = \frac{80}{7} = 11.42$$

End of Solution

■■■■