Curriculum Scheme: Rev2019
Examination: FE Semester I
Course Code: FEC105 and Course Name: Basic Electrical Engineering

Time: 03 hours | Max. Marks: 80

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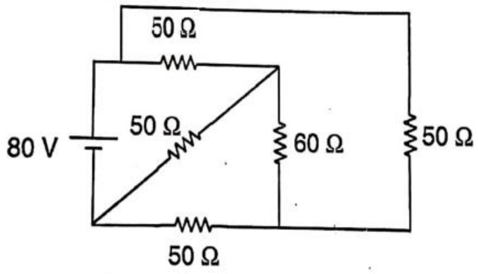
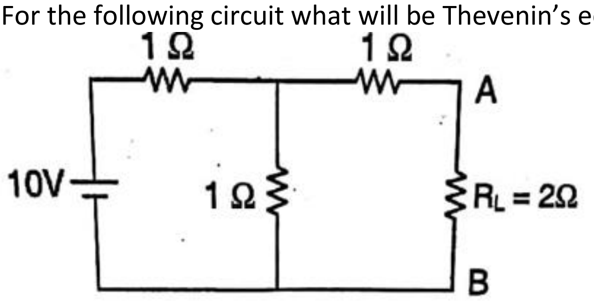
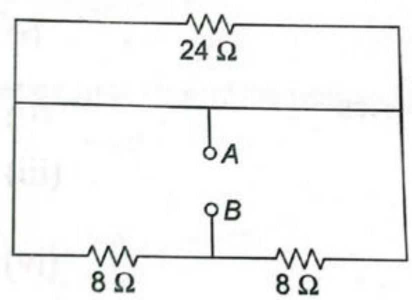
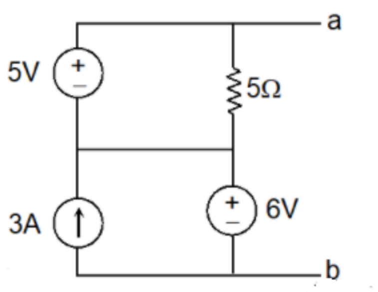
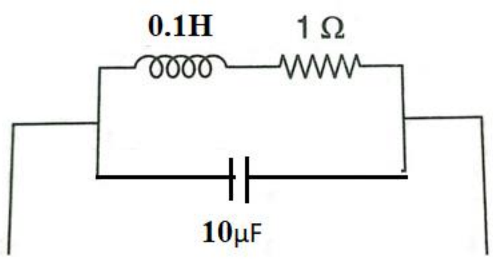
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	For the following circuit, what will be the Thevenin's equivalent resistance as seen from 60 Ω resistor 
	a. 30 Ω
	b. 40 Ω
	c. 50 Ω
	d. 60 Ω
2.	For the following circuit what will be Thevenin's equivalent voltage as seen from load resistor. 
	a. 3V
	b. 4V
	c. 5V
	d. 6V
3.	For the given circuit find R_{ab} 
	a. 4 Ω

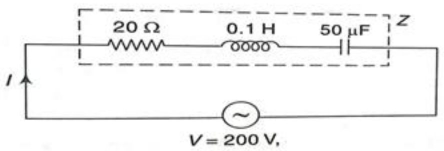
	b. 5 Ω
	c. 6 Ω
	d. 7 Ω
4.	Find V_{ab}



	a. 11V
	b. 12V
	c. 13V
	d. 14V
5.	For the given circuit, what is the frequency at which Impedance of the circuit will be maximum.

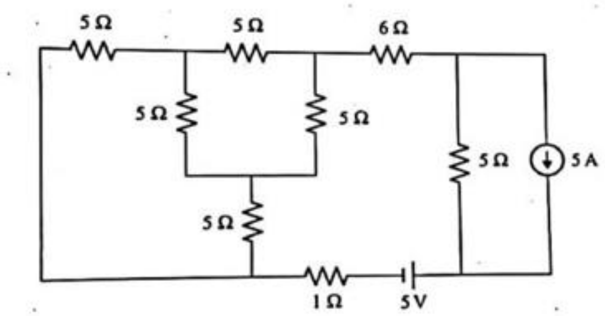


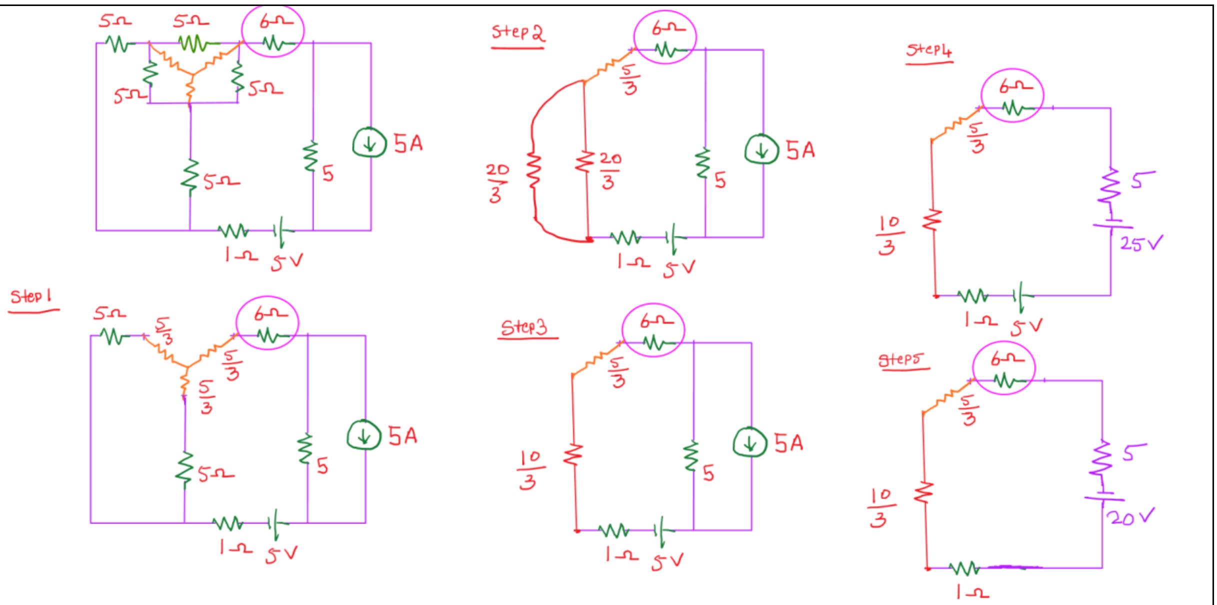
	a. 149.14Hz
	b. 159.14Hz
	c. 169.14Hz
	d. 179.14Hz
6.	For the given circuit, Find the frequency at which current is maximum



	a. 61.61Hz
	b. 71.17Hz
	c. 81.81Hz
	d. 91.91hz
7.	The voltage applied to a circuit is given by v= 180 sin (ωt) and the resulting current is given by i= 2 sin (ωt – 90^0) what is the average power taken by the circuit.
	a. 360W

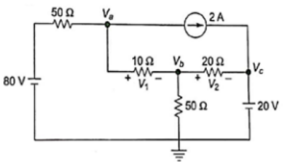
	b. 180W
	c. 90W
	d. 0W
8.	A series R-L-C circuit consists of R = 5Ω, L = 10mH and C = 50μF connected to single phase ac 230V,50Hz supply. What is the nature of circuit?
	a. Resistive
	b. Resonating
	c. Capacitive
	d. Inductive
9.	For series RLC circuit $\phi = 0^0$, the supply voltage is 100V. what is the value of quality factor if voltage across inductor is 500V?
	a. 2
	b. 1
	c. 5
	d. 3
10.	If series RLC circuit is capacitive in nature (XL < XC). What is the angle between voltage across inductor and supply voltage?
	a. 90^0
	b. $90^0 - \phi$
	c. $90^0 + \phi$
	d. $30^o - \phi$

Q2. A	Solve any 2 for 5marks each
i.	Find current through 6 Ω using source transformation 



$$I_{6\Omega} = \frac{20}{1+6+5+\frac{10}{3}+\frac{5}{3}} = 1.1764\ \Omega$$

ii. Find V_1 and V_2



KCL at V_A

$$2 + \frac{V_a - 80}{50} + \frac{V_a - V_b}{10} = 0$$

$$V_a\left[\frac{1}{50}+\frac{1}{10}\right] - \frac{V_b}{10} = -2 + \frac{80}{50} \quad — (1)$$

$V_c = 20V$

KCL at V_b

$$\frac{V_b - V_c}{20} + \frac{V_b}{50} + \frac{V_b - V_a}{10} = 0$$

$$\frac{-V_a}{10} + V_b\left[\frac{1}{20}+\frac{1}{50}+\frac{1}{10}\right] = 1 \quad — (2)$$

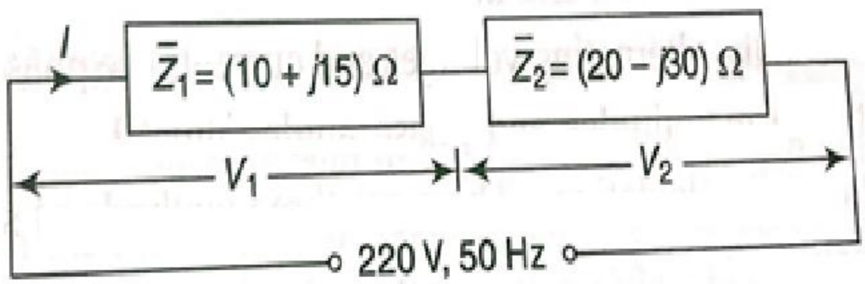
$V_a = 3.0769\ V$

$V_b = 7.6923V$

$V_1 = V_a - V_b = -4.61$

$V_2 = V_b - V_c = -12.3$

iii. For the circuit shown, find I, V_1, V_2 and power factor.



$$\bar{Z} = \bar{Z}_1 + \bar{Z}_2$$

$$= 10+15j + 20-30j$$

$$= (30-15j)\,\Omega$$

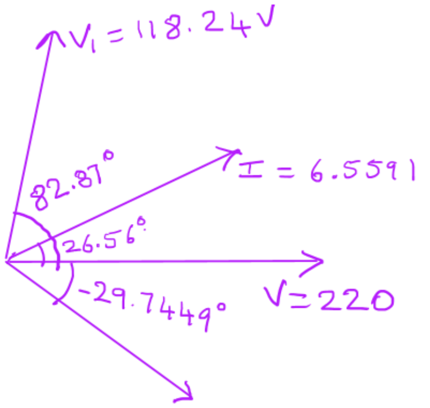
$$= (33.5410\angle -26.5650^\circ)\,\Omega$$

$$\bar{V} = V\angle V = 220\angle 0^\circ$$

$$\bar{I} = \frac{\bar{V}}{\bar{Z}} = (6.5591\angle 26.5650^\circ)\,A$$

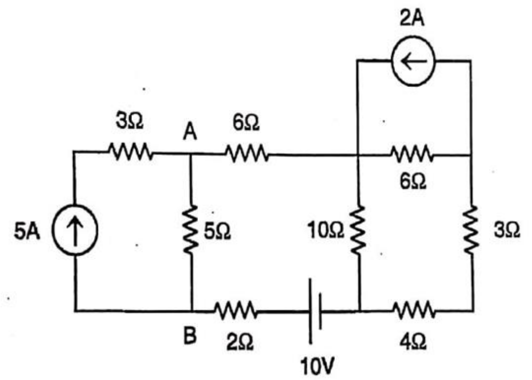
$$\bar{V}_1 = \bar{I}\bar{Z}_1 = (118.2464\angle 82.8749)\,V$$

$$\bar{V}_2 = \bar{I}\bar{Z}_2 = (236.4917\angle -29.7449^\circ)\,V$$

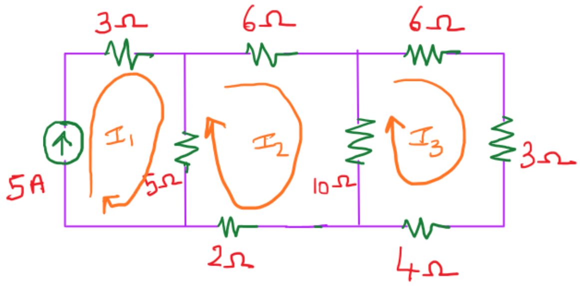


Phasor diagram

Q2. B	Solve any 1 for 10 marks each
i	Find current in 5Ω using Superposition Theorem



Considering 5A



$I_1 = 5A$

$-6I_2 - 10(I_2 - I_3) - 2I_2 - 5(I_2 - I_1) = 0$

$5I_1 - 23I_2 + 10I_3 = 0$

$-23I_2 + 10I_3 = -25 \quad -(1)$

$-6I_3 - 3I_3 - 4I_3 - 10(I_3 - I_2) =$

$10I_2 - 23I_3 = 0 \quad -(2)$

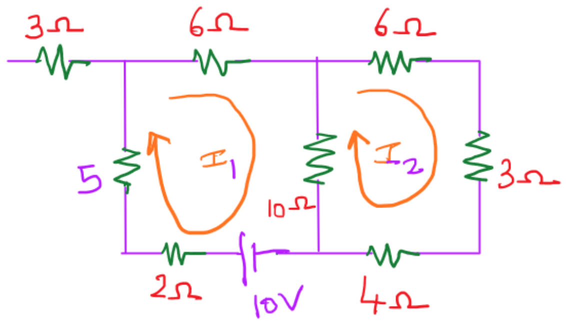
$I_2 = 1.3403\ A$

$I_3 = 0.5827\ A$

$I_{5\Omega} = (I_1 - I_2)(\downarrow)$

$\boxed{I'_{5\Omega} = 3.6597\ A(\downarrow)}$

Considering 10V



$$-6I_1 - 10(I_1 - I_2) + 10 - 2I_1 - 5I_1 = 0$$

$$-23I_1 + 10I_2 = -10 \quad \text{— (1)}$$

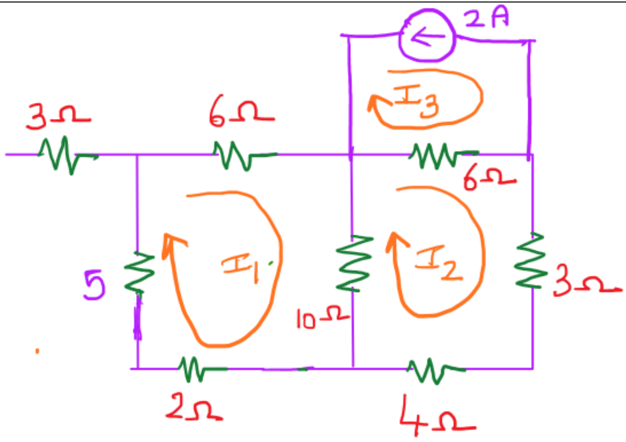
$$-6I_2 - 3I_2 - 4I_2 - 10(I_2 - I_1) = 0$$

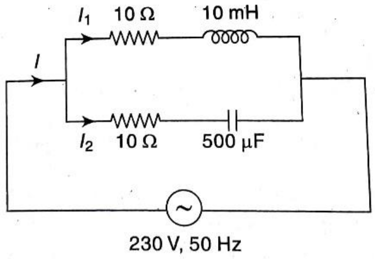
$$10I_1 - 23I_2 = 0 \quad \text{— (2)}$$

$I_1 = 0.5361\text{ A}$

$I_2 = 0.2331\text{ A}$

$$\boxed{I''_{5\Omega} = I_1 = 0.5361\text{ A}(\uparrow)}$$

	 $-5I_1 - 6I_1 - 10(I_1 - I_2) - 2I_1 = 0$ $-23I_1 + 10I_2 = 0 \quad -(1)$ $I_3 = -2A$ $-3I_2 - 4I_2 - 10(I_2 - I_1) - 6(I_2 - I_3) = 0$ $10I_1 - 23I_2 = 12 \quad -(2)$ $I_1 = -0.2797 A$ $I_2 = -0.6433 A$ $\boxed{I'''_{5\Omega} = I_1 = 0.2797A (\downarrow)}$ $I_{5\Omega} = I'_{5\Omega} + I''_{5\Omega} + I'''_{5\Omega}$ $= 3.6597A(\downarrow) + 0.5361A(\uparrow) + 0.2797A(\downarrow)$ $= 3.4033A(\downarrow)$
ii.	For a circuit shown, find (i) Total impedance of circuit and total current (ii) Branch current. I_1 and I_2 (iii) Power consumed by each branch



$\bar{Z}_1 = 10 + j(2\pi f L)$
$= 10 + j(2\pi \times 50 \times 10 \times 10^{-3})$
$= (10 + \pi j)\,\Omega$
$= (10.4818 \angle 17.4405^\circ)\,\Omega$

$\bar{Z}_2 = 10 - j\left(\frac{1}{2\pi f C}\right)$
$= 10 - \left(\frac{1}{2\pi \times 50 \times 500 \times 10^{-6}}\right) j$
$= (10 - 6.36619 j)\,\Omega$
$= (11.8544 \angle -32.4816^\circ)\,\Omega$

$\bar{Z} = \left[\bar{Z}_1^{-1} + \bar{Z}_2^{-1}\right]^{-1}$
$= (6.1013 - 0.62853 j)\,\Omega$
$= (6.1336 \angle -5.8820)\,\Omega$

$\bar{V} = 230 \angle 0^\circ$

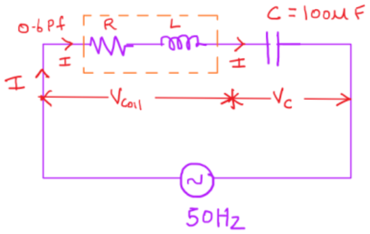
$\bar{I}_1 = \frac{\bar{V}}{\bar{Z}_1} = (21.9426 \angle -17.4405^\circ)\,A$

$\bar{I}_2 = \frac{\bar{V}}{\bar{Z}_2} = (19.4019 \angle 32.4816^\circ)\,A$

$P_1 = V I_1 \cos\phi_1$
$= 4814.7901\ W$

$P_2 = V I_2 \cos\phi_2$
$= 3764.3509\ W$

Q3. A	Solve any 2 for 5marks each
i.	A coil of power factor 0.6 is in series with a 100µf capacitor and is connected to a 50Hz supply. The potential difference Across the coil is equal to the potential difference across the capacitor. Find inductance and resistance of The coil.



Given :- $V_{coil} = V_C$

Find :- R, L

Sol^n :-

$V_{coil} = V_C$
$\therefore I Z_{coil} = I X_C$
$\therefore Z_{coil} = X_C = \frac{1}{2\pi f C} = 31.8309\,\Omega$

$Pf = \cos\phi_{coil} = 0.6$
$\therefore \phi_{coil} = \cos^{-1}(0.6)$
$\therefore \phi_{coil} = 53.1301^\circ$
$\therefore \bar{Z}_{coil} = Z_{coil} \angle \phi_{coil}$
$= 31.8309 \angle 53.1301^\circ$
$= 19.0985 + 25.4647 j$
$= R + j X_L$

$\boxed{\therefore R = 19.0985}$

$X_L = 2\pi f L = 25.4647$ $\boxed{\therefore L = 0.08105\,H}$

ii.	A balanced three – phase load connected in delta, draws a power of 10 KW at 440V at a power factor of 0.6 (lead) . find the impedance per phase and reactive volt – amperes drawn.

	$P = 10\ kW = 10{,}000\ W$ $V_L = 440V = V_{ph}$ $pf = 0.6$ (lead) Connection $\rightarrow$ Delta Find: Z_{ph}, Q Sol^n:- $P = \sqrt{3}\, V_L I_L \cos\phi$ $\therefore 10{,}000 = \sqrt{3} \times 440 \times I_L \times 0.6$ $I_L = 21.8693\ A$	$I_{ph} = \frac{I_L}{\sqrt{3}} = 12.6262\ A$ $Z_{ph} = \frac{V_{ph}}{I_{ph}} = 34.8481$ $\cos\phi = 0.6$ $\phi = -\cos^{-1} 0.6$ $\therefore \phi = -53.1301°$ $Q = \sqrt{3}\, V_L I_L \sin\phi$ $= -13333.31562\ VAR$
iii.	Three identical coils each having a reactance of 20 Ohms and resistance 10 Ohms are connected in star across a 440V three phase line. Calculate: a. Line Current and Phase Current b. Active, reactive and apparent power c. Reading of each wattmeter connected to measure power	

Given: $X_L = 20\ \Omega$
$R = 10\ \Omega$
$\boxed{\text{Type of } 3\phi \Rightarrow \text{star}}$
$V_L = 440\ V$

To Find: (i) I_L, I_{ph}
(ii) $P_{3\phi}$, $Q_{3\phi}$, $S_{3\phi}$
(iii) W_1 & W_2

Sol^n:

We have $V_L = 440V$

Phase Impedance $\overline{Z_{ph}} = R + jX_L \Rightarrow$ 3-Coils

$\overline{Z_{ph}} = 10 + j20\ \Omega$

$\overline{Z_{ph}} = 22.3606 \angle 63.4349°\ \Omega$

$\overline{Z_{ph}} = |Z_{ph}| \angle \phi_{ph}$

	$\therefore \quad \lvert Z_{ph} \rvert = 22.3606\,\Omega \quad \& \quad \phi_{ph} = 63.4349^\circ$ By Ohm's law, $I_{ph} = \dfrac{V_{ph}}{Z_{ph}}$ For star, $V_L = \sqrt{3}\,V_{ph} \quad \& \quad \boxed{I_L = I_{ph}}$ $\therefore V_{ph} = \dfrac{V_L}{\sqrt{3}} = \dfrac{440}{\sqrt{3}} = 254.0341\ V$ $\therefore I_{ph} = \dfrac{V_{ph}}{Z_{ph}} = \dfrac{\frac{440}{\sqrt{3}}}{22.3606} = 11.3607\ A$ $\therefore \boxed{I_{ph} = 11.3607\ A} = I_L$ Powers :- $P_{3\phi} = 3\,V_{ph}\,I_{ph}\cos\phi_{ph}$ $= 3\,(254.0341)(11.3607)\cos(63.4349^\circ)$ $\boxed{P_{3\phi} = 3871.983\ W = 3.8719\ KW}$ $\therefore \quad Q_{3\phi} = 3\,V_{ph}\,I_{ph}\sin\phi_{ph}$ $\boxed{Q_{3\phi} = 7.7439\ KVAR}$ $S = 3\,V_{ph}\,I_{ph}$ $\boxed{S = 8.66\ KVA}$ Wattmeter Readings : Coil $\Rightarrow Z_{ph}$ is inductive $\therefore \quad W_1 = V_L I_L \cos(30 - \phi_{ph}) \quad \& \quad W_2 = V_L I_L \cos(30 + \phi_{ph})$ $= (440)(11.3607)\cos(30 - 63.4349^\circ) \quad \vert \quad = (440)(11.3607)\cos(30 + 63.4349^\circ)$ $W_1 = 4171.4838\ W \quad \vert \quad \boxed{W_2 = -299.4946\ W}$ $= 4.1714\ KW \quad \vert \quad - \Downarrow$ Meter is connected in reverse fashion !!!
Q2. B	

i

A 415V, 50Hz, three – phase voltage is applied to a three star connected identical impedances. Each impedance consists of a resistance of 15Ω, capacitances of 177µF and inductance of 0.1 H in series.

Find

(i) Phase current,

(ii) line current,

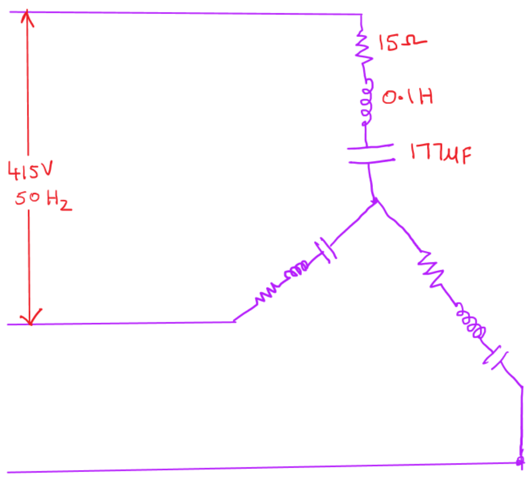
(iii) power drawn,

(iv) power factor,

(v) reactive power

(vi) total KVA.

(vii) Draw a neat phasor diagram showing all phasors.



Sol^{n}:-

$$\overline{Z_{ph}} = R + j(X_L - X_c) = 15 + \left(2\pi f L - \frac{1}{2\pi f C}\right)j$$

$$= 15 + \left(2\pi \times 50 \times 0.1 - \frac{1}{2\pi \times 50 \times 177 \times 10^{-6}}\right)$$

$$= (15 + 13.4323j)\,\Omega$$

$$= (20.1352 \angle 41.8440)\,\Omega$$

$$V_{ph} = \frac{V_L}{\sqrt{3}} = 239.6003\,V$$

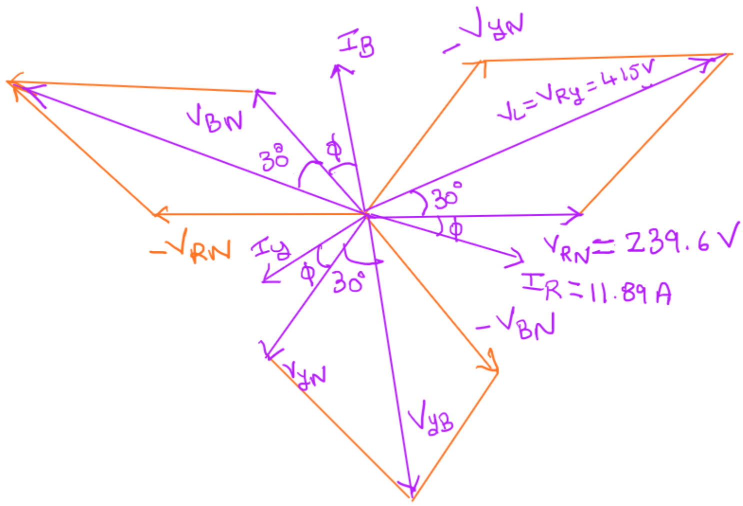
$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = 11.89957\,A = I_L$$

Power factor $= \cos\phi = 0.7449$ (lagging)

$$P = \sqrt{3}\, V_L I_L \cos\phi = 6371.9921\,W$$

$$Q = \sqrt{3}\, V_L I_L \sin\phi = 5706.0297\,VAR$$

$S = \sqrt{3}\, V_L I_L = 8553.4238\ VA$
$= 8.5534238\ kVA$

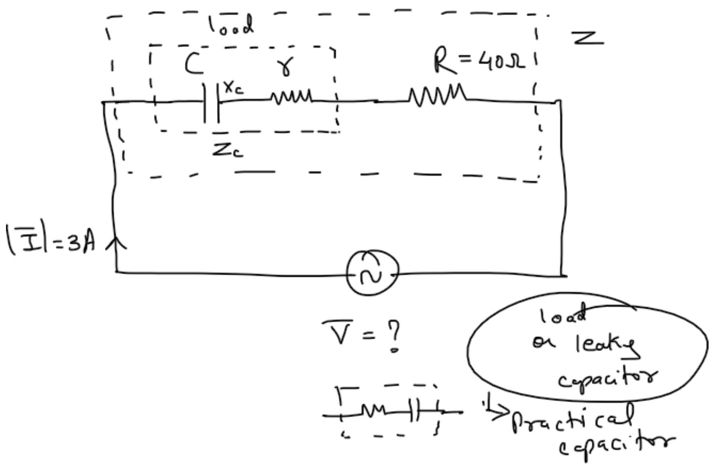


Phasor diagram

ii. A load consisting of a capacitor in series with a resistor having impedance 50 ohms, and pdf of 0.707 leading. The load is connected in series with 40 ohm resistor across AC supply and the resulting current is 3 A. Determine the supply voltage and overall phase angle.

Given: $|Z_{load}| = 50\ \Omega$
$(p.f)_{load} = 0.707$
$R = 40\ \Omega$
$|I| = 3\ A$

To find: (i) $\bar{V}$
(ii) ϕ



Sol^n :

For load, $|\bar{Z}_{load}| = 50\,\Omega$ & $(p.f)_{load} = 0.707$ (leading)

$\cos\phi_{load} = 0.707$

$\therefore \phi_{load} = \cos^{-1}(0.707) = 45^\circ$

$\boxed{\phi_{load} = -45}$ I leads V

$\therefore \bar{Z}_{load} = |\bar{Z}_{load}| \angle \phi_{load}$

$\bar{Z}_{load} = 50 \angle -45^\circ\ \Omega$

$\bar{Z}_{load} = 35.3553 - j\,35.3553$

From figure, $\bar{Z}_{load} = r - jX_c$

$\therefore \boxed{r = 35.3553\,\Omega}$ & $\boxed{X_c = 35.3553\,\Omega}$

From figure,

Total Impedance $\Rightarrow \bar{Z} = (R+r) - jX_c$

$= (40 + 35.3553) - j\,35.3553$

$\boxed{\bar{Z} = 83.2190 \angle -25.1409}\ \Omega$

$\bar{Z} = |\bar{Z}| \angle \phi$

$\therefore |\bar{Z}| = 83.2190$ & $\boxed{\phi = -25.1409}$

By Ohm's law, $\bar{V} = \bar{I} \cdot \bar{Z} = (3\angle 0^\circ)(83.2190 \angle -25.1409)$

$\therefore \boxed{\bar{V} = 249.657 \angle -25.1409\ V}$

Power factor of circuit $= \cos\phi = \cos(-25.1409)$

$\therefore$ $\boxed{\text{p.f of circuit} = 0.9052 \text{ (leading)}}$