Department of Electrical Engineering
Final Assignment
Date: 22/06/2020

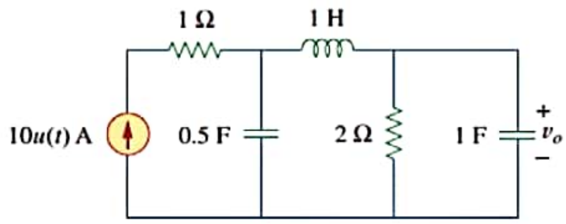
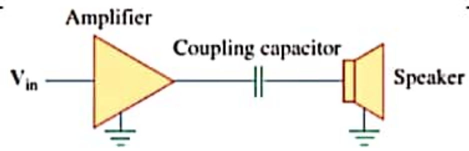
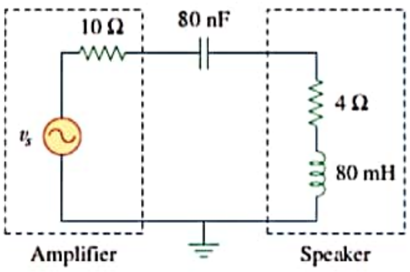
Course Details

Course Title: Electrical Network Analysis **Module:** 4th
Instructor: ______ **Total Marks:** 50

Student Details

Name: ______ **Student ID:** ______

Student Signature: ______

Q1.		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 capacitors is required to operate the turbine generator but keep it from being overloaded?	Marks 10 CLO 03
Q2.		A balanced *abc* sequence, one line voltage of a balanced Y-connected 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 currents.	Marks 10 CLO 02
Q3.		Consider a load with value of, $V_{rms} = 110\angle 85^\circ$ V , $I_{rms} = 0.4\angle 15^\circ$ A. Calculate the following: a) The complex and apparent powers b) The real and reactive powers, and c) The power factor and the load impedance.	Marks 10 CLO 01
Q4.		Apply Laplace transform and calculate the output voltage $v_o(t)$ in the circuit of figure below:  Figure	Marks 10 CLO 01
Q5.		For the circuit given in figure below, the speaker works as load while the amplifier and the capacitor act as the source. To block dc current from an amplifier, a coupling capacitor of 80 nF is used (see figures below). Calculate the following: a) At what frequency is maximum power transfer to the speaker? b) If Vs = 5 V_{rms}, how much power is delivered to the speaker at that	Marks 10 CLO 03
		 (a)  Figure	

Name: Naveed Ali
ID No: 16753

Course Title: Electrical Network Analysis.

Q1

Ans: Sol:

$P1 = 200 KW$

$\cos \theta_1 = 0.85 \qquad \theta_1 = 31.79^\circ$

$S1 = \frac{P1}{\cos \theta_1} = 2352.94 \ KVA.$

$Q1 = S1 \sin \theta_1 = 1239.5 \ KVAR.$

Additional Load

$P_1 = 300 \ KW$

$\cos \theta 2 = 0.8 \Rightarrow \theta_2 = 36.87^\circ$

$S2 = \frac{P_2}{\cos \theta_2}$

$= 375 \ KVA.$

$Q_2 = S2 \sin \theta_2 = 225 \ KVAR$

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 maximum operating pf. for a 2300 kW load and not exceeding the KVA rating of the generator is

~~cos~~ $\cos Q = P/S_1$

$= \frac{2300}{2352.94} = 0.9775.$

The maximum Load KVAR for this condition is

$Q_r = S_1 \sin Q = 2352.94 \sin(12.177^\circ)$

$Q_n = 496.313$ KVAR.

The ~~capacita~~ Capacitor must supply the difference between the total load KVAR (i.e Q) and the permissible generator KVAR (i.e Q_n)

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

—x— x —x—x—

Q2:

Sol:

Line voltage $V_{AB} = 180 \angle -20^\circ V$

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

we know that

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

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

Phase Voltage

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

$$= 103.9 \angle -50^\circ V.$$

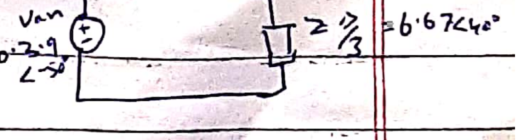
$$Z_y = \frac{Z_\Delta}{3}$$

$$= \frac{20 \angle 40^\circ}{3} = 6.67 \angle 40^\circ \Omega.$$

Line current:

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

~~$I_a =$~~



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

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

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

Phase current.

$I_{AB} = \frac{15.57 \angle -90^\circ}{\sqrt{3}} . \angle 30^\circ - 9\cancel{0} - 60^\circ A.$

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

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

—x— x— x— x— x—

Q3

Sol:- Given data

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

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

Requried data.

(a) Complex power :=?

b) Apperent Power. =?

c) Power factor =?

Sol:-

(a) complex power.

As we know that:

$$S = V_{rms} (I_{rms})^*$$

$$S = V_{rms} I_{rms} (\theta_v - \theta_i)$$

$$S = V_{rms} I_{rms} \cos(\theta_v - \theta_i) + j V_{rms} I_{rms} \sin(\theta_v - \theta_i)$$

Putting values.

$$S = (110)(0.4) \cos(85 \cdot 15) + j (110)(0.4) \sin(85 \cdot 15)$$

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

$$S = (27.86 + j 34.05) VA.$$

$$(S = 44 \angle 70^\circ \ VA).$$

~~Part~~ Part(b).

P = active power $= 27.86$

Q = reactive Power $= 34.05$

Now

Apperent power = ?

We know that:

Apperent power $= \sqrt{P^2+Q^2}$

$= \sqrt{(27.86)^2 + (34.05)^2}$

$= \sqrt{776.17 + 1159.4}$

$= \sqrt{1935.57}$

$= 43.99 \, VA.$

part C.

power factor = ?

$P.f = P/S$

$= \cos(\theta_v - \theta_i)$

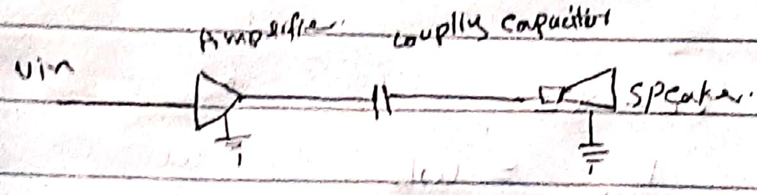
$\cos(85 - 15)$

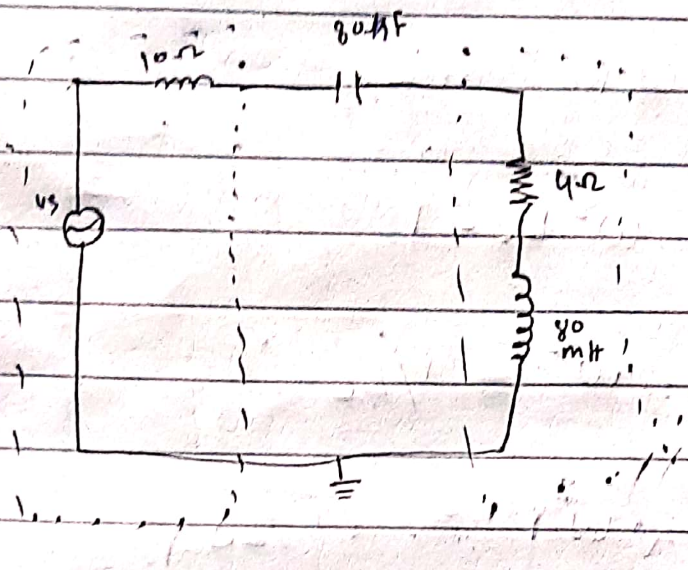
$\cos(70^\circ)$

$= \cancel{0.06} \therefore Pf = 0.342$ (lagging)

— x — x — x — x —

Q5.





3 Given data

$V_S = 5\,V_{rms}$

$C = 80\,nf$

$L = 80\,mH$.

Sol:-

Source Impedance $= Z_S = R_S + jX$.

Load impedance $= Z_L = R_L + jX_L$

form maxium transfer:

$Z_L = Z_S$ mean

$R_L = R_S$ & $X_S = X_L$

So

$$X_L = X_L$$

$$1/\omega C = \omega L.$$

Re-arraning.

$$\omega^2 LC = 1$$

$$\omega^2 = 1/LC$$

$$\sqrt{\omega^2} = \sqrt{1/LC}$$

$$\omega = 1/\sqrt{LC}$$

$$f = 1/2\pi\sqrt{LC}.$$

or $\omega = 2\pi f$.

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

$$f = 1/2\pi\sqrt{LC}.$$

$$f = \frac{1}{(6.28)\sqrt{RC}}$$

$$\cancel{f = \frac{1}{(6.28)\sqrt{RC}}}$$

$$F = \frac{1}{(6.28)\sqrt{(80\times10^{-3})(80\times10^{-9})}}.$$

$$\frac{1}{(6.28)\sqrt{(80)^2 \times 10^{-12}}}$$

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

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

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

$$F = 1990.44\ HZ.$$

Part B.

As we know that.

power deliver $= P = (Vs/Req)^2$

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

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

$$= (5/14)$$

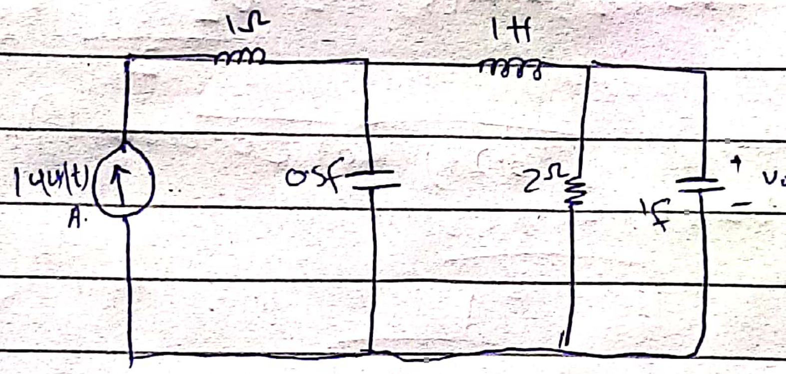
$$P = (0.3571)^2$$

$$P = 0.1275 \text{ Watt}$$

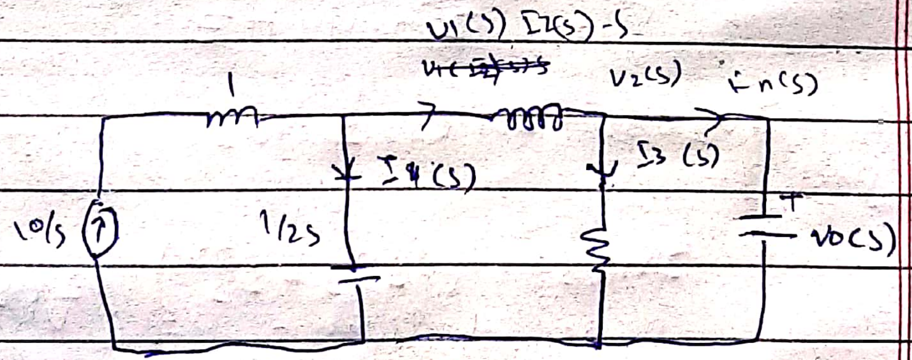
Where Vs ~~is~~ is in rms.

— x — x — x — x — x.

Q4



Soln:



Appling KCL.

node 1.

$$10/s = V_1(s)\,2s + \frac{V_2(s) - V_1(s)}{s}$$

$$10/s = \frac{2s^2 V_1(s) + V_2(s) - V_1(s)}{s}$$

$$V_1(s)(2s^2-1) + V_2(s) = 10 \quad \text{--- (1)}$$

Node 2.

$$V_2(s) - V_1(s) = \frac{V_2(s)}{2} + \frac{V_2(s)}{1/s}$$

$$\frac{V_2(s) - V_1(s)}{s}$$

$$= \frac{V_2(s)}{2} + s V_2(s)$$

$$2V_2(s) - 2V_1(s) = sV_2(s) + 2s^2 V_2(s)$$

$$2V_1(s) + (-2 + s + 2s^2) V_2(s) = 0$$

$$\begin{bmatrix} 2s^2-1 & 1 \\ 2 & 2s^2+s-2 \end{bmatrix} \begin{bmatrix} V_1(s) \\ V_2(s) \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$$

using Cramer's rules

$$\Delta = (2s^2-1)(2s^2+s-2) - 2$$

$\Delta = 4s^4 + 2s^3 - 4s^2 - 2s^2 - s + \cancel{2} - \cancel{2}$

$\Delta = 4s^4 + 2s^3 - 6s^2 - s$

$$V_2(s) = \frac{\begin{vmatrix} 2s^2 - 1 & 10 \\ 2 & 0 \end{vmatrix}}{4s^4 + 2s^3 - 6s^2 - s}$$

$$V_2(s) = \frac{-20}{4s^4 + 2s^3 - 6s^2 - s}$$

As

$V_2(s) = V_o(s)$

$$\boxed{V_o(s) = \frac{-20}{4s^4 + 2s^3 - 6s^2 - s}}$$

Ans

— x — x — x —