<u>Department of Electrical Engineering</u>

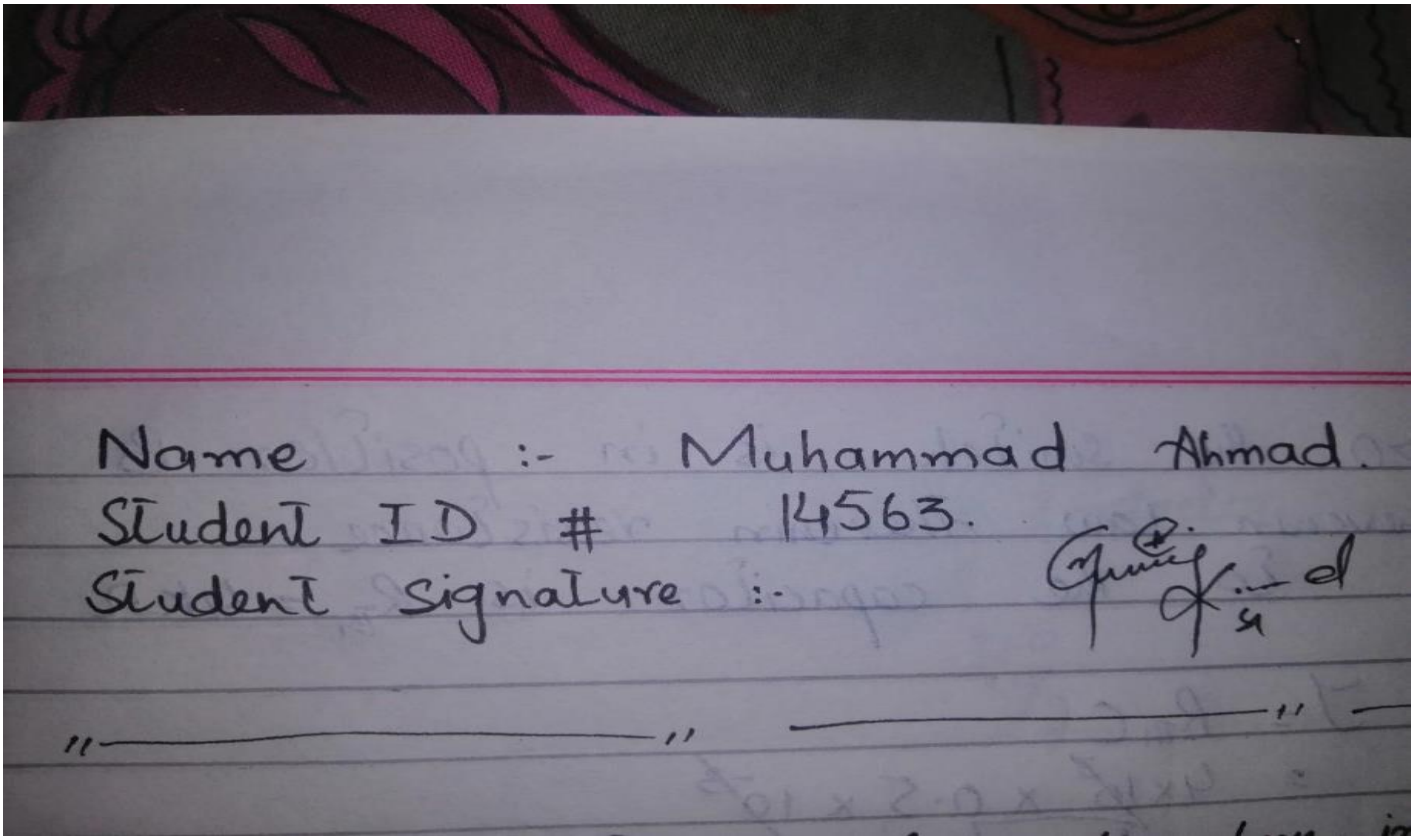
Course Title: Electrical Network Analysis

Module: 4th semester

<u>Student Detail</u>

Name : Muhammad Ahmad

Roll No :14563



QNo1. Assume that a 2000-KW turbine-generator of 0.85 power factor operates at the rated load. An additional load of 300 KW at 0.8 power factor is added. What KVAR of capacitor is required to operate the turbine generator but keep it from being overload?

Solution :-

Given :-

$P_1 = 2000$ KW

$P_2 = 300$ KW

$p.f_1 = 0.85$.

$p.f_2 = 0.8$.

Original Load :-

$P_1 = 2000$ kW.

$P.f_1 = 0.85$.

$\cos\theta = 0.85$.

$\theta_1 = \cos^{-1}(0.85)$.

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

$$= \frac{2000}{0.85}$$

$$= 2352.94 \text{ KVA}.$$

$Q_1 = S_1 \sin\theta_1$.

$Q_1 = (2352.94)\sin(31.79)$.

$= 1239.54$ KVAR.

ne-
rates at
ad of
dded.
quired
but

Additional load:-

$$P_2 = 300 KW.$$
$$\cos\theta_2 = 0.8$$
$$\theta_2 = \cos^{-1}(0.8)$$
$$\theta_2 = 36.87^\circ$$

$$S_2 = \frac{P_2}{\cos\theta_2}$$
$$= \frac{300}{0.8}$$
$$S_2 = 375 KVA.$$

$$Q_2 = S_2 \sin\theta_2.$$
$$= (375)\sin(36.87).$$
$$= 225.00 KVAR.$$

Total Load:-

$$S = S_1 + S_2.$$
$$S = (P_1+P_2)+(Q_1+Q_2)J.$$
$$S = P + JQ.$$
$$P = 2000 + 300.$$
$$P = 2300 KW.$$
$$Q = 1239.5 + 225$$
$$Q = 1464.5 KVAR.$$

Now the minimum P.F for 2300 KW load & not exceeding the KVA rating

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

$$\cos\theta = \frac{2300 \times 10^3}{2352.94 \times 10^3}$$

$$\cos\theta = 0.9778.$$

$$\theta = 12.177^\circ$$

The maximum load KVAR

$$Q_{max} = S_1 \sin\theta.$$

$$Q_{max} = (2352.94)\sin(12.177^\circ)$$

$$Q_{max} = 496.313 \text{ KVAR}.$$

The capacitor must supply the difference b/w total loads. KVAR and the permissible

Thus $Q_c = Q - Q_{max}$.

$= 1464.5 - 496.313$.

$= \boxed{968.187 \text{ KVAR}}$

QNO2:- A balanced abc, sequence one line voltage of a balanced Y-connection source is $V_{AB} = 180\angle -20^\circ$ V. If the source is connected to a Δ-connected load of $20\angle 40^\circ\ \Omega$. Find the phase and line current.

Solution

Solution :-

line Voltage. $V_{AB} = 180\angle -20^\circ V$

$Z\Delta = 20\angle 40^\circ \Omega$.

formula

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

Phase Voltage:-

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

$$= \underline{103.9\angle -50^\circ V}$$

$$Z_y = \frac{Z\Delta}{3}$$

$$= \frac{20\angle 40}{3}$$

$$= \underline{6.67\angle 40^\circ \Omega}$$

Line Current

$$I_a = \frac{V_{ax}}{Z_a/3}$$

$$= \frac{103.9\angle -50^\circ}{6.67\angle 40^\circ}$$

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

$I_b = I_a \angle -120^\circ = 15.57\angle 150^\circ A$.

$I_c = I_a \angle +120 = 15.57\angle 30$

Phase Current

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

$$= \underline{9 \angle -60^\circ \, A}.$$

$$I_{BC} = I_{AB} \angle -120^\circ$$

$$= \underline{9 \angle -180}.$$

$$I_{AC} = I_{AB} \angle +120^\circ.$$

$$= \underline{9 \angle 60^\circ \, A}.$$

QNo3:- Consider a load with value of $V_{rms} = 110 \angle 85^\circ V$, I_{rms} $0.4 \angle 15^\circ A$ Calculate the following

Solution:-

Given

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

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

(a) Complex power & Apparent power.

$$S = (V_{rms})(I_{rms}).$$

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

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

$$\boxed{S = 44 \angle 70^\circ \, VA}.$$

The apparent power.

$$S = |S|$$

$$\boxed{S = 44 \, VA}$$

(5)

(b) find Real and Reactive Power.

$S = 44\angle 70°$

$S = 44[\cos(70°) + j(\sin(70°))]$.

$S = 44[0.3420 + j0.939]$.

$S = 15.05 + j41.35$.

Since

$S = P + jQ$.

The real power is.

$\boxed{P = 15.05\ W}$.

The reactive power

$\boxed{Q = 41.35\ VAR}$.

(c) The power factor and the load Impedence.

The power factor is.

$P.f = \cos(70°)$.

$\therefore \boxed{P.F = 0.342 \text{ (lagging)}}$

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

The load Impedence.

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

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

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

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

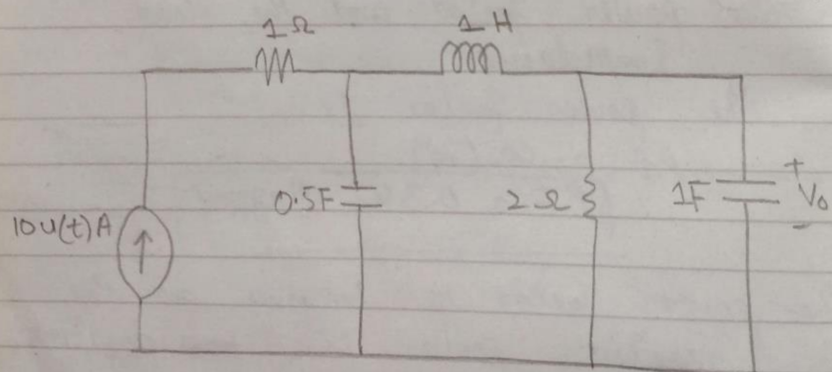
$$\boxed{Z = 275\angle 70^\circ\,\Omega}$$

$$Z = 275\left[\cos(70^\circ) + J\sin(70^\circ)\right].$$

$$= 275\left[0.342 + J0.939\right]$$

$$Z = \boxed{94.05 + J258.25\,\Omega} \text{ Ans}$$

QNo4:- Apply laplace transform & calculate the output $V_0(t)$ in the ckt fig



Solution

The Impedance inductor in S-domain is,.

$$Z(s) = sL$$

for $L = 1H$, $Z(s) = s$.

The impedance capacitor in s-domain is,

$$Z(s) = \frac{1}{sC}.$$

For

$C = 0.5F$

$$Z(s) = \frac{2}{s}.$$

$C = 1F, \quad Z(s) = \frac{1}{s}.$

At Node 1,

$$\frac{\frac{10}{s} - V}{1} = \frac{V_1 - V_0}{s} + \frac{s}{2} V_0.$$

$$10 = (s+1) V_1 + \left(\frac{s^2}{2} - 1\right) V_0 \rightarrow (1).$$

At Node 2

$$\frac{V_1 - V_0}{s} = \frac{V_0}{2} + s V_0$$

$$V_1 = V_0 \left(\frac{s}{2} + s^2 + 1\right) \longrightarrow (2)$$

Substituting (2) into (1) gives.

$$10 = (s+1)\left(s^2 + \frac{s}{2} + 1\right) V_0 + \left(\frac{s^2}{2} - 1\right) V_0$$

$$= s(s^2 + 2s + 1.5) V_0.$$

$$V_0 = \frac{10}{s(s^2 + 2s + 1.5)}$$

$$= \frac{A}{s} + \frac{Bs + C}{s^2 + 2s + 1.5}$$

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

s^2 : $0 = A + B.$

s : $0 = 2A + C.$

Constant

$$10 = 1.5A \rightarrow A = \frac{20}{3}$$

$$B = -\frac{20}{3}$$

$$C = -\frac{40}{3}$$

$$V_0 = \frac{20}{3}\left[\frac{1}{s} - \frac{s+2}{s^2+2s+1.5}\right]$$

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

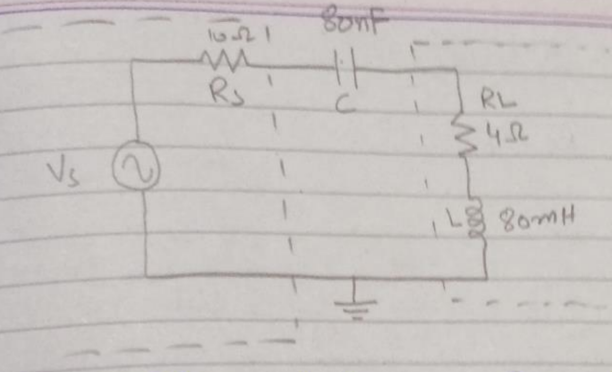
Taking the inverse Laplace Transfrom

$$\boxed{V_0(t) = \frac{20}{3}\left[1 - e^{-t}\cos 0.7071t - 1.414e^{-t}\sin 0.7071t\right]u(t)\,V}$$

QNO5 :- A coupling capacitor of 80nF is used to block dc current

Solution :-

@ At what frequency is maximum power transfor to the speaker.



The amplifier and the capacitor act as a source; hence the source impedance.

$$Z_S = R_S - jX_C.$$

The speaker act as a load; hence load impedance.

$$Z_L = R_L + jX_L.$$

The maximum power is transferred to the speaker or load when the load Impedance is equal to the complex conjugate of thevenin Impedance.

In the ckt, the thevenins Impedance is equal to the source Impedance. Hence maximum power is transferred to the speaker when.

$Z_L = Z_s'$

$R_s = R_L$

$X_C = X_L.$

$X_C = X_L \rightarrow \frac{1}{\omega C} = \omega L.$

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

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

Substitute 80 nF for capacitor & 80 mH for Inductor (L)

$f = \frac{1}{2(\pi)(\sqrt{(80\times10^{-3})(80\times10^{-9})})}.$

$= \frac{1}{2(3.14)(80\times10^{-6})}$

$= \frac{1\times10^{+6}}{502.4}$

~~0.001990~~

$= \frac{1000000}{502.4}$

1990.44

$f = \boxed{1.990\ KHz}$

(b) $P = \cancel{\Delta s} \; (I_s)^2 R_L$.

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

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

$$= 510mW.$$

Thus the power P, delivered to the speaker at the frequency $\boxed{f = 1.990k_z}$ is $\boxed{510mW}$

L.

Angular Frequency.

for ξ