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

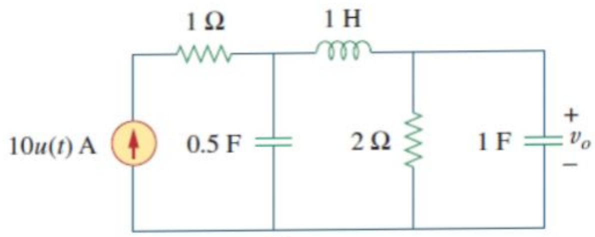
Course Details

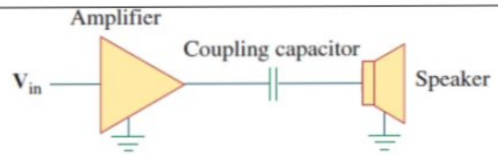
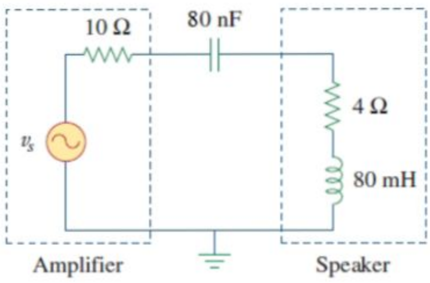
Course Title: Electrical Network Analysis **Module:** 4th
Instructor: ______ **Total Marks:** 50

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 $V_{AB} = 180\angle-20^{o}$ V. If the source is connected to a Δ-connected load of $20\angle40^{o}\ \Omega$, find the phase and line currents.	Marks 10 CLO 02
Q3.		Consider a load with value of, $V_{rms} = 110\angle85^{o}$ V , $I_{rms} = 0.4\angle15^{o}$ 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: Hazrat Bilal ID: 14622

Module: 4th Course Title: Electrical Network Analysis.

Department: Electrical Engineering.

Instructor: Dr Shahryar Sir

Q No2: 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.

Solution:-

Given

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

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

using formula

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

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

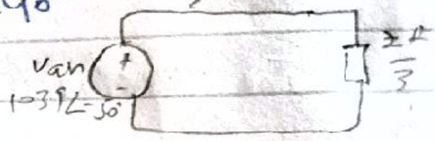
Phase voltage

$$V_{an} = \frac{180\angle -20^\circ}{\sqrt{3}} \cdot \angle -30^\circ = 103.9\angle -50^\circ V$$

$$Z_y = \frac{Z_\Delta}{3} = \frac{20\angle 40}{3} = 6.67\angle 40^\circ \Omega$$

Line current

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



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

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

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

Phase current.

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

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

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

Q No 1:- Assume that a 2000-KW trubine generator of 0.85 power factor operates at 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?

Solution:- orignal load:

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

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

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

Additional load:

$P_2 = 300\, KW$, $\cos\theta_2 = 0.8 \rightarrow \theta_2 = 36.87^\circ$

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

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

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 2300 kw load and not axceeding the KVA rating of the generator is

$\cos\theta = \frac{P}{S_1} = \frac{2300}{2352.94} = 0.9775$

or $\theta = 12.177^\circ$

The maximum load KVAR for this condition is

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

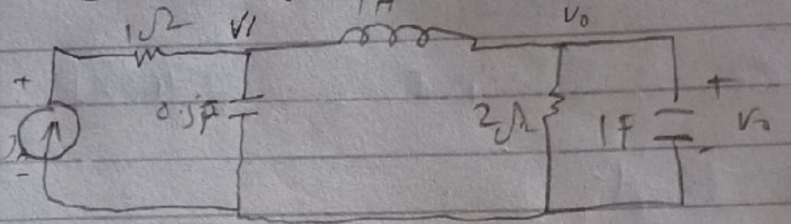
$Q = 496.313\, KVAR$

The capacitor must apply the

difference b/w the total load KVAR and the permissible generator KVAR thus,

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

Q No4:- Apply Laplace transform and calculate the output voltage $v_o(t)$ in the circuit of figure below.



Solution:-

At node 1

$$\frac{\frac{10}{s} - v_1}{1} = \frac{v_1 - v_0}{s} + \frac{s}{2} v_0 \longrightarrow 10 = (s+1) v_1 + \left(\frac{s^2}{2} - 1\right) v_0 \longrightarrow (1)$$

At node 2,

$$\frac{v_1 - v_0}{s} = \frac{v_0}{2} + s v_0 \longrightarrow v_1 = v_0 \left(\frac{s}{2} + s^2 + 1\right) \longrightarrow (2)$$

substituting (2) into (1)

$$10 = (s+1)(s^2 + s/2 + 1) v_0 + \left(\frac{s^2}{2} - 1\right) v_0 = s(s^2 + 2s + 1.5) v_0$$

$$v_0 = \frac{10}{s(s^2 + 2s + 1.5)} = \frac{A}{s} + \frac{Bs + C}{s^2 + 2s + 1.5}$$

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

s^2: $0 = A + B$

s: $0 = 2A + C$

constant: $i_o = 1.5A \longrightarrow A = 20/3, B = -20/3,$
$C = -40/3$

$$V_o = \frac{20}{3}\left[\frac{1}{s} - \frac{s+2}{s^2+2s+1.5}\right] = \frac{20}{3}\left[\frac{1}{s} - \frac{s+1}{(s+1)^2 + 0.7071^2}\right.$$

$$\left. - 1.414\frac{0.7071}{(s+1)^2 + 0.7071^2}\right]$$

Taking the inverse laplace tranform finally yields.

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

QNO3:- consider a load with value of,
$V_{rms} = 110\angle 85^0\ V$, $I_{rms} = 0.4\angle 15^0 A$. calculate the following:
a) The complex and apparent power
b) The real and reactive power
c) The power factor and load impedance.

solution:-

a) The complex power

$S = V_{rms} I^*_{rms}$

$S = (110\angle 85^0)(0.4\angle -15^0)$

$S = 110 \times 0.4\angle(85^0 - 15^0)$

$S = 44\angle 70^0\ VA$

The apparent power is

$S = |S|$

$\therefore$ $\boxed{S = 44 \text{ VA}}$

b)

Express the complex power in rectangular form.

$S = 44\angle 70$

$S = 44[\cos(70°) + j\sin(70°)]$

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

$S = 15.05 + j41.35$

Since $S = P + jQ$

$\therefore$ $\boxed{P = 15.05 \text{ W}}$

The rective power is

$\therefore$ $\boxed{Q = 41.35 \text{ VAR}}$

c) The power factor is

$pf = \cos(70°)$

$\therefore$ $\boxed{pf = 0.342 \text{ (lagging)}}$

The power factor is lagging as the

as the rective power is positive the load impedance is

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

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

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

$$Z = \frac{110\sqrt{2} \angle 85^0}{0.4\sqrt{2} \angle 15^0}$$

$Z = 275 \angle 70^0 \Omega$

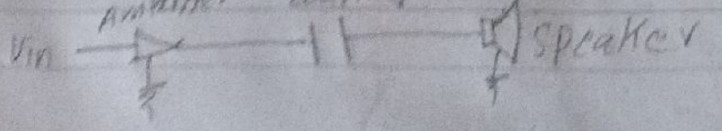
$Z = 275 [\cos(70^0) + j\sin(70^0)]$

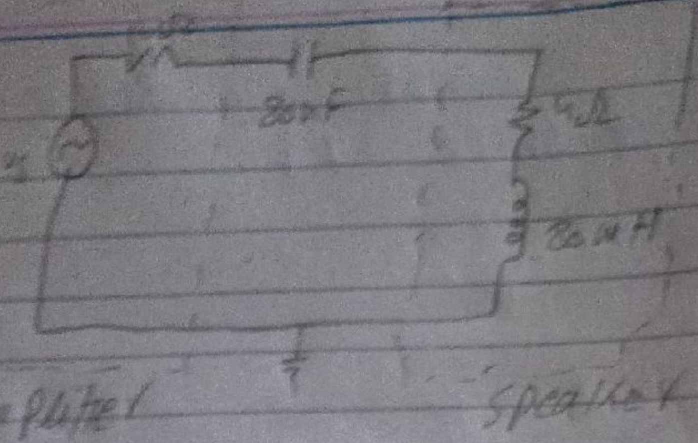
$Z = 275 [0.342 + j0.9397]$

$\therefore$ $\boxed{Z = (94.05 + j258.4)\Omega}$

Q No5:- For the circuit given in figure below, the speaker work as a load while the amplifier and the capacitor act as a source. To block dc current from an amplifier a coupling capacitor of 80 nF is used. calculate the following

a) At what frequency is maximum powe transfer to the spker?
b) If $V_s = 5V_{rms}$ How much power is delivered to the speaker at that





Solution:-

Given

coupling speaker = 80uF

V_s = 5 V_{rms}.

Source impedance, $Z_S = R_S - jX_1$

load impedance, $Z_L = R_L + jX_g$

for maximum load transfer

$Z_S - Z_L \rightarrow R_S - R_L$, $X_S - X_L$

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

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

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

$f = 2055$ KHz

b) $P = \left[\frac{V_s}{10+4}\right]^2 4 = \left(\frac{5}{14}\right)^2 4 = \frac{25}{196} \cdot 4$

$P = 8.52$ mW