Course Details

Course Tittle Electrical Network Analysis

Module 4th

Student Details

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Q) Assume that a 2000-KW - - - - -

- - - - - - But keep it from being overloaded?

Sol

Original load:

$P_1 = 2000KW$, $\quad \cos\theta = 0.85 \rightarrow \theta_1 = 31.79^\circ$

$$S_1 = \frac{P_1}{\cos\theta_1} = 2352.94 KVA$$

$$Q_1 = S_1 \sin\theta_1 = 1239.5 KVAR$$

Additional load:

$P_1 = 300KW$ $\quad \cos\theta_2 = 0.8 \rightarrow \theta_2 = 36.87^\circ$

$$S_2 = \frac{P_2}{\cos\theta_2} = 375 KVA$$

$$Q_2 = S_2 \sin\theta_2 = 225 KVAR$$

Total load:

$$S = S_1 + S_2 = (P_1 + P_2) + j(Q_1 + Q_2) = P + jQ$$

$$P = 2000 + 300 = 2300 KW$$

$$Q = 1239.5 + 225 = 1464.5 KVAR$$

The minimum operating pf for a 2300KW load & not exceeding the KVA rating of the generato is

$$\cos\theta = \frac{P}{S_1} = \frac{2300}{2352.94}$$

$$\Rightarrow 0.9775$$

OR

$$\theta = 12.177^\circ$$

The maximum load KVAR for this condition is

$$\cancel{\cos\theta = \frac{P}{S_1} = 2300}$$

$$Q = S_1 \sin\theta = 2352.94 \sin(12.177)$$

$$Q = 496.313 \text{ KVAR}$$

The capacitor must supply the difference between the total load KVAR (i.e Q) and the Permissible generator KVAR (i.e Q.)

Thus,

$$Q = Q - Q_n = 968.2 \text{ KVAR}$$

Q2 A balanced abc sequence one line
- ---- Find the phase and the
currents.

Sol:- Line Voltage $V_{AB} = 180\angle -20^\circ V$

$Z_\Delta = 20\angle 40^\circ \Omega$

Using Formula

$V_L = \sqrt{3}\, V_P \angle 30^\circ \Rightarrow V_P = \frac{V_L}{\sqrt{3}\angle 30^\circ}$

Phase voltage:

$V_{an} = \frac{180\angle -20^\circ}{\sqrt{3}} \cdot \angle -30^\circ$

$\Rightarrow 103.9\angle -50^\circ V$

$Z_Y = \frac{Z_\Delta}{3} = \frac{20\angle 40}{3}$

$\Rightarrow 6.67\angle 40^\circ \Omega$

Line current

$I_a = \frac{V_{an}}{Z_\Delta/3} = \frac{103.9\angle -50^\circ}{6.67\angle 40^\circ}$

$I_a = 15.57\angle -90^\circ A$

$I_b = I_a \angle -120^\circ = 15.59\angle +150^\circ A$

$I_c = I_a \angle +120^\circ = 15.59\angle 30^\circ A$

Phase Current

$$I_{AB} = \frac{15.57\angle -90^\circ}{\sqrt{3}} \cdot \angle 30^\circ$$

$$\Rightarrow 9\angle -60^\circ \text{ A}$$

$$I_{BC} = I_{AB}\angle -120^\circ = 9\angle -180^\circ \text{ A}$$

$$I_{CA} = I_{AB}\angle +120^\circ = 9\angle 60^\circ \text{ A}$$

Q3 Consider a load with value - - - -
- - - - - -
(a) - - -
(b) - - - -
(c) The power factor & the load impedence

Sol:

Given Data

$V_{rms} = 110\angle 85^\circ V$

$I_{rms} = 0.4\angle 15^\circ A$

Step 2

The complex power is

$S = V_{rms} I_{rms}$

$S = (110\angle 85^\circ)(0.4\angle -15^\circ)$

$S = 110 \times 0.4 \angle (85^\circ - 15^\circ)$

$\therefore S = 44\angle 70^\circ VA$

The apparent powe is

$S = |S|$

$S = 44 VA$

Step 3

Express the complex power in rectangular form

$S = 44\angle 70^\circ$

$S = 44[\cos(70^\circ) + j\sin(70^\circ)]$

$S = 44[0.3420 + j0.9397]$

$S = 15.05 + j41.35$

Since $S = P + jQ$

The real power is

$\therefore P = 15.05\ W$

The reactive power is

$Q = 41.35\ VAR$

Step 4

The power factor is

$Pf = \cos(70^\circ)$

$Pf = 0.342$ (lagging)

The power factor is lagging as the reactive power is positive.

$Z = \frac{V}{I}$

$V = \sqrt{2}\, V_{rms}$

$I = \sqrt{2}\, I_{rms}$

Step 5

$$Z = \frac{110\sqrt{2} \angle 85^\circ}{0.4\sqrt{2} \angle 15^\circ}$$

$$Z = 275 \angle 70^\circ \ \Omega$$

$$Z = 275 [\cos(70^\circ) + j\sin(70^\circ)]$$

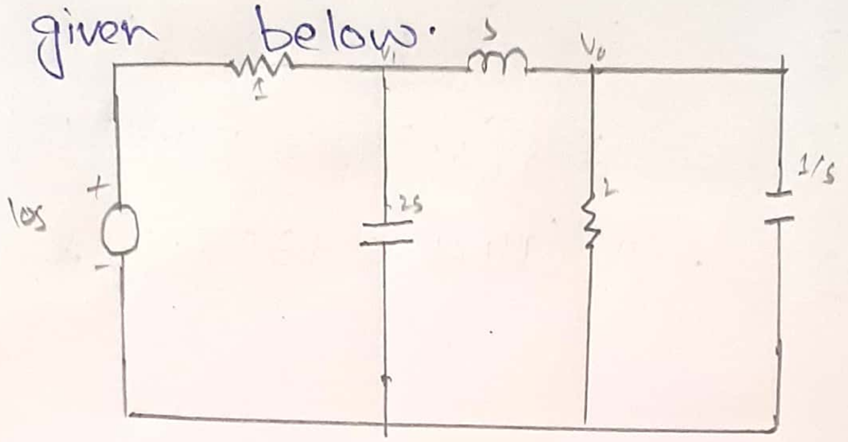
$$Z = 275 [0.342 + j 0.9397]$$

$$Z = (94.05 + j258.4) \ \Omega$$

Q4| Apply Laplace transform - - - - -
- - - in the circuit figure below.

Sol:

S-domain version of the circuit is given below.



Node 1

$$\frac{\frac{10}{s} - V_1}{1} = \frac{V_1 - V_o}{s} + \frac{s}{2}V_o \rightarrow 10 = (s+1)V_1 + \left(\frac{s^2}{2} - 1\right)V_o \rightarrow (1)$$

Node 2

$$\frac{V_1 - V_o}{s} = \frac{V_o}{2} + sV_o \rightarrow V_1 = V_o\left(\frac{s}{2} + s^2 + 1\right) \rightarrow (2)$$

Subtituting (2) into (1) gives

$$\cancel{10 = (s+1)(s^2+s/2)}$$

$$10 = (s+1)(s^2 + s/2 + 1)V_o + \left(\frac{s^2}{2} - 1\right)V_o = s(s^2 + 2s + 1.5)V_o$$

$$V_o = \frac{10}{s(s^2+2s+1.5)} = \frac{A}{s} + \frac{Bs + C}{s^2 + 2s + 1.5}$$

$10 = A(s^2+2s+1.5) + Bs^2 + Cs$

$s^2: \quad 0 = A+B$

$s: \quad 0 = 2A+C$

Constant: $10 = 1.5A \rightarrow A = 20/3 \;\; B = -20/3, \; C = -40/3$

$$V_o = \frac{20}{3}\left[\frac{1}{s} - \frac{s+2}{s^2+2s+1.5}\right]$$

$$\Rightarrow \frac{20}{3}\left[\frac{1}{s} - \frac{s+1}{(s+1)^2+0.7071^2} - 1.414\frac{0.7071}{(s+1)^2+0.7071^2}\right]$$

Taking the inverse Laplace transform finally yields.

$$V_o(t) = \frac{20}{3}\left[1 - e^{-t}\cos 0.7071t - 1.414e^{-t}\sin 0.7071t\right]u(t)\,V$$

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Q5 For the circuit given in Figure below --- 10

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(a) - - -

(b) ---- Much Power is delievered to the Speaker at that.

Sol

Given Data :

$V_s = 5V_{rms}$

$C = 80nF$

$L = 80mH$

Sol:

Source impedence = $Z_s = R_s + jx_1$

Load impedence = $Z_L = R_L + jx_L$

Form maximum transfer

$Z_L = Z_s$ mean

$R_L = R_s$ & $x_c = x_L$

$X_c = X_L$

$$\frac{1}{\omega C} = \omega L$$

Re-arranging

$$\omega = \frac{1}{\sqrt{LC}} = 2\pi f$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f \Rightarrow \frac{1}{2(3.14)\sqrt{(80\times10^{-3})(80\times10^{-9})}}$$

$$\Rightarrow \frac{1}{6.28\sqrt{(80)^2\times10^{-12}}}$$

$$\Rightarrow \frac{1}{(6.28)(80)(\sqrt{10^{-12}})}$$

$$\Rightarrow \frac{1}{(6.28)(80)(0.000001)}$$

$$\Rightarrow \frac{1}{0.0005024}$$

$$f = 1990.44 \text{ Hz}$$

Now Part B

As we know that

Power deliver $= P = \left(\frac{V_s}{R_{eq}}\right)^2$

$$P = \left(\frac{V_s}{R_1+R_2}\right)^2 R_L$$

$$P = \left(\frac{5}{10+4}\right)^2 4 = 0.5104\,w$$

$$\Rightarrow 510 \text{ mw}.$$