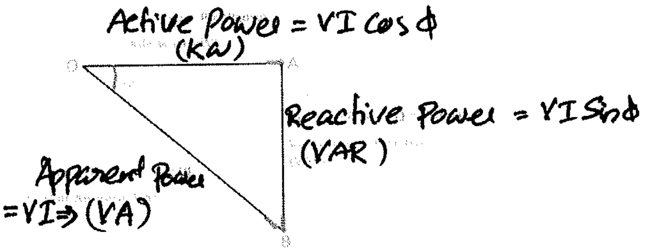
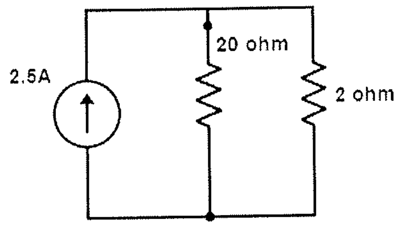
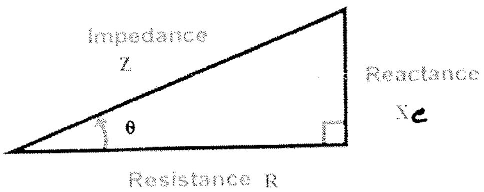
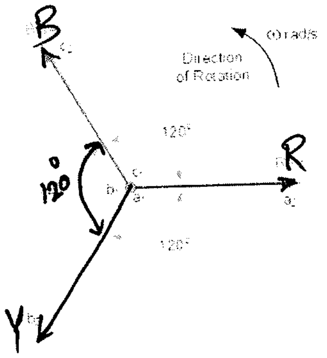
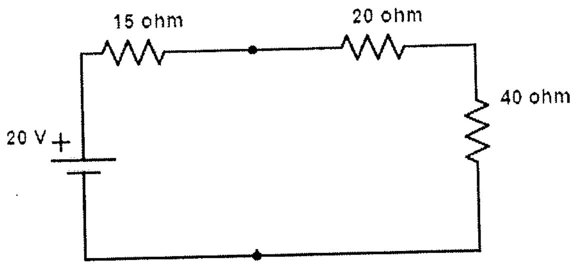
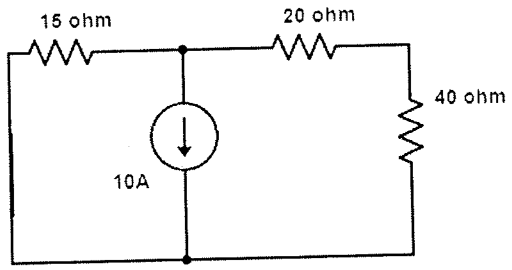
Scoring Indicators

COURSE NAME : Fundamentals of Electric circuits
COURSE CODE : 3033 **QID : 2110220135**

Q.No.	Scoring Indicators	Split score	Sub Total	Total score
	PART A			9
I.1	Open Circuited		1	
I.2	Node		1	
I.3	A=A<θ		1	
I4	Z=R-jXc or $Z = \sqrt{R^2 + X_c^2}$		1	
I.5	Minimum current		1	
I.6			1	
I.7	i. Admittance mthod, ii. Vector method		1	
I.8	$I_L = \sqrt{3} I_{ph}$		1	
I.9	Zero		1	
	PART B			24
II.1	*Statement-3 marks*			
	Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load resistance only when the load resistance is equal to the source impedance. For this circuit the maximum power transferred only when Rs= R_L. The maximum power transferred , $P_{max} = \frac{V_{th}^2}{4R_{th}}$	3	3	
II.2	*Each step- 0.5 marks*			
	1. Remove the resistance (if any) across the two given terminals and kept the terminal as open circuited. 2. Compute the open circuit voltage,V_{th} 3. Remove all voltage and current sources by short circuiting and open circuiting respectively. 4. Find Thevenin's resistance R_{th}. 5. Draw the thevenin equivalent circuit with V_{th} and R_{th}. 6. Complete the equivalent circuit by connecting	6*0.5	3	

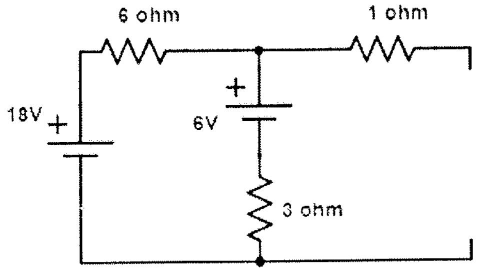
	the load resistance.			
II.3	*Short circuit current-1 mark* *Norton's resistance-1 mark* *Current through 2 ohm-1 mark*			
	➢ Remove 2Ω and short the terminal ➢ Find the short circuit current, I_{sc}= 2.5A ➢ Find R_N. R_N= 10‖10+15=20Ω ➢ Norton equivalent is  ➢ $I_{2\Omega}$= 2.27A	1 1 1	3	
II.4	*Impedance triangle-2 mark* *Terms explanation-1 mark*			
	Impedance Triangle  Impedance Z Opposition offered by the elements in an ac circuit is called impedance. $Z = \sqrt{R^2 + X_C^2}$ Reactance X Opposition offered by ~~inductor or~~ capacitor in an ac circuit. ~~Inductive reactance, X_L=Lω~~ Capacitive reactance, Xc=1/Cω	2 1	3	
II.5	*three points-1mark each*			
	For a series RLC circuit, 1.Resonance occurs when X_L=X_C. At resonance, 2.current is maximum. I_m=V/R 3.Pf is unity	3	3	

II.6	*1 mark for each definition*			
	Definitions of Active power, Reactive power and Apparent Power.	3	3	
II.7	*Total impedance-2 marks* *Current-1 mark*			
	Z=Z1||Z2 $Z1=\sqrt{8^2+7^2}=10.6\Omega$ $Z2=\sqrt{5^2+6^2}=7.8$ $Z=\frac{Z_1 Z_2}{Z_1+Z_2}=4.49$ $I=\frac{V}{Z}=22.27\ A$	2 1	3	
II.8	Defenition-1.5 marks Equation-1.5 marks			
	Q-factor:- the current magnification in the parallel RLC circuit at resonance is called Q-factor. Q-factor= I_c/I Now, $I_c=\frac{V}{X_c}=V\omega C$ $I=\frac{V}{L/CR}=\frac{VCR}{L}$ $Q-\text{factor}=\frac{1}{R}\sqrt{\frac{L}{C}}$	3	3	
II.9	*Expressions-1.5 marks* *Phasor diagram-1.5 marks*			
	<u>Voltage equations</u> $E_1=E_m\sin\omega t$ $E_2=E_m\sin(\omega t+120^0)$ $E_3=E_m\sin(\omega t-120^0)$	1.5	3	
	<u>Phasor Diagram</u> 	1.5		
	Any 3 points -1 mark each			

II.10	Advantages of three phase systems 1. The total power delivered is constant if load is balanced. 2. The output of 3 phase motor is 1.5 times the output of 1 phase motor for a given size. 3. Three phase induction motors are self starting. 4. The efficiency of polyphase motors is greater than single phase motor. 5. Power factor is more than the single phase motor for same rating. 6. Polyphase system is more reliable. Parallel operation of polyphase alternator is simple.	3	3	
	PART C			**42**
III.	*20 V alone- 3 marks* *10A alone-3 marks* *Total current-1 mark*			
	➢ Consider 20V alone ➢ Remove 10A by open the terminal.  ➢ Current through 40 ohm=20/(15+20+40)=0.266**A** ➢ Consider 10A alone ➢ Remove 20V by shorting its terminal  ➢ 20 series 40=60 ➢ Current dividing rule, I'= -2A ➢ By super position principle, current through 4 ohm=0.266-2= -1.73**A**	3 3 1	7	

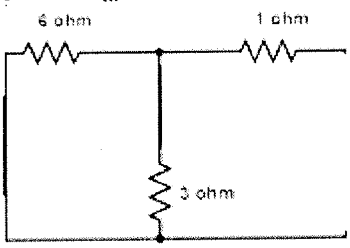
<table>
<tr><td>IV</td><td>Thevenin's voltage-3 marks
Thevenin resistance-3 marks
Thevenin equivalent circuit-1 mark</td><td></td><td></td><td></td></tr>
<tr><td></td><td>

- Remove 7Ω and open the terminals

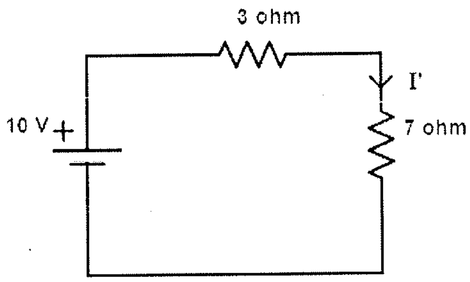


- V_{th}=6V+ voltage drop across 3 Ω=6+4=10 V

To find R_{th}:-



- Rth=6||3+1=3**Ω**
- Thevenin's equivalnt is



- Current through 7 Ω, $I' = \frac{10}{10} = 1A$

</td><td>3

2

2</td><td>7</td><td></td></tr>
<tr><td>V</td><td>RLC circuit diagram-2 marks
Explanation of different terms-2 marks
Impedance triangle-1.5 marks
Vector diagram-1.5 mark</td><td></td><td></td><td></td></tr>
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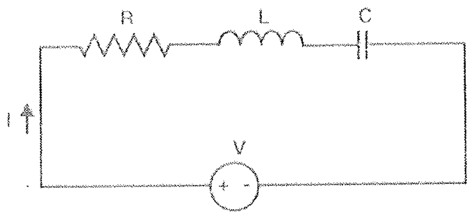
RLC Series circuit



Impedance,Z=$\sqrt{R^2 + (X_L - X_c)^2}$

Current I=V/Z

</td><td>2</td><td>7</td><td></td></tr>
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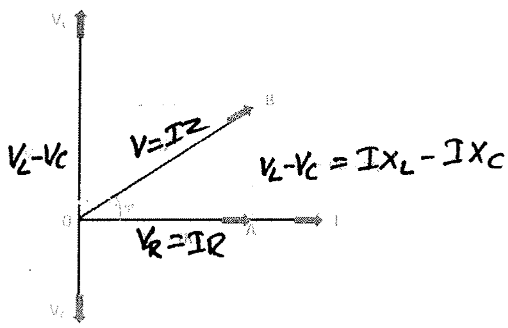
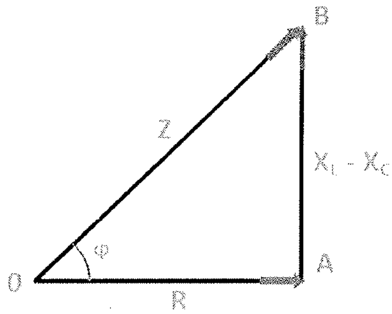
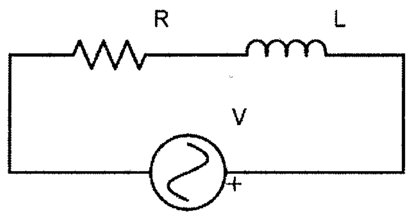
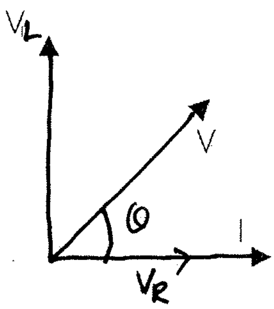
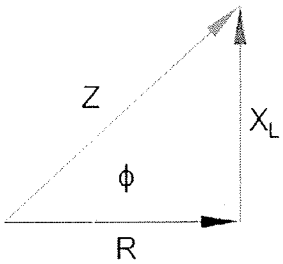
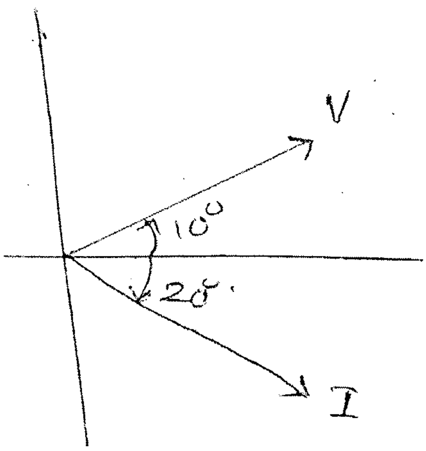
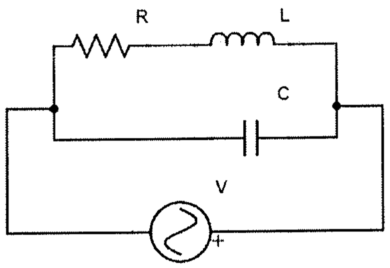
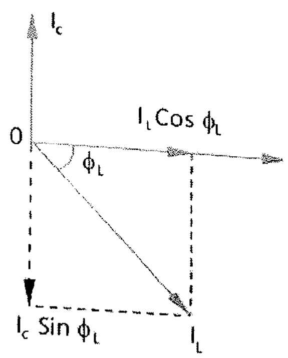
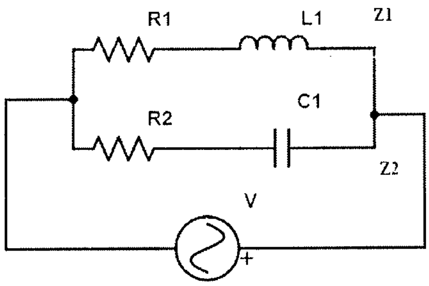
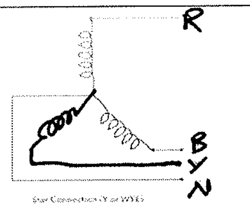
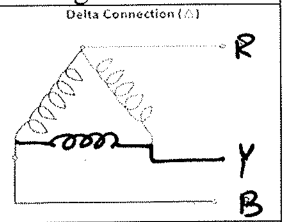
	Power factor, cos $\Phi = R/Z$ Power $P = VI\cos\Phi$ <u>Vector diagram</u>  <u>Impedance triangle</u>  	2 1.5 1.5		
VI	*Circuit diagram-2 marks* *Vector diagram-1.5 marks* *Impedance triangle-1.5 marks* *Equation for Z,I,pf,P-2 marks*			
	  Let $v = V_m \sin\omega t$ be the applied voltage $V_R = IR$, Voltage across resistor and is in phase with I $V_L = IX_L$, Voltage across inductor and is lead 90^0 with I	3 3	7	

	$V = \overline{V_R} + \overline{V_L}$ Impedance $Z=\sqrt{R^2 + X_L^2} = R+jX_L$ Current I=V/Z Power factor=cosΦ= V_R/V=IR/IZ=**R/Z** Active Power=VI cosΦ Reactive Power= VI sinΦ Apparent Power= VI <u>Impedance triangle</u> 	1		
VII	*Power factor-2 marks* *Power-3 marks* *Vector diagram-2 marks*			
	$v(t)=141.4 \sin(314t+10^0)$ $i(t)= 14.14 \sin(314t-20^0)$ (i) pf=cosΦ=cos(10+20)=0.866 lag (ii) P=VI cosΦ $V=V_m/\sqrt{2}=141.4/\sqrt{2}=100V$ $I=I_m/\sqrt{2}=14.14/\sqrt{2}=10A$ P= 100×10×0.866=866W (iii) Vector diagram 	2 3 2	7	

VIII	*Z-1marks* *Current-1 mark* *Pf-1 mark* *Power-1 mark* *Voltage across R & C-2 marks*			
	$X_C = \frac{1}{C\omega} = \frac{1}{2\pi\times50\times100\times10^{-6}} = 31.83\Omega$ (i) Impedance $Z = \sqrt{R^2 + (X_C)^2}$ $=59.4\Omega$ (i) Current, I=V/Z= 1.68 A (ii) Pf=cosΦ=R/Z=0.842 lead (iii) Power consumed= VI cos Φ= 141.45W (iv) Voltage Across R, V_R= IR=84V Voltage across C, V_c=IXC=53.76V	1 1 1 1 1 2	7	
IX	*RLC circuit-2 marks* *Resonant condition-3 mark* *Vector diagram- 2 marks*			
	Parallel RLC circuit  Vector diagram  Condition for resonance is the net reactive component become zero. I_c-I_L sinΦ_L=0.........1	2 2	7	

	At parallel resonance, 1. The circuit impedance is maximum 2. Circuit current is minimum 3. Power factor is unity. Now $I_L = V/Z$ $I_c = V/X_c$ $\sin\Phi_L = X_L/Z$ Eq.1 become , $\mathbf{X_L . X_c = Z^2}$ Resonant frequency, $f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$	3		
X	*Diagram-2 marks* *Explanation-5 marks*			
	Admittance method Admittance, Y=1/Impedance. Consider a parallel circuit having two impedance Z_1 and Z_2.  **For branch 1** $Z1 = R1 + jX1 = \sqrt{R_1^2 + X_1^2}$ Conductance ,$g1 = R_1/Z_1^2$ Susceptance, $b1 = X_1/Z_1^2$ $Y1 = g_1 - jb_1$ **For branch 2** $Z_2 = R_2 - jX_2 = \sqrt{R_2^2 + X_2^2}$ Conductance ,$g2 = R_2/Z_2^2$ Suceptance, $b2 = X_2/Z_2^2$ $Y_2 = g2 + jb2$	1 2 4	7	

	Total admittance $Y=Y_1+Y_2$ Current $I= VY$ Power factor $\cos\Phi= G/Y$			
XI	*Line current- 2 marks* *Power-2 marks* *Reactive power-2 mark* *Apparent power-1 mark*			
	$Z=8+j6$, $V_L=230$ V, star $V_{ph}=V_L/\sqrt{3}=132.8V$ $Z_{ph}=\sqrt{8^2+6^2}=10\Omega$ (i) Current, $I_{ph}=V_{ph}/Z_{ph}=$ 13.28A. Line current, $I_L=I_p=13.28A$. (ii) Power$=\sqrt{3}\ V_L\ I_L\cos\Phi$ $Pf=\cos\Phi=R/Z=8/10=0.8$ P=4232W (iii) Reactive Power, $Q=\sqrt{3}\ V_L\ I_L\sin\Phi=$**3174 VAR** (iv) Total kVA$=\sqrt{3}\ V_L\ I_L=$**5290VA**	1 2 2 1 1	7	
XII	$V_{ph}=V_L=400V$, $I=10A$ $\cos\Phi=0.7$ (i) $I_{ph}=I_L/\sqrt{3}=5.77A$ (ii) $Z_{ph}= V_{ph}/I_{ph}=69.28\Omega$ (iii) $R_{ph}=Z_{ph}\cos\Phi=48.49\Omega$ $X_{ph}=\sqrt{Z^2-R^2}=49.48\Omega$ (iv) Active Power, $P=\sqrt{3}\ V_L\ I_L\cos\Phi=4850W$ (v) Reactive power, $Q=\sqrt{3}\ V_L\ I_L\sin\Phi=4948$ VAR (vi) Apparent Power, $S=\sqrt{3}\ V_L\ I_L=6928.2VA$	1 1 2 1 1 1	7	
XIII	*Any seven points -1 mark each*			

Si. No.	Star(Y) connected system	Delta(Δ)connected system
1	Neutral point is there and it can be earthed.	No neutral point
2	$V_L=\sqrt{3}\ V_{ph}$	$V_L=V_{ph}$
3	$I_L=I_{ph}$	$I_L=\sqrt{3}\ I_{ph}$
4	3 phase three wire and 3 phase 4 wire system	Only 3-phase 3-wire system
5	Low insulation is required as phase voltage is low	Heavy insulation is required as phase voltage=line voltage
6		
7	Usually star connection is used in the transmission and distribution.	Delta is used in the Distribution.
8	Three phase power, $P = \sqrt{3}\ V_L I_L \cos\theta$	Three phase power, $P = \sqrt{3}\ V_L I_L \cos\theta$

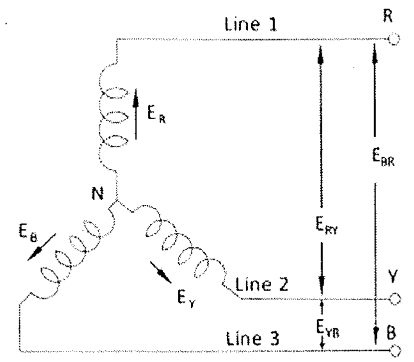
7*1

7

XIV

Diagram-1 mark
Phasor diagram-3 marks
Explanation-3 marks

Star Connected Three phase system



1

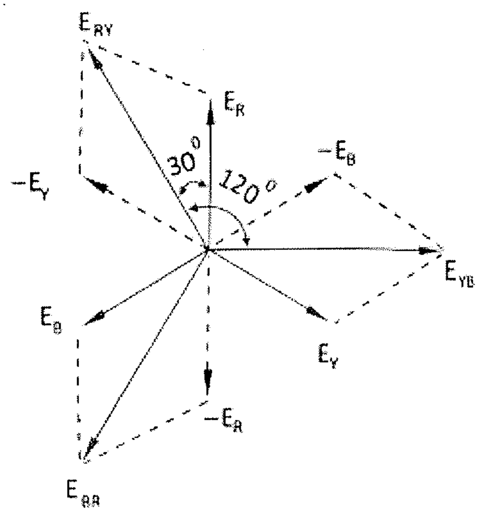
7

Let

E_R, E_y and E_B = phase voltages of R, Y, B phases and are equal to 'E_{ph}'

E_{Ry}, E_{yB} and E_{BR} = line voltages of RY, YB, BR respectively and are equal to 'E_L'

Vector Diagram



2

The p.d. between outers R and Y is

$E_{Ry} = E_R - E_y$ .... Vector difference

$= E_R + (-E_y)$ .... Vector sum.

4

The phase angle between vectors E_R and $(-E_y)$ or E_y reversed is 60°.

∴ From vector diagram shown in Fig. 4.9 (b).

$$E_{Ry} = \sqrt{E_R^2 + E_y^2 + 2E_R E_y \cos 60^0}$$

$$= \sqrt{E_{ph}^2 + E_{ph}^2 + 2E_{ph} \cdot E_{ph} \times \frac{1}{2}}$$

$\because E_R = E_y = E_B = E_{ph}$ for a balanced system

$$= \sqrt{3 E_{ph}^2} = \sqrt{3}\, E_{ph} *$$

Similarly p.d. between outers Y and B is

$$E_{yB} = E_y - E_B = \sqrt{3}\, E_{ph}.$$

and p.d. between outers B and R is

$$E_{BR} = E_B - E_R = \sqrt{3}\, E_{ph}.$$

Hence, in balanced star connected system

$$E_{Ry} = E_{yB} = E_{BR} = \boxed{E_L = \sqrt{3}\, E_{ph}.}$$