The bandwidth of output will be $B_1 + B_2$.

So sampling rate will be $2(B_1 + B_2)$.

End of Solution

Q.29 The value of the integral $2\int_{-\infty}^{\infty}\left(\frac{\sin 2\pi t}{\pi t}\right)dt$ is equal to

(a) 0
(b) 0.5
(c) 1
(d) 2

Ans. **(d)**

The Fourier transform of

$$\frac{2\sin(t\tau/2)}{t} \longrightarrow 2\pi\,\text{rect}\left(\frac{\omega}{\tau}\right)$$

$$\frac{\sin(2\pi t)}{\pi t} \longrightarrow \text{rect}\left(\frac{\omega}{4\pi}\right)$$

So, $$\int_{-\infty}^{\infty}\frac{\sin(2\pi t)}{\pi t}e^{-j\omega t}dt = \text{rect}\left(\frac{\omega}{4\pi}\right)$$

Putting $\omega = 0$ in above equation

$$\int_{-\infty}^{\infty}\frac{\sin(2\pi t)}{\pi t}dt = 1$$

$$2\int_{-\infty}^{\infty}\frac{\sin(2\pi)}{\pi t}dt = 2$$

End of Solution

Q.30 Let $y(x)$ be the solution of the differential equation $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$ with initial conditions $y(0) = 0$ and $\left.\frac{dy}{dx}\right|_{x=0} = 1$. Then the value of y (1) is ________.

Ans. **(7.38)**

A.E. $$m^2 - 4m + 4 = 0$$

$$m = 2, 2$$

$$y = (C_1 + C_2x)\,e^{2x}$$

$y(0) = 0 \Rightarrow$ $$C_1 = 0$$

$$y = C_2xe^{2x}$$

$$y' = C_2e^{2x} + 2C_2xe^{2x}$$
$$y'(0) = 1$$
$$\Rightarrow \quad C_2 = 1$$
$$y = xe^{2x}$$
$$y(1) = e^2 = 7.38$$

End of Solution

Q.31 The line integral of the vector field $F = 5xz\hat{i} + (3x^2 + 2y)\hat{j} + x^2zk$ along a path from (0, 0, 0) to (1, 1, 1) parameterized by (t, t^2, t) is __________.

Ans. **(4.41)**

$$E = 5xz\bar{i} + \left(3x^2 + 2y\right)\bar{j} + x^2z\bar{k}$$
$$= \int_C \bar{F}.\bar{d}r$$
$$= \int_C 5xz\,dx + \left(3x^2 + 2y\right)dy + x^2zdz$$
$$x = t, \quad y = t^2, \quad z = t, \; t = 0 \text{ to } 1$$
$$dx = dt$$
$$dy = 2t\;dy, \quad dz = dt$$
$$= \int_0^1 5t^2dt + \left(3t^2 + 2t^2\right)2tdt + t^3dt$$
$$= \int_0^1 \left(5t^2 + 11t^3\right)dt$$
$$= \left[\frac{5t^3}{3} + \frac{11t^4}{4}\right]_0^1 = \frac{5}{3} + \frac{11}{4} = \frac{53}{12} = 4.41$$

End of Solution

Q.32 Let $P = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$. Consider the set S of all vectors $\begin{pmatrix} x \\ y \end{pmatrix}$ such that $a^2 + b^2 = 1$ where $\begin{pmatrix} a \\ b \end{pmatrix} = P\begin{pmatrix} x \\ y \end{pmatrix}$. Then S is

(a) a circle of radius $\sqrt{10}$

(b) a circle of radius $\frac{1}{\sqrt{10}}$

(c) an ellipse with major axis along $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$

(d) an ellipse with minor axis along $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$

Ans. **(c)**

$$\begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a \\ b \end{bmatrix}$$

$$3x + y = a$$

$$x + 3y = b$$

$a^2 + b^2 = 1 \Rightarrow$

$$10x^2 + 10y^2 + 12xy = 1$$

Ellipse with major axis along $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$.

End of Solution

Q.33 Let the probability density function of a random variable , X, be given as :

$$f_x(x) = \frac{3}{2}e^{-3x}u(x) + ae^{4x}u(-x)$$

where $u(x)$ is the unit step function.
Then the value of 'a' and Prob $\{X \leq 0\}$, respectively, are

(a) $2, \frac{1}{2}$

(b) $4, \frac{1}{2}$

(c) $2, \frac{1}{4}$

(d) $4, \frac{1}{4}$

Ans. **(a)**

$$f_x(x) = \begin{cases} ae^{4x} & x < 0 \\ \frac{3}{2}e^{-3x} & x \geq 0 \end{cases}$$

$$\int_{-\infty}^{\infty} f_x(x) = 1$$

$$\int_{-\infty}^{0} ae^{4x}dx + \int_{0}^{\infty} \frac{3}{2}e^{-3x}dx = 1$$

$$\left[\frac{ae^{4x}}{4}\right]_{-\infty}^{0} + \left[\frac{\frac{3}{2}e^{-3x}}{-3}\right]_{0}^{\infty} = 1$$

$$\frac{a}{4} + \frac{3}{6} = 1$$

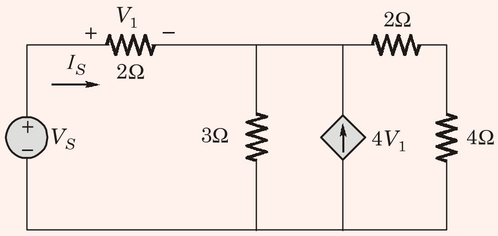
$$a = 2$$

$$P(x \le 0) = \int_{-\infty}^{0} 2e^{4x}\,dx$$

$$= \left[\frac{e^{4x}}{2}\right]_{-\infty}^{0} = \frac{1}{2}$$

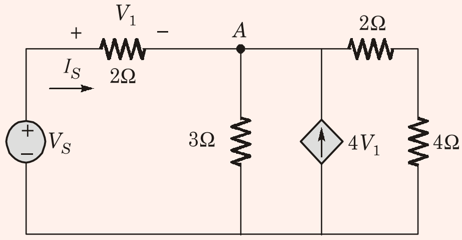
End of Solution

Q.34 The driving point input impedance seen from the source V_S of the circuit shown below, in Ω, is_______.



Ans. **(20)**

To find impedance seen by V_s



$$Z_s = \frac{V_s}{I_s}$$

$$V_1 = 2I_s$$

Applying KCL at node A

$$I_s + 4\,V_1 = \frac{V_A}{3} + \frac{V_A}{6}$$

$$V_A = V_s - V_1 \text{ and } V_1 = 2I_s$$

So, $$I_s + 8I_s = \frac{V_s - 2I_s}{3} + \frac{V_s - 2I_s}{6}$$

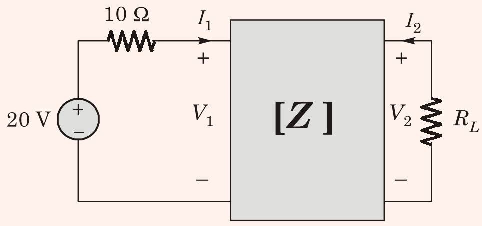
$\Rightarrow$ $$54\,I_s = 2V_s - 4I_s + V_s - 2I_s$$

$\Rightarrow$ $$3V_s = 60I_s$$

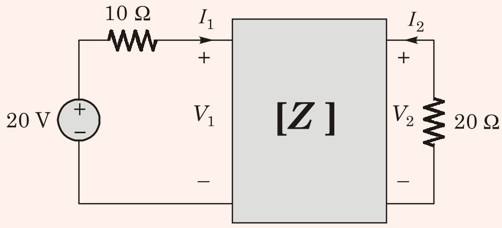
$$\frac{V_s}{I_s} = 20\ \Omega$$

End of Solution

Q.35 The z-parameters of the two port network shown in the figure are $z_{11} = 40\ \Omega$, $z_{12} = 60\ \Omega$, $z_{21} = 80\ \Omega$ and $z_{22} = 100\ \Omega$. The average power delivered to $R_L = 20\ \Omega$, in watts, is______.



Ans. **(35.55)**



given $Z_{11} = 40\ \Omega$, $Z_{12} = 60$ W,

$Z_{21} = 80\ \Omega$, $Z_{22} = 100\ \Omega$

From the figure $V_2 = -20\ I_2$ ...(i)

and $V_1 = 40I_1 + 60I_2$ ...(ii)

$V_2 = 80I_1 + 100I_2$ ...(iii)

From equation (i) and (iii), we get

So, $-20I_2 = 80I_1 + 100I_2$

$\Rightarrow$ $I_2 = -\frac{2}{3}I_1$ ...(iv)

Using equation (ii) and (iv), we get

So, $V_1 = 40I_1 + 60I_2 = 40I_1 + 60\left(\frac{-2}{3}I_1\right)$

$V_1 = 0$

From the figure, $20 = 10I_1 + V_1$

Since, $V_1 = 0$

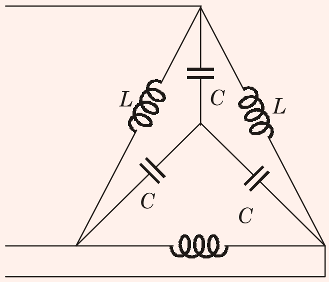
So, $I_1 = 2$ A

So, $I_2 = -\frac{4}{3}$ A

Power dissipated in $R_L = I_2^2\ R_L = \left(\frac{4}{3}\right)^2 \times 20 = \frac{16}{9} \times 20 = 35.55$ W

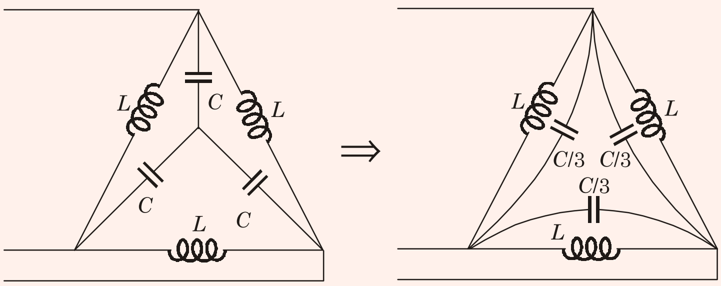
End of Solution

Q.36 In the balanced 3-phase, 50Hz, circuit shown below, the value of inductance (L) is 10 mH. The value of the capacitance (C) for which all the line currents are zero, in millifarads, is________.



Ans. **(3.03)**

Using star to delta conversion



Line current will be zero when the parallel pair of induction-capacitor is resonant at f = 50 Hz.

So, $$50 \times 2\pi = \frac{1}{\sqrt{LC/3}}$$

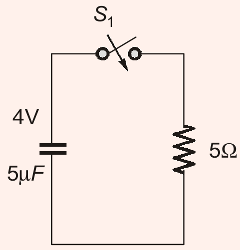
$$100\pi = \frac{1}{\sqrt{LC/3}}$$

Since, L = 10 mH

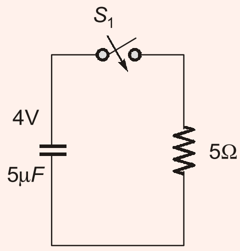
C will be 3.03 mF

End of Solution

Q.37 In the circuit shown below, the initial capacitor voltage is 4 V. Switch S_1 is closed at $t = 0$. The charge (in μC) lost by the capacitor from $t = 25$ μs to $t = 100$ μs is_______.



Ans. **(6.99)**



$$i(t) = \left(\frac{4}{5} e^{-t/\tau}\right)$$

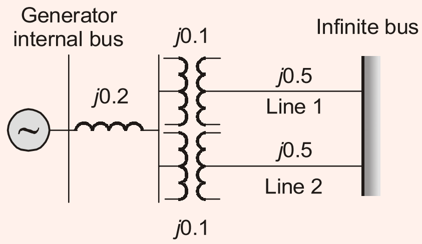
$$\tau = RC = 25 \times 10^{-6} \text{ sec}$$

Change lost by capacitor from $t = 25$ μs to 100 μs is

$$\int_{25\,\mu\text{sec}}^{100\,\mu\text{sec}} i(t)dt = 6.99 \times 10^{-6} \text{ C}$$

End of Solution

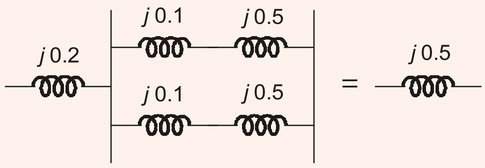
Q.38 The single line diagram of a balanced power system is shown in the figure. The voltage magnitude at the generator internal bus is constant and 1.0 p.u. The p.u. reactances of different components in the system are also shown in the figure. The infinite bus voltage magnitude is 1.0 p.u. A three phase fault occurs at the middle of line 2. The ratio of the maximum real power that can be transferred during the pre-fault condition to the maximum real power that can be transferred under the faulted condition is _________.



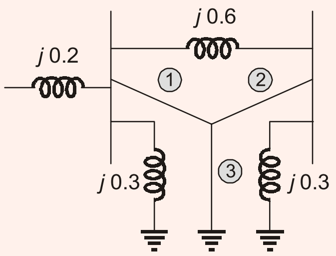
Ans. **(2.4)**

$$\text{The ratio} = \frac{P_1}{P_2} = \frac{X_2}{X_1}$$

X_1 =



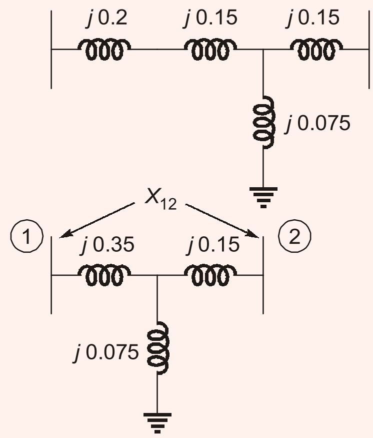
X_2 =



(1). $\Rightarrow$ $$\frac{j\,0.3 \times j\,0.6}{j\,1.2} = j\,0.15$$

(2). $\Rightarrow$ $$\frac{j\,0.3 \times j\,0.6}{j\,1.2} = j\,0.15$$

(3). $\Rightarrow$ $$\frac{j\,0.3 \times j\,0.3}{j\,1.2} = j\,0.075$$



$$X_{12} = X_2 =$$

$$j\,0.35 + j\,0.15 + \frac{j\,0.35 \times j\,0.15}{j\,0.075} = j\,1.2 \text{ p.u.}$$

$$\frac{P_1}{P_2} = \frac{X_2}{X_1} = \frac{j\,1.2}{j\,0.5} = 2.4$$

End of Solution

Q.39 The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K(s+1)}{s(1+Ts)(1+2s)}, K > 0, T > 0.$$

The closed loop system will be stable if,

(a) $0 < T < \frac{4(K+1)}{K-1}$

(b) $0 < K < \frac{4(T+2)}{T-2}$

(c) $0 < K < \frac{T+2}{T-2}$

(d) $0 < T < \frac{8(k+1)}{K-1}$

Ans. **(c)**

Open loop transfer function

$$G(s) = \frac{K(s+1)}{s(1+Ts)(1+2s)}; \; K > 0 \text{ and } T > 0$$

For closed loop system stability, characteristic equation is

$$1 + G(s)H(s) = 0$$

$$1 + \frac{K(s+1)}{s(1+Ts)(1+2s)}.1 = 0$$

$s(1 + Ts)(1 + 2s) + k(s + 1) = 0$

$2Ts^3 + (2 + T)s^2 + (1 + k)s + k = 0$

Using Routh's criteria

s^3	$2T$	$(1+k)$
s^2	$(2+T)$	k
s^1	$\dfrac{(2+T)(1+k)-2Tk}{(2+T)}$	0
s^0	k	

For stability, $k > 0$

and $(2 + T)(1 + k) - 2Tk > 0$

$k(2 + T - 2T) + (2 + T) > 0$

or

$-(T - 2)k + 2(2 + T) > 0$

$$-k > -\frac{(2+T)}{(T-2)}$$

or $$k < \frac{T+2}{(T-2)}$$

Hence for stability,

$$0 < k < \frac{T+2}{T-2}$$

End of Solution

Q.40 At no load condition, a 3-phase, 50 Hz, lossless power transmission line has sending-end and receiving-end voltages of 400 kV and 420 kV respectively. Assuming the velocity of traveling wave to be the velocity of light, the length of the line, in km, is ____________.

Ans. **(294.59)**

At no load, $$V_s = AV_R$$

$$400 = A\,420$$

$$A = \frac{400}{420} = 0.9524$$

$$A = 1 + \frac{YZ}{2} = 1 + \frac{(r + j\omega L)(g + j\omega C)}{2}$$

For lossless line $r = 0$, $g = 0$

then $$A = 1 - \frac{(\omega C)(\omega L)}{2}$$

$$\beta l = \sqrt{\omega L\, \omega C}$$

$$A = 0.9524 = 1 - \frac{\beta^2 l^2}{2}$$

$$\beta l = 0.3085$$

$$\beta = \frac{0.3085}{l}$$

$$\frac{V}{f} = \frac{2\pi}{\beta}$$

$$\frac{30 \times 10^5}{50} = \frac{2\pi}{\left(\frac{0.3085}{l}\right)}$$

$$l = 294.59 \text{ km}$$

End of Solution

Q.41 The power consumption of an industry is 500 kVA, at 0.8 p.f. lagging. A synchronous motor is added to raise the power factor of the industry to unity. If the power intake of the motor is 100 kW, the p.f. of the motor is ____________.

Ans. **(0.3162)**

$$P_1 = 500 \times 0.8 = 400 \text{ kW}$$

$$Q_1 = 500 \times 0.6 = 300 \text{ kVAR}$$

The power factor is to be raised to unity

The motor has to supply 300 kVAR

The motor rating is 100 kW, 300 kVAR

$$\phi_m = \tan^{-1}\left(\frac{Q}{P}\right)$$

$$\phi_m = \tan^{-1}\left(\frac{300}{100}\right) = 71.56$$

$$\text{Power factor of motor} = \cos\phi_m = \cos 71.56 = 0.316$$

End of Solution

Q.42 The flux linkage (λ) and current (i) relation for an electromagnetic system is $\lambda = \left(\sqrt{i}\right)/g$. When i = 2A and g(air-gap length) = 10 cm, the magnitude of mechanical force on the moving part, in N, is _______.

Ans. **(141.4)**

Stored energy in electromagnetic system

$$E = \frac{1}{2}\lambda i$$

$$E = \frac{1}{2}\frac{i\sqrt{i}}{g}$$

Restoring force in EM system

$$= -\frac{dE}{dx} = F$$

Here $x = g =$ air gap length

Now $$F = -\left(-\frac{1}{2}\cdot\frac{i^{3/2}}{g^2}\right) = \frac{1}{2}\times\frac{i^{3/2}}{g^2}$$

$$= \frac{1}{2}\times\frac{(2)^{3/2}}{0.1\times 0.1} = 141.4 \text{ N}$$

End of Solution

Q.43 The starting line current of a 415 V, 3-phase, delta connected induction motor is 120 A, when the rated voltage is applied to its stator winding. The starting line current at a reduced voltage of 110 V, in ampere, is ________.

Ans. **(31.807)**

415 V, 3-phase, Δ connected induction motor $(I_{st})_{line} = 120$ A at rated voltage.
at, V = 110 V, i.e. reduced voltage

$$I_{st} = x(I_{st})_{rated}$$

where, $$x = \frac{V_{reduced}}{V_{rated}}$$

$$x = \frac{110}{415}$$

$$(I_{st})_{at\ 110\ V} = \left(\frac{110}{415}\right)\times 120$$

$$= 31.807 \text{ A}$$

End of Solution

Q.44 A single-phase, 2 kVA, 100/200 V transformer is reconnected as an auto-transformer such that its kVA rating is maximum. The new rating, in kVA, is ______.

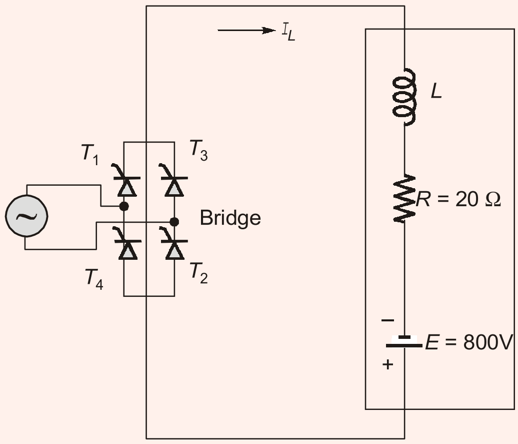
Ans. **(6)**

2 kVA, 100/200 V transformer, $a_{2\text{winding}} = \dfrac{200}{100} = 2$

$$[(\text{kVA})_{\text{auto}}]_{\max} = (a_{2\text{winding}}+1)\,(\text{kVA})_{2\text{winding}}$$
$$= (2+1)\times 2$$
$$= 6$$

End of Solution

Q.45 A full-bridge converter supplying an RLE load is shown in figure. The firing angle of the bridge converter is 120°. The supply voltage $v_m(t) = 200\,\pi\,\sin(100\pi t)\ V$, $R = 20\ \Omega$, $E = 800$ V. The inductor L is large enough to make the output current I_L a smooth dc current. Switches are lossless. The real power feedback to the source, in kW, is________.



Ans. **(6)**

$$V_o = 2\frac{V_m}{\pi}\cos\alpha = 2\frac{200\pi}{\pi}\cos 120°$$

$$V_o = -200 \text{ V}$$

$$|V_o| = 200 \text{ V}$$

Power balance equation, $EI_o = I_o^2 R + V_o\, I_o$

$$800\, I_o = I_o^2(20) + 200 I_o$$

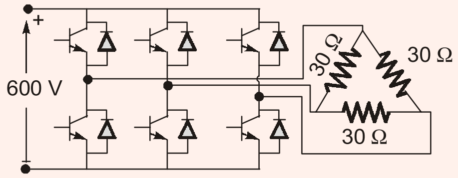
$$I_o = 30 \text{ A}$$

$$I_o = I_{or}$$

$$\text{Power fed to source} = V_o I_o$$
$$= 200 \times 30 = 6 \text{ kW}$$

End of Solution

Q.46 A three-phase Voltage Source Inverter (*VSI*) as shown in the figure is feeding a delta connected resistive load of 30 Ω/phase. If it is fed from a 600 V battery, with 180° conduction of solid-state devices, the power consumed by the load, in kW, is______.



Ans. **(24)**

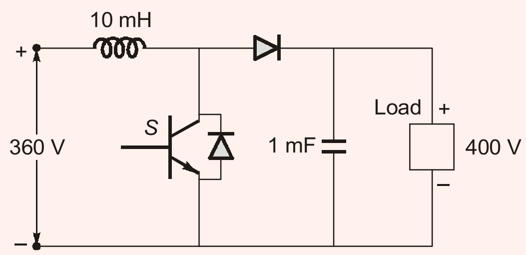
$$V_L = V_{ph} = \sqrt{\frac{2}{3}} V_s$$

$$V_{ph} = \sqrt{\frac{2}{3}} \times 600$$

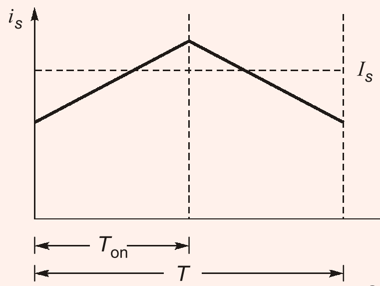
$$P = 3\frac{V_{ph}^2}{R} = \frac{3 \times \frac{2}{3} \times 600^2}{30} = 24 \text{ kW}$$

End of Solution

Q.47 A DC-DC boost converter, as shown in the figure below, is used to boost 360V to 400 V, at a power of 4 kW. All devices are ideal. Considering continuous inductor current, the rms current in the solid state switch (*S*), in ampere, is _________.



Ans. **(3.5)**



$$\frac{V_o}{V_s} = \frac{1}{1-\alpha}$$

$$\frac{400}{360} = \frac{1}{1-\alpha}$$

$$\alpha = 0.1$$

$$V_s I_s = \text{Power}$$

$$360\, I_s = 4000$$

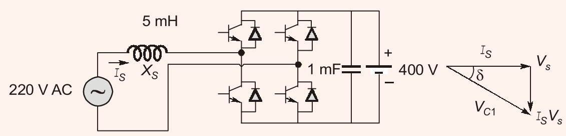
$$I_s = 11.1 \text{ A}$$

Neglecting ripple in i_s, $$I_{\text{switch (rms)}} = I_s\left(\frac{T_{on}}{T}\right)^{1/2}$$

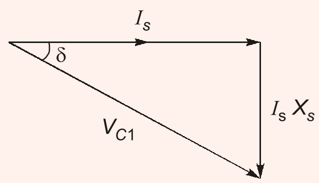
$$= I_s\sqrt{\alpha} = 11.1\sqrt{0.1} = 3.5 \text{ A}$$

End of Solution

Q.48 A single-phase bi-directional voltage source converter (VSC) is shown in the figure below. All devices are ideal. It is used to charge a battery at 400 V with power of 5 kW from a source V_s = 220 V (rms), 50 Hz sinusoidal AC mains at unity p.f. If its AC side interfacing inductor is 5 mH and the switches are operated at 20 kHz, then the phase shift (δ) between AC mains voltage (V_s) and fundamental AC rms VSC voltage (VC1), in degree, is ________.



Ans. **(9.21)**



$$P = V_s I_s \text{ p.f.}$$

$$5 \times 10^3 = 220 \times I_s \times 1$$

$$I_s = 22.72 \text{ A}$$

$$\tan\delta = \frac{I_s X_s}{V_s}$$

$$\delta = \tan^{-1}\left(\frac{22.72\times 2\pi\times 50\times 5\times 10^{-3}}{220}\right)$$

$$\delta = 9.21°$$

End of Solution

Q.49 Consider a linear time invariant system $\dot{x} = Ax$, with initial conditions $x(0)$ at $t = 0$. Suppose α and β are eigenvectors of (2×2) matrix A corresponding to distinct eigenvalues λ_1 and λ_2 respectively. Then the response $x(t)$ of the system due to initial condition $x(0) = \alpha$ is

(a) $\alpha e^{\lambda_1 t}$ (b) $e^{\lambda_2 t}\alpha\beta$

(c) $e^{\lambda_2 t}\alpha\alpha$ (d) $e^{\lambda_1 t}\alpha + e^{\lambda_2 t}\beta$

Ans. **(a)**

$$\dot{x} = Ax$$

Eigen values are λ_1 and λ_2

We can write,

$$\phi(t) = \begin{bmatrix} e^{\lambda_1 t} & 0 \\ 0 & e^{\lambda_2 t} \end{bmatrix}$$

Response due to initial conditions,

$$x(t) = \phi(t)\,.\,x(0)$$

$$x(t) = \begin{bmatrix} e^{\lambda_1 t} & 0 \\ 0 & e^{\lambda_2 t} \end{bmatrix}\begin{bmatrix} \alpha \\ 0 \end{bmatrix}$$

$$= \alpha\, e^{\lambda_1 t}$$

End of Solution

Q.50 A second -order real system has the following properties :

(a) the damping ratio $\zeta = 0.5$ and undamped natural frequency $\omega_n = 10$ rad/s,

(b) the steady state value of the output, to a unit step input, is 1.02.

The transfer function of the system is

(a) $\frac{1.02}{s^2 + 5s + 100}$ (b) $\frac{1.02}{s^2 + 10s + 100}$

(c) $\frac{100}{s^2 + 10s + 100}$ (d) $\frac{102}{s^2 + 5s + 100}$

Ans. **(b)**

Damping ratio $\xi = 0.5$

Undamped natural frequency $\omega_n = 10$ rad/sec

Steady state output to a unit step input

$$C_{ss} = 1.02$$

$$\text{Hence steady state error} = 1.02 - 1.00$$

$$e_{ss} = 0.02$$

$\because$ Characteristics equation is,

$$s^2 + 2\xi\omega_n s + \omega_n^2 = 0$$
$$s^2 + 2 \times 0.5 \times 10\ s + 100 = 0$$
$$s^2 + 10s + 100 = 0$$

From options, if we take option (b) then

$$C_{ss} = \lim_{s\to 0} s.C(s) = \lim_{s\to 0} s \times \frac{1}{s} \times \frac{102}{s^2 + 10s + 100}$$
$$C_{ss} = 1.02$$

Hence option (b) is correct answer.

End of Solution

Q.51 Three single-phase transformers are connected to form a delta-star three-phase transformer of 110 kV/11 kV. The transformer supplies at 11 kV a load of 8 MW at 0.8 p.f. lagging to a nearby plant. Neglect the transformer losses. The ratio of phase currents in delta side to star side is

(a) $1:10\sqrt{3}$
(b) $10\sqrt{3}:1$
(c) 1 : 10
(d) $\sqrt{3}:10$

Ans. **(a)**

At 11 kV, load is 8 MW, 0.8 Pf lagging

$$\Rightarrow \quad \frac{(V_{ph})_\Delta}{(V_{ph})_Y} = \frac{(I_{ph})_Y}{(I_{ph})_\Delta}$$

$$\Rightarrow \quad (I_{ph})_\Delta = (I_{ph})_Y \times \frac{(V_{ph})_Y}{(V_{ph})_\Delta}$$

$$\frac{(I_{ph})_\Delta}{(V_{ph})_Y} = \frac{11/\sqrt{3}}{110} = 1:10\sqrt{3}$$

End of Solution

Q.52 The gain at the breakaway point of the root locus of a unity feedback system with open loop transfer function $G(s) = \frac{Ks}{(s-1)(s-4)}$ is

(a) 1
(b) 2
(c) 5
(d) 9

Ans. **(a)**

$$\text{OLTF} \Rightarrow G(s) = \frac{Ks}{(s-1)(s-4)}$$

Now, characteristics equation

$1 + G(s)H(s) = 0$

$$\frac{Ks}{(s-1)(s-4)} + 1 = 0$$

$$\Rightarrow \quad Ks + (s^2 - 5s + 4) = 0$$

$$K = -\frac{(s^2 - 5s + 4)}{s} = [s - 5 + 4/s]$$

For break away point: $\dfrac{dK}{ds} = 0$

$$\frac{dK}{ds} = -\left[1 - 0 - \frac{4}{s^2}\right] = 0$$

we get $s = \pm 2$

Therefore valid break away point is

$s = 2,$

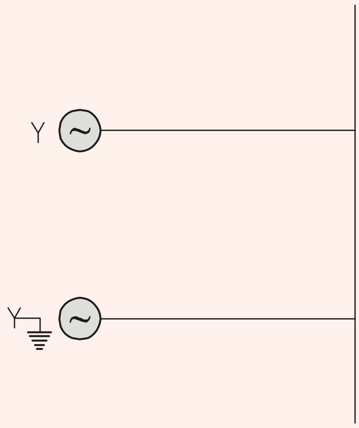
Now gain at $s = 2$ is

$$\Rightarrow K = \frac{\text{Product of distances from all the poles to break away point}}{\text{Product of distance from all the zeros to break away point}}$$

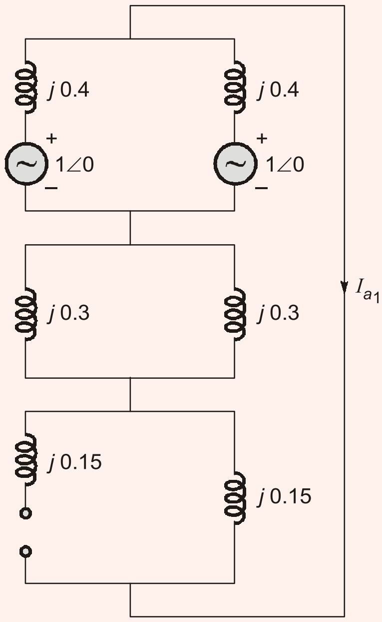
$$\text{Gain, } K = \frac{1 \times 2}{2} = 1$$

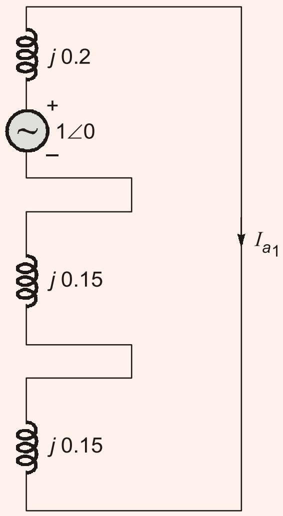
End of Solution

Q.53 Two identical unloaded generators are connected in parallel as shown in the figure. Both the generators are having positive, negative and zero sequence impedance of j0.4 p.u, j0.3, p.u. and j0.15 p.u., respectively. If the pre-fault voltage is 1 p.u., for a line-to-ground (L-G) fault at the terminals of the generators, the fault current, in p.u., is________.



Ans. **(6)**





$$I_f = 3\,I_{a_1} = \frac{3}{0.2 + 0.15 + 0.15}$$

$$I_f = 6 \text{ p.u.}$$

End of Solution

Q.54 An energy meter, having meter constant of 1200 revolutions/kWh, makes 20 revolutions in 30 seconds for a constant load. The load, in kW, is________.

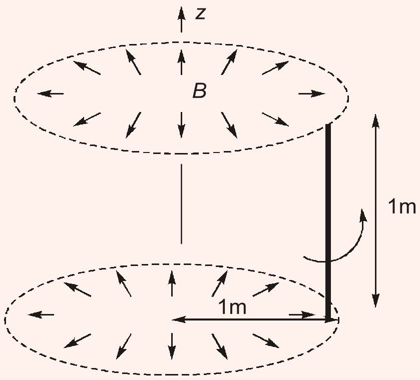
Ans. **(2)**

1200 rev/kWh, 20 rev, 30 sec

$$P_{\text{loss}} = \frac{20 \times 3600}{1200 \times 30} = 2 \text{ kW}$$

End of Solution

Q.55 A rotating conductor of 1 m length is placed in a radially outward (about the z-axis) magnetic flux density (B) of 1 Tesla as shown in figure below. Conductor is parallel to and at 1 m distance from the z-axis. The speed of the conductor in r.p.m. required to induce a voltage of 1 V across it, should be______.



Ans. **(9.55)**

$$\text{Voltage induced} = \int_0^1 E_m \cdot dl$$

(where E_m is induced electric field)

$$= E_m \cdot \text{volts}$$

$$\text{Since voltage induced} = 1 \text{ V}$$

So, $$E_m = 1 \text{ V/m}$$

$$\text{As we know } E_m = \bar{V} \times \bar{B}$$

$$\text{where } V = (\text{radius of path}) \times (\text{angular velocity})$$

$$\frac{1V}{m} = (V \times 1 \text{ Tesla})$$

$$v = 1 \text{ m/sec}$$

$$v = r \times \omega = 1 \text{ m/sec}$$

$$\text{Since } r = 1 \text{ m, So } \omega = 1 \text{ rad/sec}$$

Now from this we get $$\omega = 2 \times \pi \times \frac{N}{60} = 1 \text{ rad/sec}$$

$$N = \frac{30}{\pi} = 9.55 \text{ revolutions per minute.}$$

End of Solution

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