CMR INSTITUTE OF TECHNOLOGY

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Internal Assesment Test - II

Sub:	**BASIC ELECTRICAL ENGINEERING**							Code:	18ELE23
Date:	04/09/2021	Duration:	90 mins	Max Marks:	50	Sem:	2nd	Branch:	EEE

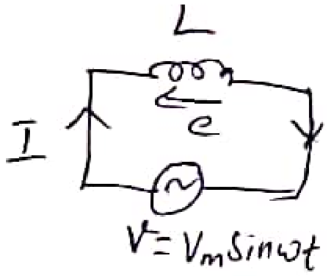
Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1. a)	Prove that in a purely inductive circuit the current lags voltage by 90^0. Also prove that its power consumption is zero.	5	CO2	L2
1. b)	An alternating voltage (80 + j60) V is applied to a circuit and the current flowing is (-4 + j10) A. Find: i) The impedance of the circuit, ii) The phase angle, iii) Power consumed.	5	CO2	L3
2	Given v = 200 sin 377t volts and i = 8 sin (377t – 30^0) amps for an a.c. circuit, determine: i) Power factor ii) True power iii) Apparent power iv) Reactive power. Indicate the unit of power calculated.	10	CO2	L3
3.	Two circuits A and B are connected in parallel across 200V, 50 Hz supply. Circuit A consists of 10Ω resistance and 0.12 H inductance in series while circuit B consists of 20Ω resistance in series with 40µF capacitance. Calculate i) Current in each branch ii) Supply current iii) Total power. iv) Draw the phasor diagram.	10	CO2	L3
4.a)	State the various advantages of three phase system over single phase system.	5	CO3	L1
4.b)	Explain the generation of three phase voltages with neat diagram.	5	CO3	L2
5	Derive the relation between line and phase quantities in a three phase star connected circuit. Derive the expression for the power. Also draw its complete phasor diagram.	10	CO3	L2
6	Show that the two wattmeter are sufficient to measure the power in a three phase circuit. Assume lagging power factor, star connected load. How power factor is obtained from two wattmeter readings.	10	CO3	L2

7.a)	Three similar coils each having resistance of 10Ω and reactance of 8 Ω are connected in star, across 400V, 3 phase supply. Determine: i) Line current ii) Total power iii) Reading of each of two wattmeter connected to measure power.	5	CO3	L3
7.b)	The three arms of a three phase load each comprise an inductor of resistance 25Ω and of inductance 0.15H in series with a 120µF capacitor. The supply voltage is 415V, 50 Hz. Calculate the line current and total power in watts, when the three arms are connected in delta.	5	CO3	L3

IAT-2.
Solution.

1. a)



(1)

$$V = L\frac{di}{dt} \Rightarrow V_m \sin\omega t = L\frac{di}{dt} \quad (1)$$

$$di = \frac{V_m}{L}\sin\omega t\, dt.$$

$$i = \int di = \int \frac{V_m}{L}\sin\omega t\, dt$$

$$i = \frac{V_m}{\omega L}\sin\left(\omega t - \frac{\pi}{2}\right) \quad (1)$$

$$i = I_m \sin\left(\omega t - \frac{\pi}{2}\right) \text{ where } I_m = \frac{V_m}{\omega L} = \frac{V_m}{X_L}$$

$$X_L = \omega L = 2\pi f L\ \Omega.$$

Phase angle of $-\frac{\pi}{2}$ is -90°. (1)

∴ current lags voltage applied by 90°.

$$\text{Power, } P = v \times i = V_m \sin\omega t \times I_m \sin\left(\omega t - \frac{\pi}{2}\right)$$

$$= -\frac{V_m I_m}{2}\sin(2\omega t)$$

$$\therefore P_{av} = \int_0^{2\pi} -\frac{V_m I_m}{2}\sin(2\omega t)\, d(\omega t) = 0. \quad (1)$$

(5)

1. b) $V = 80 + j60 = 100\angle 36.87^\circ V$

$I = -4 + j10 = 10.77\angle 111.8^\circ A$

i) $Z = \frac{V}{I} = 9.285\angle -74.931\ \Omega$ (2)

ii) Phase angle $= 74.931^\circ$ (1) (5)

iii) $P = VI\cos\phi = 280W.$ (2)

2. $V_m = 200V,\ I_m = 8A,\ \omega = 377 = 2\pi f,\ \phi = 30^\circ$. (2)

$f = \dfrac{377}{2\pi} = 60\,Hz$. (2)

i) $P.f = \cos\phi = 0.866$ lagging. (2)

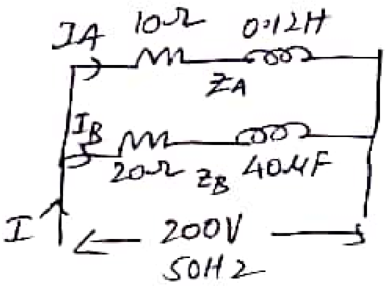
ii) True power $= VI\cos\phi = \dfrac{V_m}{\sqrt{2}} \times \dfrac{I_m}{\sqrt{2}} \cos\phi = 692.8\ W$ (2)

iii) Apparent power $= VI = \dfrac{V_m}{\sqrt{2}} \times \dfrac{I_m}{\sqrt{2}} = 800\ VA$ (2)

iv) Reactive power $= VI\sin\phi = \dfrac{V_m}{\sqrt{2}} \times \dfrac{I_m}{\sqrt{2}} \sin\phi = 400\,VAR$. (2)

(10)

3.



$Z_A = 10 + j2\pi f L$

$= 10 + j37.7\ \Omega = 39\angle 75.144^\circ\ \Omega$

$Y_A = \dfrac{1}{Z_A} = 0.0256\angle -75.144^\circ\ \mho$ (1)

$Z_B = 20 - j\left(\dfrac{1}{2\pi f C}\right) = 20 - j79.5774\ \Omega$

$= 82.052\angle -75.892^\circ\ \Omega$

$Y_B = \dfrac{1}{Z_B} = 0.01218\angle 75.892^\circ\ \mho$ (1)

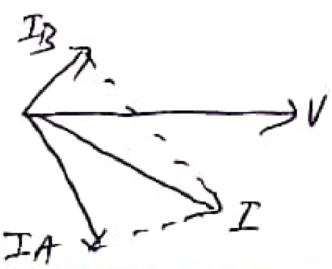
i) $I_A = VY_A = 5.12\angle -75.144^\circ A = 1.3127 - j4.9488A$.

$I_B = VY_B = 2.437\angle 75.892^\circ A = 0.5937 + j2.3625A$ (2)

ii) $I = I_A + I_B = 1.9064 - j2.5863A = 3.2129\angle -53.605^\circ A$ (2)

iii) $\cos\phi_T = 0.5933$ lagging. (2)

iv)



(2)

(10)

3

4.a) Five advantages 5

4.b) Circuit Diagram 3

Explanation. 2 5

5. Star connected load circuit diagram 1

$V_L = V_{RY} = V_{YB} = V_{BR}$ and $I_L = I_R = I_Y = I_B$

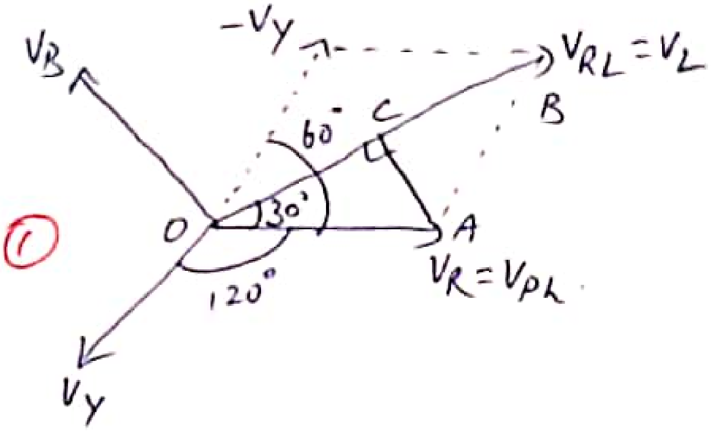
$V_{ph} = V_R = V_Y = V_B$ and $I_{ph} = I_R = I_Y = I_B$. 1

$\therefore \boxed{I_L = I_{ph}}$ 1

$V_{RY} = V_R - V_Y$

$V_{YB} = V_Y - V_B$

$V_{BR} = V_B - V_R$ 1



$\angle BOA = 30°$.

$OC = CB = \frac{V_L}{2}$

From ΔOAB, $\cos 30° = \frac{OC}{OA} = \frac{V_{RY}/2}{V_R}$ 10

$$\frac{\sqrt{3}}{2} = \frac{V_L/2}{V_{Ph}}$$

$$\boxed{V_L = \sqrt{3}\, V_{Ph}}$$ 2

Power $P_{Ph} = V_{Ph} I_{Ph} \cos\phi$

$P = 3 P_{Ph}$. 2

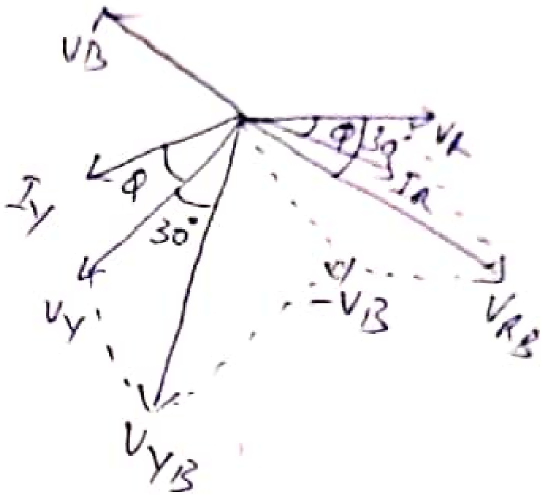
$\therefore \boxed{P = \sqrt{3}\, V_L I_L \cos\phi}$ W

Draw complete Phasor 2

6. Draw 2 wattmeter method for star connected load. 2 4

$$W_1 = I_R V_{RB} \cos(I_R \wedge V_{RB})$$

$$W_2 = I_Y V_{YB} \cos(I_Y \wedge V_{YB}) \quad 1$$



$$V_R = V_Y = V_B = V_{ph},$$

$$V_{RB} = V_{YB} = V_L \quad 1$$

$$I_R = I_Y = I_L = I_{ph}$$

From phasor, $I_R \wedge V_{RB} = 30 - \phi$,

$$I_Y \wedge V_{YB} = 30 + \phi \quad 1$$

$$W_1 = I_R V_{RB} \cos(30-\phi) = V_L I_L \cos(30-\phi)$$

$$W_2 = I_Y V_{YB} \cos(30+\phi) = V_L I_L \cos(30+\phi)$$

$$\therefore W_1 + W_2 = V_L I_L \left[\cos(3-\phi) + \cos(30+\phi)\right] \quad 10$$

$$\boxed{W_1 + W_2 = \sqrt{3}\, V_L I_L \cos\phi} \quad 2$$

P.f, $W_1 + W_2 = \sqrt{3}\, V_L I_L \cos\phi$.

$$W_1 - W_2 = V_L I_L \sin\phi$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{\tan\phi}{\sqrt{3}} \Rightarrow \tan\phi = \frac{\sqrt{3}(W_1 - W_2)}{(W_1 + W_2)} \quad 1$$

$$\therefore \phi = \tan^{-1}\left[\frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right]$$

$$\text{P.f } \cos\phi = \cos\left\{\tan^{-1}\left[\frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right]\right\} \quad 2$$

5

7.a) $Z_{ph} = 10 + j8\,\Omega = 12.806\angle 38.66^\circ\,\Omega$, $V_L = 400V$.

i) $V_{ph} = \frac{V_L}{\sqrt{3}}\ \frac{400}{\sqrt{3}} = 230.94V$.

$I_{ph} = \frac{V_{ph}}{Z_{ph}} = 18.033A$ 2

$\therefore I_L = I_{ph} = 18.033A$. 5.

ii) $P = \sqrt{3}\,V_L I_L \cos\phi = 9.756\,kW$ 1

iii) $W_1 = V_L I_L \cos(30-\phi) = 7.131\,kW$

$W_2 = V_L I_L \cos(30+\phi) = 2.625\,kW$ 2

7.b) $Z_{ph} = R + jX_L - jX_C$

$= 25 + j47.1238 - j26.5258$ 1

$= 25 + j20.598\,\Omega = 32.392\angle 39.48^\circ\,\Omega$

For delta, $V_{ph} = V_L = 415V$

$\therefore I_{ph} = \frac{V_{ph}}{Z_{ph}} = 12.8118\angle -39.48^\circ A$ 5

2

$I_L = \sqrt{3}\,I_{ph} = 22.1906A$.

$P = \sqrt{3}\,V_L I_L \cos\phi = 12.3114\,kW$. 2