Course :-

ELECTRICAL
NETWORK
ANALYSIS

MODULE :-

4th SEM

INSTRUCTOR :-

DR SHAHYAR

NAME :-

Syed Muhammad Raza

Student ID :-

14620

Course :-

ELECTRICAL
NETWORK
ANALYSIS

MODULE :-

4th SEM

INSTRUCTOR :-

DR SHAHYAR

NAME :-

Syed Muhammad Raza

Student ID :-

14620

Q[1]: 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 turbin generator but keep it from being overloaded?

* An asterisk indicates a challenging problem.

Original load :

$P_1 = 2000\ kW, \ \cos\theta_1 = 0.85 \rightarrow \theta_1 = 31.79$

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

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

Additional load :

$P_2 = 300kW$, $\cos\theta_2 = 0.8 \rightarrow \theta_2 = 36.87°$

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

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

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 exceeding the kVA rating of the generator is

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

$$\text{or} \quad \theta = 12.177°$$

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 supply the difference between the total load KVAR (i.e Q) and the permissible generator KVAR (i.e Q) Thus,

$Q_c = Q - Q = 968.2$ kVAR

Q2:- One line voltage of the balanced Y-connected source is $V_{AB} = 180\angle -20^\circ$ V. If source is connected to the Δ-connected load of $20\angle 40^\circ\ \Omega$ Find the phase and live current.

Using Formula :-

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

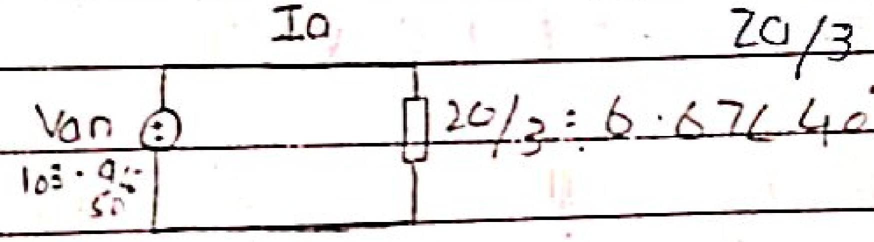
Phase Voltage :-

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

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

line Current :-

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



$$I_a = 15.57 \angle -90^\circ \text{ A}$$

$$I_b = I_a \angle -120^\circ = 15.59 \angle +150^\circ \text{ A}$$ ✓

$$I_c = I_a \angle +120^\circ = 15.59 \angle 30^\circ \text{ A}$$ ✓

Phase Current :-

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

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

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

Q No # 3
Answer

Given :-

$V_{rms} = 110\angle 85^\circ$ V
$I = 0.4\angle 15^\circ$ A

Step 2 of 5 :

(a)
The Complex power is
$S = V_{rms} I^*_{rms}$
$S = (110\angle 85^\circ)(0.4\angle -15^\circ)$
$S = 110 \times 0.4 \angle (85^\circ - 15^\circ)$
$\therefore \boxed{S = 44\angle 70^\circ \text{ VA}}$

The apparent power is
$S = |S|$
$\therefore S = 44$ VA

Step 3 of 5

(b)
Express the Complex power in rectangular form

$S = 44\angle 70^\circ$

$S = 44 \left[\cos(70°) + j\sin(70°)\right]$

$S = 44 \left[0.3420 + j0.9397\right]$

$S = 15.05 + j\,41.35$

since $S = P + jQ$

The real power is.

$\boxed{P = 15.05\ W}$

The reactive power is

$\boxed{Q = 41.35\ VAR}$

Step 4 of 5.

(c)

The power factor is

$pf = \cos(70°)$

$PF = 0.342$ (lagging)

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

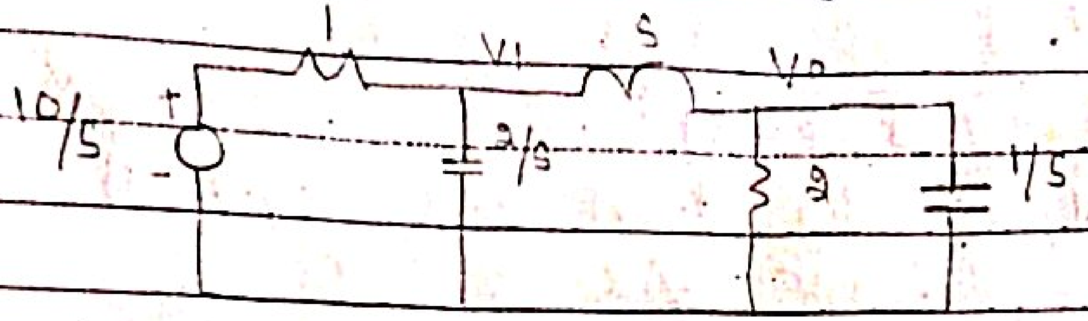
The load impedance is.

$Z = V/I$

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

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

Q4: The s-domain version of the circuit is show below.



At node 1,

$$\frac{\frac{10 - V_1}{s}}{1} = \frac{V_1 - V_o}{2} + \frac{s}{2} V_o$$

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

At node 2,

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

Substituting (2) into (1) gives

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

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

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

$s^2 : 0 = A+B$

$s : 0 = 2A+C$

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

$C = -40/3$.

$$V_0 = \frac{20}{3}\left[\frac{1}{s} - \frac{s+2}{s^2+2s+1.5}\right] = \frac{20}{3}\left[\frac{1}{s} - \frac{s+1}{(s+1)^2+0.7071^2} - 1.414\frac{0.7071}{(s+1)^2+0.7071^2}\right]$$

Taking the inverse Laplace tranform finally yields.

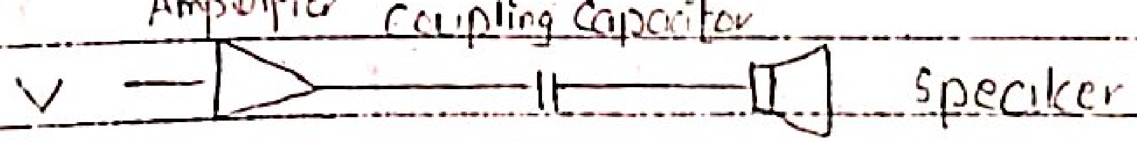
$$V_0(t) = \frac{20}{3}\left[1 - e^{-t}\cos 0.7071t - 1.41e^{-t}\sin 0.707\right.$$

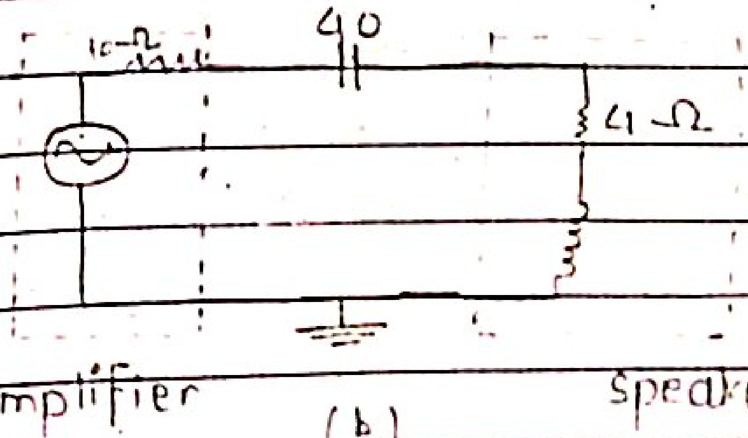
$u(t)\,V$.

Q5:- A coupling capacitor is used to block dc current from an amplifier as shown in Fig. 11.98(a). The amplifier and the capacitor act as the source, while the speaker is the load as in Fig 11.98 (b).

(a) At what frequency is maximum power transferred to the speaker?

(B) If $V_s = 4.6$ Vms, how much power is delivered to the speaker at the frequency





(b)

(a) Source impedance $Z_s = R_s - j$
load impedance $Z_l = R_l + jX_s$

For maximum load transfer

$Z_l = Z_s^* \rightarrow R_s = R_L, \; X_C = X_L$

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

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

$F = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(80\times10^{-3})(40\times10^{-9})}} = 2.814\,k$

(b) $P = \left[\frac{V_s}{(10+4)}\right]^2 4 = \left[\frac{4.6}{14}\right]4 = 431.8\,mhs$

Since V_2 is in rms