Model Question Paper I

FUNDAMENTALS OF ELECTRIC CIRCUITS

Time: 3 Hour *Max.Marks: 75*

PART A

I. Answer **all** questions in one word or one sentence. Each question carries 1 mark (9*1=9 marks)

1	Name any one dc network theorem	M 1.02	R
2	Two branches meeting at a point in a circuit is called…….	M 1.01	U
3	Write the format of polar form	M 2.01	U
4	Match the following types of load and their power factors: Resistive - lagging Capacitive-in phase Inductive – leading	M 2.01	U
5	Write the equation of power in a pure resistive circuit	M 2.01	U
6	Any one method of solving parallel circuit is …………..	M3.02	R
7	Power factor in a parallel circuit at resonance is ……………..	M 3.04	U
8	Write the relation between line and phase values of voltage in star system	M 4.02	U
9	Equation of three phase ac power is ……………	M 4.04	U

PART B

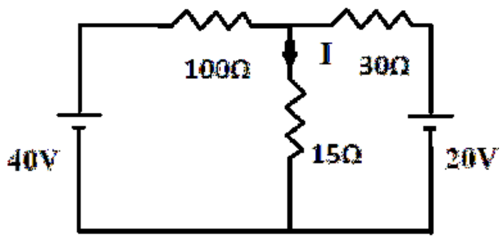
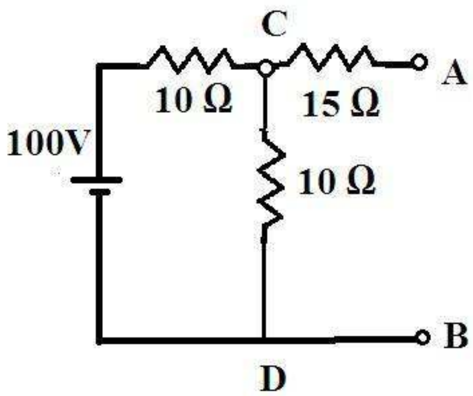
II. Answer any **eight** questions from the following, each question carries 3 marks.
(8 * 3=24 marks)

1	State reciprocity theorem.	M 1.02	R
2	Write the procedure to Nortonize a given circuit.	M 1.03	U
3	Two vectors A=20+j30,B= -10-j15.find A-B and express the result in polar form	M2.01	A
4	Draw the vector and impedance diagrams of R-L series circuit	M 2.02	A
5	Determine the capacitance of the capacitor of a circuit consisting of 110V, 40W lamp in series with a capacitor. Supply voltage is 230V,50 Hz.	M 2.03	A
6	Define the terms in a parallel circuit (1).Resonance (2).Q factor	M 3.04	R
7	Draw the vector diagram of a parallel circuit with one branch consisting of a resistor of 14Ω and a reactance of 20Ω. A second branch consists of a resistor of 25Ω.A potential difference of 100V,50Hz is applied across the combination.	M 3.02	A
8	Write any three advantages of three phase systems	M 4.01	R
9	Obtain the relation between line and phase values of voltage in a star connected system.	M 4.02	U
10	Write the equations of various three phase powers .	M4.04	U

PART C

Answer ALL questions. Each question carries 7 marks.

(6*7=42 marks)

III	By using superposition theorem find the current through 15Ω resistor.  	M 1.04	A
	OR		
IV	Obtain Norton's equivalent circuit of the given circuit.  	M 1.04	A
V	Write the procedure to thevenize a given circuit.	M 1.03	U
	OR		
VI	State and explain the theorems (a)Maximum power transfer theorem (b) Superposition theorem.	M 1.02	U
VII	A circuit consists of 10 Ω resistance and 8Ω inductive reactance are in series and takes a current of 6 ampere. Determine (i) voltage across resistance and inductance (ii) total supply voltage (iii)power factor of the circuit.	M 2.03	A
	OR		

VIII	Perform the following operations and find magnitude and slope in each case.(a)A+B(b)A-B (c) AB, where A=20+j15 and B= 30-j4	M 2.01	A
IX	Derive the equation of active power in an R-L series circuit	M 2.02	U
	OR		
X	Draw the vector and impedance diagrams of R-C series circuit. Also write the equation of power factor.	M2.03	U
XI	Two impedances Z1=(10+j15)ohm and Z2=(6-j8)ohm are connected in parallel. If the total current supplied is 15A,determine the current and power taken by each branch. Use admittance method.	M 3.03	A
	OR		
XII	A coil of resistance 14 Ω and reactance 20 Ω is shunted by a non – resistance of 25 Ω and a p.d of 100V at 50Hz is impressed across the combination.Find (i)the current in each branch(ii)total current	M 3.03	A
XIII	A balanced star connected load of 8+j6 ohm per phase is connected to a 3- phase,230V.Find (i)Line current (ii)Power (iii)Reactive power	M 4.02	A
	OR		
XIV	With the help of a vector diagram derive the relation between line and phase values of current in a delta connected system .	M 4.02	A

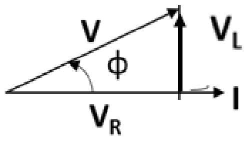
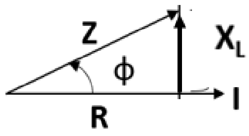
Scoring Indicators

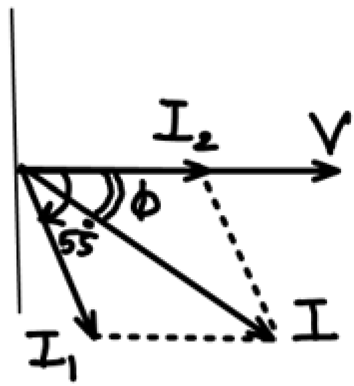
Model Question Paper I

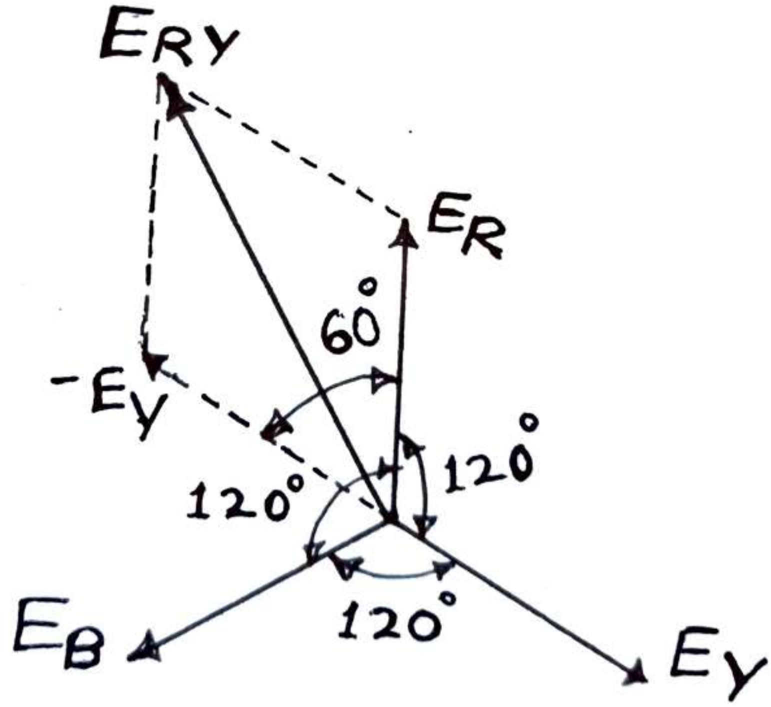
FUNDAMENTALS OF ELECTRIC CIRCUITS

Q No	Scoring Indicators	Split score	Sub Total	Total Score
	PART A			
I. 1	Superposition theorem Maximum power transfer theorem Thevenin's theorem Norton's theorem Reciprocity theorem *(Write any one theorem)*		1	1
I. 2	Junction or Node		1	1
I. 3	A vector, E= E<Ө , where E-magnitude and Ө-inclination		1	1
I. 4	Resistance-in phase Capacitive-leading Inductance-lagging		1	1
I. 5	P=VI watts		1	1
I. 6	Vector method Admittance method j-method *(Write any one method)*		1	1
I. 7	unity ***(Write any one)***		1	1
I. 8	$V_L = \sqrt{3}\, V_{ph}$		1	1
I. 9	$P= \sqrt{3}\, V_L\, I_L \cos\phi$		1	1

<table>
<tr><td></td><td>PART-B</td><td></td><td></td><td></td></tr>
<tr><td>II. 1</td><td>Reciprocity theorem states that the current at one point in a circuit due to a voltage at a second point is the same as the current at the second point due to the same voltage at the first.</td><td></td><td>3</td><td>3</td></tr>
<tr><td>II. 2</td><td>1. Remove the resistance (if any) across the two given terminals and put a short- circuit across them
2. Compute the short circuit current
3. Remove all voltage and current sources
4. Find Norton's resistance
5. Join the current source in parallel across the Norton's resistance
6. Complete the equivalent circuit</td><td>6 *0.5mark</td><td>3</td><td>3</td></tr>
<tr><td>II. 3</td><td>A = 20+j30, B= -10-j15, A-B =?
A-B=20 +j 30 + 10 +j 15= 30 + j45
Magnitude=
$\sqrt{30^2 + 45^2}$ =54.08
$\theta = \tan^{-1}\frac{45}{30}$
$=56.309^0$
Therefore in polar form ,
A-B=54.08< 56.309^0
(Calculation of each quantity carries 1marks)</td><td>3 *1mark</td><td>3</td><td>3</td></tr>
</table>

II. 4	 PHASOR DIAGRAM  IMPEDANCE DIAGRAM	2 *1.5 marks	3	3
II. 5	*Voltage across the capacitor* $V_C = \sqrt{230^2 - 110^2}$ = 202 V $I = \frac{P}{V} = \frac{40}{110} = 0.3636$ A $X_C = \frac{V_C}{I} = \frac{202}{0.3636} = 555.55\ \Omega$ But $X_C = \frac{1}{2\pi f C}$ C= 5.73 μF	0.5+0.5+0.5+1+0.5	3	3
II. 6	(1)**Resonance** – When the reactive component of the line current becomes zero. The frequency at this condition is called resonance frequency (2) **Q-factor-** Current magnification in an RLC parallel circuit is called its Q-factor $Q\ factor = \frac{I_C}{I}$ *Also* $Q\ factor = \frac{X_L}{R}$	1.5+1.5	3	3

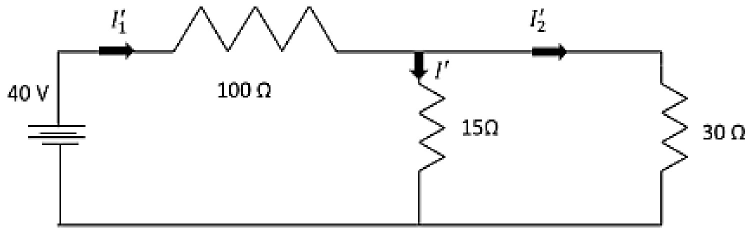
II.7	For branch-1 $Z_1 = \sqrt{14^2 + 20^2} = 24.41\ \Omega$ $I_1 = \frac{V}{Z_1} = \frac{100}{24.41} = 4.097\ A$ $\phi_1 = \text{Cos}^{-1}\frac{R}{Z_1} = \cos^{-1}\frac{14}{24.41} = 55^0\ (lag)$ For branch-2 $I_2 = \frac{V}{Z_2} = \frac{100}{25} = 4\ A$ $\phi_2 = \text{Cos}^{-1}\frac{R}{Z_2} = \cos^{-1}\frac{25}{25} = 0$  *(Equations- 1 mark, Calculations- 1.5 marks ,figure-0.5 mark)*	1+1.5 +0.5	3	3
II. 8	1.Total power delivered is constant 2.Output of 3 phase motor is 1.5 times the output of single phase motor of same size 3.Three phase motors are self starting 4.Rotating magnetic field can be setup 5.More reliable ***(Write any three)***	1+1+1	3	3

II. 9	 Let $E_R = E_Y = E_B = E_{ph}$ are the phase values of voltage Let $E_{RY} = E_L$ be the line value of voltage By parallelogram law method, $E_{RY} = \sqrt{(E_{ph}^2 + E_{ph}^2 + 2 * E_{ph}^2 * \cos 60)}$ ie , $E_L = \sqrt{3E_{ph}^2} = \sqrt{3} * E_{ph}$ **(For each step 1 mark ,diagram-1 mark)**	1+1+1	3	3
II.10	Active power= $\sqrt{3}E_L I_L \cos\phi$ Reactive power= $\sqrt{3}E_L I_L \sin\phi$ Apparent power= $\sqrt{3}E_L I_L$	1+1+1	3	3

<table>
<tr><td></td><td>PART-C</td><td></td><td></td><td></td></tr>
<tr><td>III</td><td>

When 20V source is removed, the circuit becomes as shown in figure 1

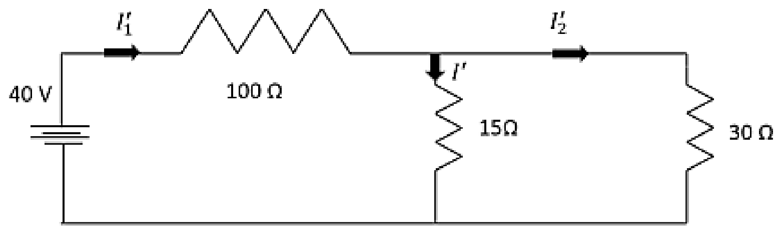
figure 1



To find I_1'

$$Total\ resistance = 100 + \left(\frac{15\ x 30}{15+30}\right) = 110\Omega$$

$$I_1' = \frac{40}{110} = 0.36\ A$$



by current division rule ,

$$I' = 0.36\ x\ \frac{30}{(15+30)} = 0.24\ A$$

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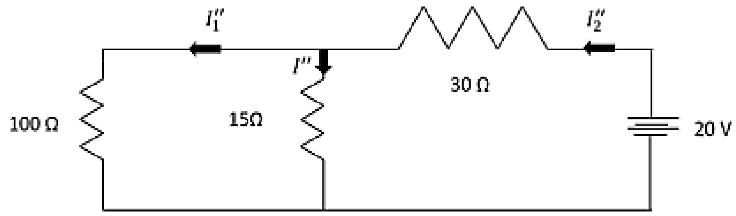
	When 40V source is removed, the circuit becomes as shown in figure 2 **Figure 2**  To find I_2'' $Total\ resistance = 30 + \left(\frac{15\ x 100}{15+100}\right) = 43\Omega$ $I_2'' = \frac{20}{43} = 0.47\ A$ by current division rule $I'' = 0.47\ x\ \frac{100}{(15+100)} = 0.41\ A$			
	therefore , current through 15 Ω resistor is I= I' + I'' = 0.24 +0.41 =0.65 A ***(Calculations of step -1- and step-2 -2.5 marks each step-3- 0.5 mark, Figures-0.5 marks each)***			

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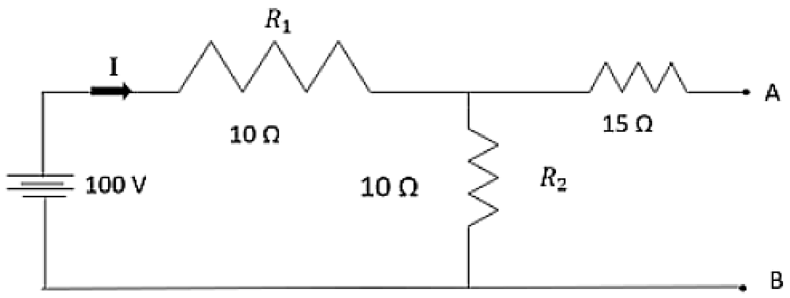
<tr>
<td rowspan="3">IV</td>
<td>
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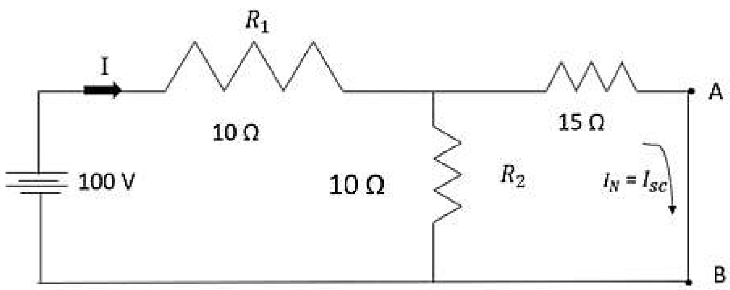
<tr>
<td>To find I_{sc} by short-circuiting the terminals A and B as shown below


To find battery current, I
Total resistance = $10 + \frac{10x15}{10+15}$ = 10+6 =16Ω
Therefore I = $\frac{100}{16}$ = 6.25 A
By current division rule I_{sc} = $I \text{ x} \frac{R2}{R2+R3}$
= 6.25 x $\frac{10}{10+15}$ = 2.5 A</td>
<td rowspan="2">7</td>
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<td rowspan="2">7</td>
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<tr>
<td>To find R_N with respect to A and B,short circuit the</td>
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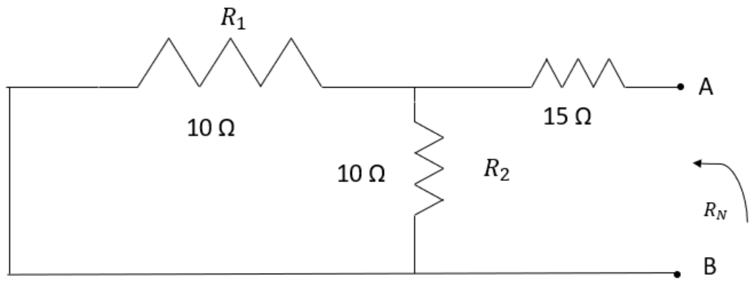
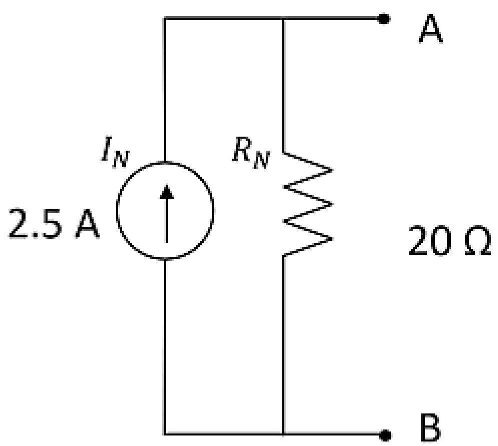
<td>voltage source.then the circuit becomes


$$\text{Then } R_N = 15 + \frac{10x10}{10+10} = 15 + 5 = 20\ \Omega$$
Hence Norton's equivalent circuit can be obtained as :


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<tr>
<td>V</td>
<td>1. Temporarily remove the load resistance
2. Find the open circuit voltage called Thevenin's voltage
3. Compute the equivalent resistance(Thevenin's resistance) of the whole network as viewed from the open load terminals
4. Obtain the Thevenin's equivalent circuit
5. Re-connect the load resistance
6. Find the load current</td>
<td>7</td>
<td>7</td>
<td>7</td>
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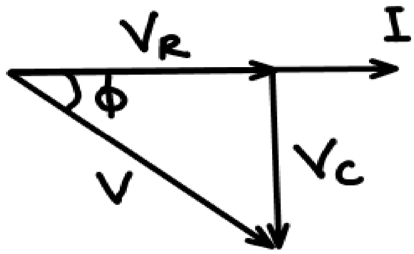
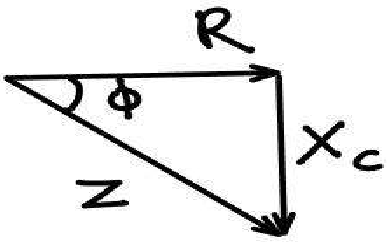
<tr>
<td>VI</td>
<td>(a)Maximum power transfer theorem
A resistive load will abstract maximum power from a</td>
<td>3.5+
3.5</td>
<td>7</td>
<td>7</td>
</tr>
</table>

	network when the load resistance is equal to the resistance of the network as viewed from the output terminals with all energy sources(emfs) removed with their internal resistances (b)**Superposition theorem-** In a network of linear resistances containing more than one source of emf, the current which flows at any point is the sum of all the currents which would flow at that point if each emf where considered separately and all the other emfs replaced by their internal resistances			
VII	Given , R=10Ω , X_L = 8 Ω, I=6A (i) V_R =IR=6x10=60V V_L =IX_L =6x8 = 48V (ii) Z =$\sqrt{R^2 + XL^2}$ =12.8 Ω Therefore supply voltage, V= IZ =6x12.8 =76.8 V (iii) p.f = $\frac{R}{Z}$ =0.781 ***(Equations- 3 marks, Calculations- 4 marks)***	3+4	7	7
VIII	(a) A+B = 20+j15+30-j4 = 50+11j Magnitude = $\sqrt{50^2 + 11^2} = 51.2$ $Slope = \tan^{-1}\frac{11}{50} = 12.4^0$ (b)	3+4	7	7

	A-B=20+j15-30+j4 = -10+j19 Magnitude = $\sqrt{(-10^2) + 19^2} = 21.47$ $$Slope = \tan^{-1}\frac{-19}{10} = -62.2^0$$ (c) AB=(20+j15)*(30-j4) =600-80j+450j+60 =660+j370 Magnitude = $\sqrt{660^2 + 370^2} = 756.64$ $$Slope = \tan^{-1}\frac{370}{660} = 29.27^0$$ ***(Equations- 3 marks, Calculations- 4 marks)***			
IX	Instantaneous power, P= v * i = □□□□□ □□ * □□□□□ (□□ − □) = $\frac{□□*□□}{2}$ (□□□ (□□ − □□ + □) − □□□ (□□ + □□ + □)) = $\frac{□□*□□}{2}$ □□□ (□) − $\frac{□□*□□}{2}$ (□□□ (2□□ + □)) Since the second term is a double frequency component and its value becomes zero when	**1*7**	7	7

	integrated over a complete cycle. Total power, P $= \frac{\square_{\square} * \square_{\square}}{2}$ □□□ □ $= \frac{\square_{\square}}{\sqrt{2}} \frac{\square_{\square}}{\sqrt{2}}$ □□□ □ = □□□□□□□□□□□ □ *(Each main steps- 1 mark each =1*7=7marks)*			
X	 (Vector diagram)  (Impedance diagram) power factor $= \frac{\square}{\square}$ *(Figures-3 marks each ,equation= 1mark)*	3+3+1	7	7
XI	**For Branch-I** $\square_1 = \sqrt{10^2 + 15^2} = 18.03$ □ Conductance $\square_1 = \frac{\square_1}{\square_1^2} = 0.0308$ ℧	3+4	7	7

susceptance

$$□_{1} = \frac{-□_{□1}}{□_{1}^{2}} = -0.046\ ℧\ (□□□□□□□□□□)$$

For Branch-II

$$□_{2} = \sqrt{6^{2} + 8^{2}} = 10\ □$$

Conductance

$$□_{2} = \frac{□_{2}}{□_{2}^{2}} = 0.06\ ℧$$

susceptance

$$□_{2} = \frac{□_{□2}}{□_{2}^{2}} = 0.08\ ℧$$

Total conductance, $□ = □_{1} + □_{2} = 0.0908\ ℧$

Total susceptance, $□ = □_{1} + □_{2}$

$= -0.046 + 0.08 = 0.0339\ ℧$

Admittance of the circuit $Y = \sqrt{□^{2} + □^{2}} = 0.0969\ ℧$

Supply Voltage , $V = \frac{□}{□} = \frac{15}{0.0969} = 154.79\ □$

$$□_{1} = \frac{□}{□_{1}} = 8.585\ □$$

$$□_{2} = \frac{□}{□_{2}} = 15.479\ □$$

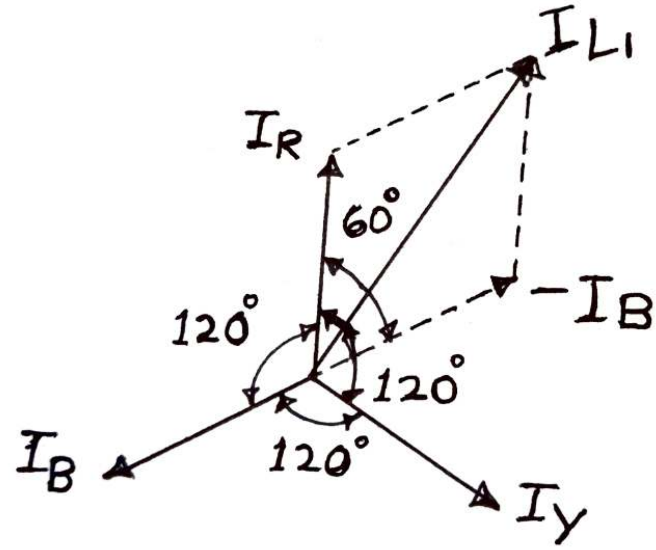
$$P_{1} = □_{1}^{2} * □_{1} = 737\ □$$

$$□_{2} = □_{2}^{2} * □_{2} = 1437.6\ □$$

(Equations- 3 marks, Calculations- 4 marks)

XII	For branch-1 (i) $Z_1 = \sqrt{14^2 + 20^2}$ =24.41 Ω $I_1 = \frac{V}{Z1} = \frac{100}{24.41}$ =4.096A $\phi_1 = \frac{R}{Z1} = 55^0$ (lag) For branch-2 $I_2 = \frac{V}{Z2} = \frac{100}{25} = 4A$ $\phi_2 = \frac{R}{Z2} = \frac{R}{R} = (1) = 0^0$ (ii) **either resolving the branch currents method or parallelogram law method can be applied**. Here, resolving of branch currents method is used. Total X-components = $4\cos 0^0 + 4.096\cos 55^0$ =6.346 Total Y-components = $4\sin 0^0 - 4.096\sin 55^0$ = -3.35 Therefore total current,I = $\sqrt{□^2 + □^2}$ =7.176A ***(Equations- 3 marks, Calculations- 4 marks)***	3+4	7	7

XIII	(i) $E_{ph} = \frac{230}{\sqrt{3}} = 132.8\ V$ $Z_{ph} = \sqrt{R_{ph}^2 + X_{ph}^2} = \sqrt{8^2 + 6^2}$ $= 10\ \Omega$ $I_{ph} = \frac{E_{ph}}{Z_{ph}} = 13.28\ A$ Line current, $I_L = I_{ph} = 13.28\ A$ $cos\ \emptyset = \frac{R_{ph}}{Z_{ph}} = 0.8\ lag$ (ii) Power = $\sqrt{3}\ E_L I_L cos\ \emptyset = 4232\ W$ (iii) $\phi = \cos^{-1} 0.8$ Reactive Power $= \sqrt{3}\ E_L I_L Sin\emptyset = 3174\ VAr$ ***(Equations- 3 marks, Calculations- 4 marks)***	3+4	7	7

XIV	 Let $I_R = I_Y = I_B = I_{ph}$ be the phase values of currents Let $I_{L1} = I_R - I_B = I_R + (-I_B)$ be the line value of current By parallelogram law method, $I_{L1} = \sqrt{(I_{ph}^2 + I_{ph}^2 + 2 * I_{ph}^2 * \cos 60)}$ $= \sqrt{3 I_{ph}^2} = \sqrt{3} * I_{ph}$, $\cos 60^0 = 0.5$ ie. Line current $= \sqrt{3}$ phase current ***(Diagram- 3 marks, Derivation- 4 marks)***	3+4	7	7

Module wise question analysis

Question No	**Module**				**No of questions**
	I	**II**	**III**	**IV**	
Part A (1 Mark)	2	3	2	2	9
Part B (3 Marks)	2	3	2	3	10
Part C (7 Marks)	4	4	2	2	12
Total questions	**8**	**10**	**6**	**7**	**31**
Total (Marks)=123	**36**	**40**	**22**	**25**	

Cognitive level wise question analysis

Question No	**Cognitive level**			**No of questions**
	Remember	**Understanding**	**Apply**	
Part A (1 Mark)	2	7	0	9
Part B (3 Marks)	3	3	4	10
Part C (7 Marks)	0	4	8	12
Total questions	**5**	**14**	**12**	**31**
Total (Marks)=123	**11**	**44**	**68**	

Prepared By :	Scrutinised By :
Jayaram S Head Of Department Electrical & Electronics Engineering Govt. Polytechnic College Attingal	Binu B. R Head Of department Electrical & Electronics Engineering Govt. Polytechnic College, Pala

Model Question Paper II

FUNDAMENTALS OF ELECTRIC CIRCUITS

Time: 3 Hour *Max.Marks: 75*

PART A

I. Answer **all** questions in one word or one sentence. Each question carries 1 mark.

1	A circuit with no source of emf is called ……	M 1.01	U
2	Write any passive parameters in an electric circuit.	M 1.01	R
3	A node in a circuit is the meeting of ……	M 1.01	U
4	Write the format of trigonometric form…	M 2.01	U
5	Equation of alternating voltage is ….	M 2.02	R
6	Q factor of an RLC parallel circuit is ……………	M 3.04	U
7	Resonance in an RLC parallel circuit occurs when ….	M 3.04	U
8	Define phase sequence in a three phase system	M 4.01	R
9	Write the relation between line and phase values of current in delta connected system	M 4.02	U

PART B

II. Answer any **eight** questions from the following, each question carries 3 marks.
(8 * 3=24 marks)

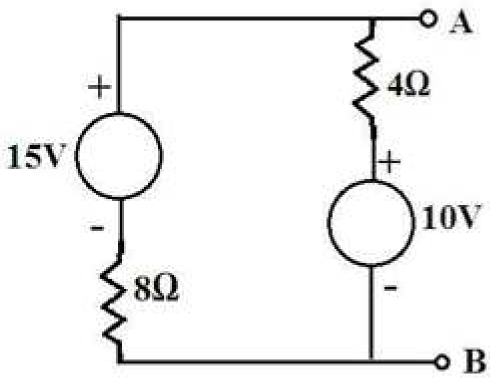
1	Define the terms (i) active circuit (ii) loop (iii) linear network	M 1.01	R
2	State superposition theorem.	M 1.02	R
3	Derive the equation of power in a pure capacitive circuit.	M 2.01	U
4	Draw the vector and impedance diagrams of an R-L-C series circuit for X_L greater than X_C	M 2.02	U
5	Find the magnitude and slope of two vectors for A+B, where	M 2.01	A

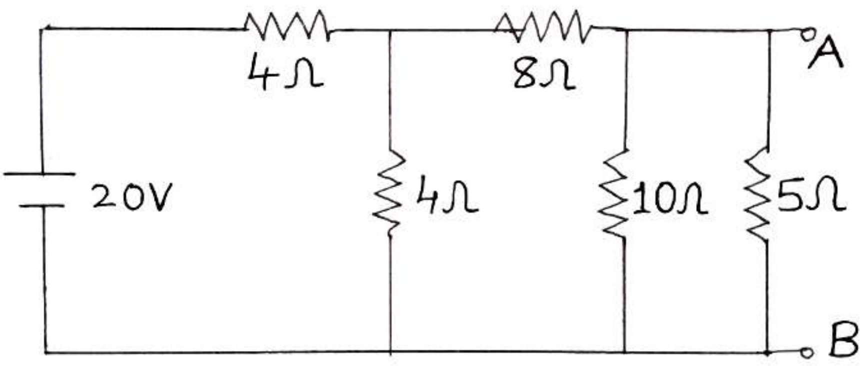
	A=6+j8, B=3-j4.		
6	Define the terms in a parallel circuit (a)Admittance (b)Resonance.	M 3.02 M 3.04	R
7	Write the procedure of vector method in parallel circuits .	M 3.02	U
8	Compare the line and phase quantities in a delta system.	M 4.02	U
9	How star and delta connections are formed in three phase system	M 4.02	U
10	Derive the equation of active power in three phase systems.	M 4.04	U

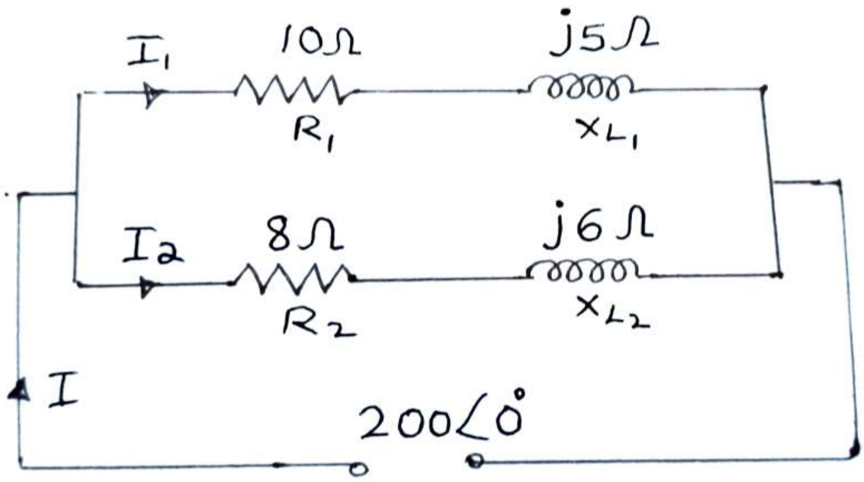
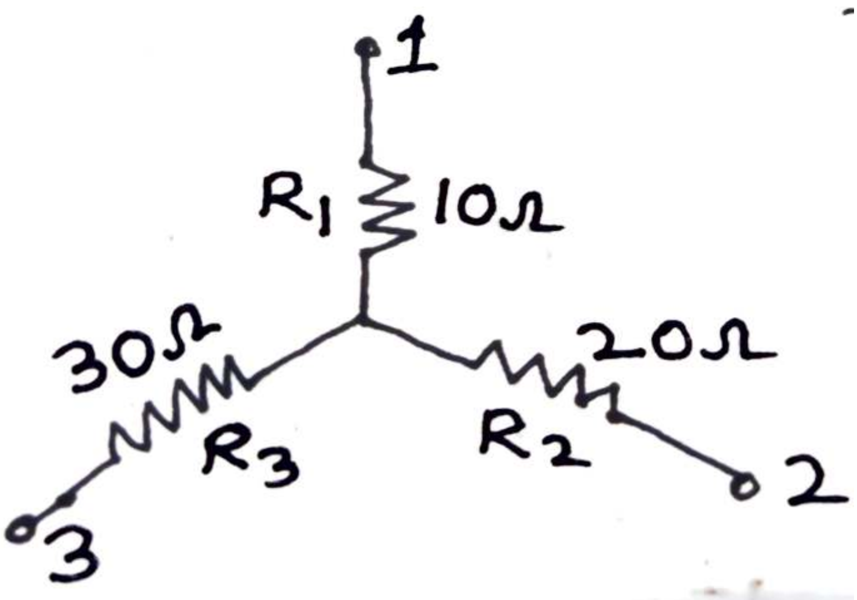
PART C

Answer ALL questions. Each question carries 7 marks.

(6*7=42 marks)

III	Convert the given circuit to a single voltage source in series with a single resistance . 	M 1.04	A
	OR		

IV	By Norton's theorem, find the current flowing through 5 ohm resistor.  	M 1.04	A
V	Write the procedure to Nortanize a given circuit.	M 1.03	U
	OR		
VI	State and explain the theorems (a)Maximum power transfer theorem (b) reciprocity theorem	M 1.02	U
VII	Define and derive resonance frequency in an RLC series circuit .	M 2.04	U
	OR		
VIII	Derive the equation of active power in an R-C series circuit	M 2.02	U
IX	A circuit consists of two branches connected in parallel across a 100V, 50Hz supply. Branch-1-a resistor of 200 Ω, Branch-2- a 50 Ω resistor in series with a 30μF capacitor. Calculate the branch currents and total current.	M 3.03	A
	OR		
X	Draw the vector diagram of the given circuit .	M 3.03	A

			
XI	For the given star system , find the equivalent values in delta system 	M 4.03	A
	OR		
XII	With the help of a vector diagram derive the relation between line and phase values of voltage in a star connected system.	M 4.02	A
XIII	Explain with a diagram the generation of three phase ac voltages.	M 4.01	U
	OR		
XIV	Write any seven comparisons between star and delta systems.	M 4.02	U

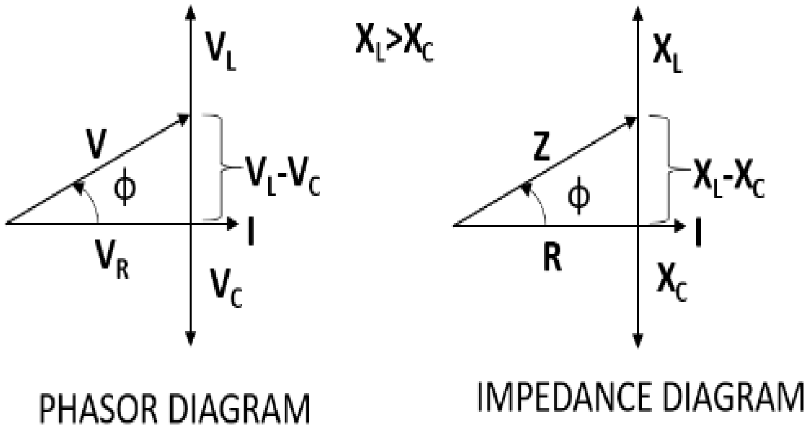
Scoring Indicators

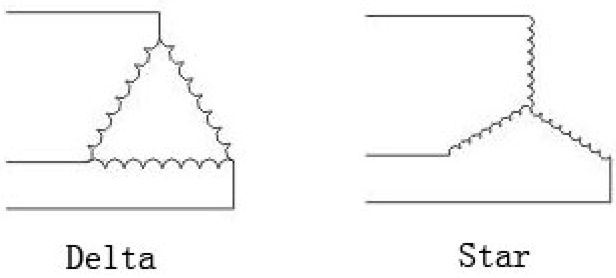
Model Question Paper II

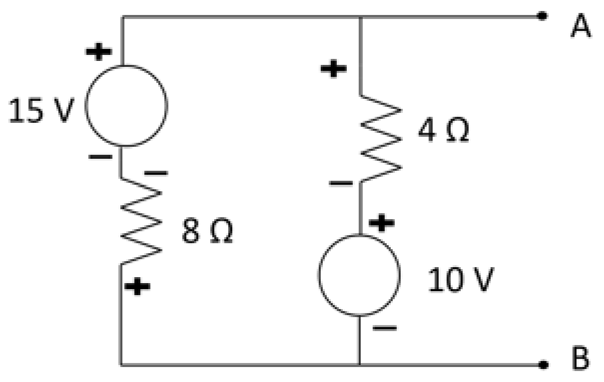
FUNDAMENTALS OF ELECTRIC CIRCUITS

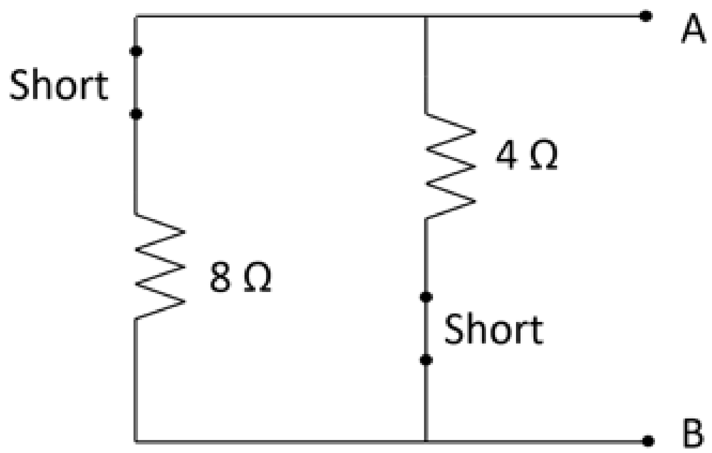
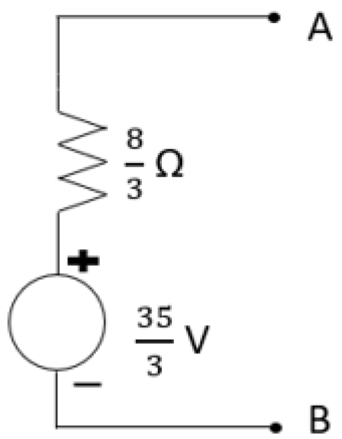
Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			
I. 1	Passive circuits		1	9
I. 2	Resistor, Capacitor, Inductor *(write any one)*		1	
I. 3	Two or more branches of elements		1	
I. 4	A vector, E= E(cosΘ + j sinΘ), where E-magnitude and Θ-inclination		1	
I. 5	$V = V_m\ Sin\omega t$		1	
I. 6	$Q\ factor = \frac{I_C}{I}$ $Also$ $Q\ factor = \frac{X_L}{R}$ **Q-factor-** Current magnification in an RLC parallel circuit is called its Q-factor		1	
I. 7	the reactive components of the line current becomes zero		1	
I. 8	Phase sequence is the order or sequence in which the current or voltage in different phases attain their maximum values one after the other		1	

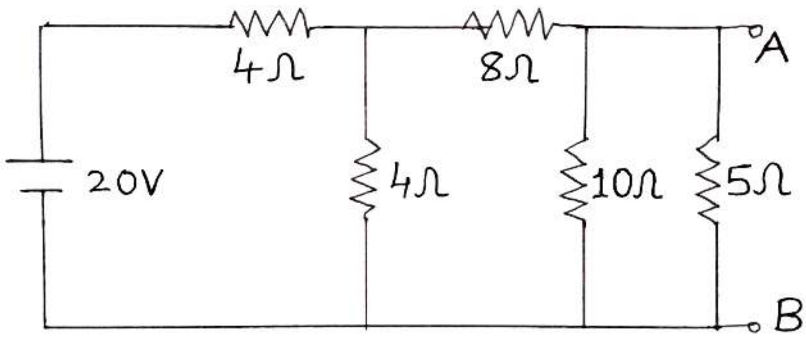
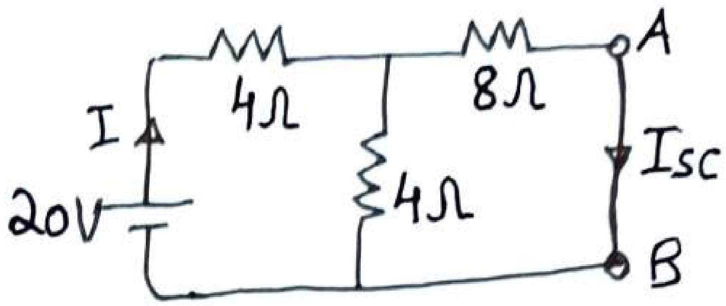
I. 9	$I_L = \sqrt{3}\ I_P$		1	
	PART B			
II. 1	(i) **Active circuit** -is one which contains one or more than one source of emf along with passive elements	1	3	
	(ii) Loop -is a closed path formed starting from a node passing through a set of nodes and returning to the starting node without passing the same node more than once.	1		
	(iii) Linear network- is a circuit whose parameters are constant with time ,also they do not change with voltage or current.	1		
II. 2	**<u>Superposition Theorem</u>** In a network of linear resistances containing more than one source of emf, the current which flows at any point is the sum of all the currents which would flow at that point if each emf where considered separately and all the other emfs replaced by their internal resistances		3	
II. 3	**<u>Pure capacitive circuit.</u>** Instantaneous power $p = vi$ $p = V_m \sin\omega t\ \ I_m \sin(\omega t + 90)$ $= V_m I_m \sin\omega t\ \cos\omega t$ $= \frac{V_m I_m}{2} \sin 2\omega t$ Since the above equation consists of a double frequency component, the value will be zero if we integrate the equation for the whole cycle . ie; Power =0 ***(Each main step carries 0.5 mark)***		3	

II. 4		1.5+ 1.5	3	
II. 5	**A+B = 6 + j8 + 3- j4 = 9 + j4** $Magnitude = \sqrt{9^2 + 4^2} = 9.85\ units$ $Slope = \tan^{-1}\frac{4}{9} = 23.96^o$	1+ 1+ 1	3	
II. 6	a) **Admittance**, Y is the reciprocal of impedance	1.5	3	
	a) **Resonance** – When the reactive component of the line current becomes zero. The frequency at this condition is called resonance frequency	1.5		
II. 7	<u>**Procedure for vector method**</u> 1.Voltage is taken as reference vector 2.Each branch current and its phase angle are determined separately 3.The resultant current is obtained by adding the branch currents vectorially	3	3	
II. 8	$V_L = V_P$ $I_L = \sqrt{3}\ I_P$	1.5 + 1.5	3	
II.9		1.5 + 1.5	3	

	Star connection-this connection is obtained by joining together similar ends at common point. **Delta connection**- this connection is obtained by joining the dissimilar ends.That is the starting end of one coil is connected to the finishing end of the other coil and so on.  				
II.10	<u>**Active power in three phase system**</u> $Power\ output\ per\ phase\ = E_{ph}\, I_{ph} \text{Cos}\, \emptyset$ $Total\ power\ output\ = 3E_{ph}\, I_{ph} \text{Cos}\, \emptyset$ $if\ the\ load\ is\ star\ connected\ \ then$ $E_{ph} = \frac{E_L}{\sqrt{3}}$ $I_{ph} = I_L$ $Total\ power\ or\ Active\ power\ = 3\ \frac{E_L}{\sqrt{3}}\ I_L \cos \emptyset$ $= \sqrt{3}\, E_L\, I_L \cos \emptyset$ ***(Each main step carries 0.5 mark)***			3	
	PART C				

	Convert the given circuit to a single voltage source in series with a single resistance .			
				
III	**Step 1 : To find V_{th} or V_{AB}** With A and B open ,the voltage sources are in subtractive series because they oppose each other. Net voltage around the circuit =15-10 = 5V Total resistance=8+4=12Ω hence circuit current = 5/12 A Drop across 4Ω = 4x 5/12 = 5/3 V Thevenin's voltage, V_{AB} =(voltage across 4Ω) +10V = 5/3+10= 35/3 V	2.5	7	7

	Step 2: To find R_{th} or R_{AB} Replace all voltage sources with ' shorts ' as shown  Rth = $8 \times 4/(8+4) = 32/12 = 8/3\ \Omega$	2.5		
	Step 3 : Thevenin's Equivalent Circuit 	2		
IV	By Norton's theorem, find the current flowing through 5 ohm		7	

	resistor  			
	Step 1: Remove the 5 ohm resistor and put a short circuit across it . Here the 10 ohm resistor as a result becomes short circuited  	1		
	Step 2: To find I_{sc} or I_N Total resistance from Battery side = 4 + 4//8 $= 4 + \left(4 + \frac{4x8}{4+8}\right)$ $= \frac{20}{3}\Omega$	2		

<table>
<tr>
<td></td>
<td>Battery current

$$I = \frac{20}{20/3} = 3\ A$$
Hence by current division rule

$$I_{sc} = I_N = I * \frac{4}{4+8} = 3 * \frac{4}{4+8} = 1A$$</td>
<td></td>
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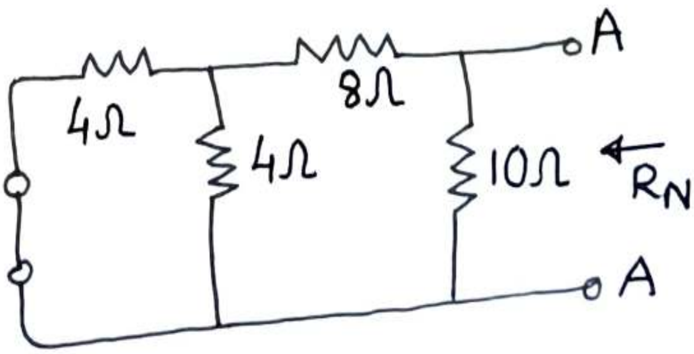
<td>Step3 .

To find RN

Voltage source is shorted



$$R_N = ((4 /\!/ 4) + 8) /\!/ 10$$
$$= \left(\frac{4 \times 4}{4+4} + 8\right) /\!/ 10$$
$$= 10 /\!/ 10 = \frac{10}{2} = 5\Omega$$</td>
<td>2</td>
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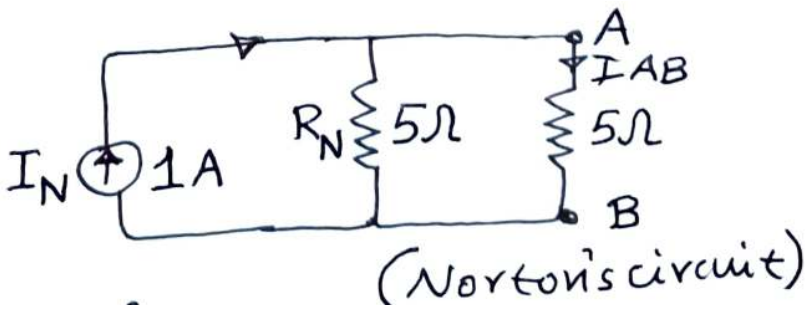
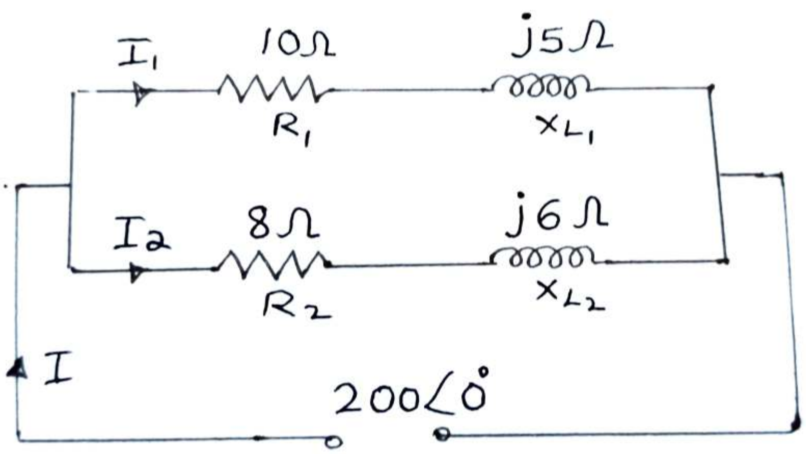
</table>

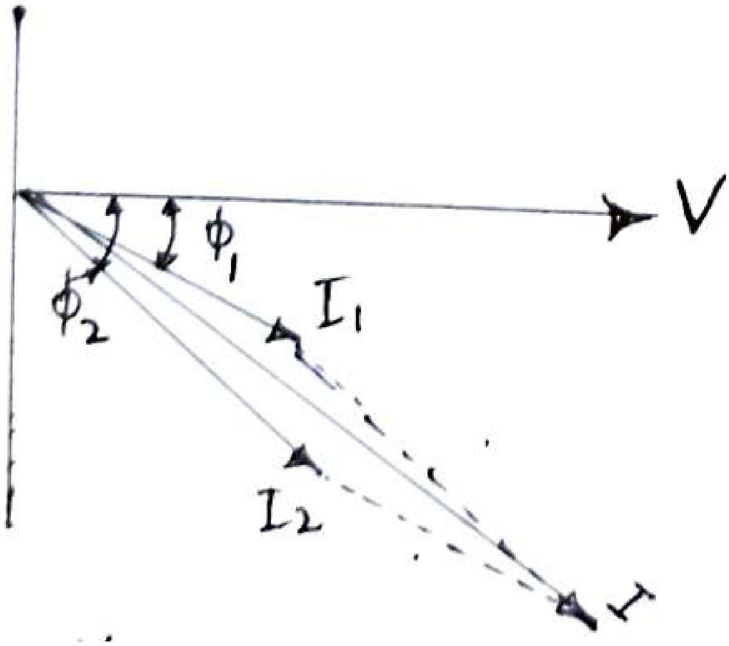
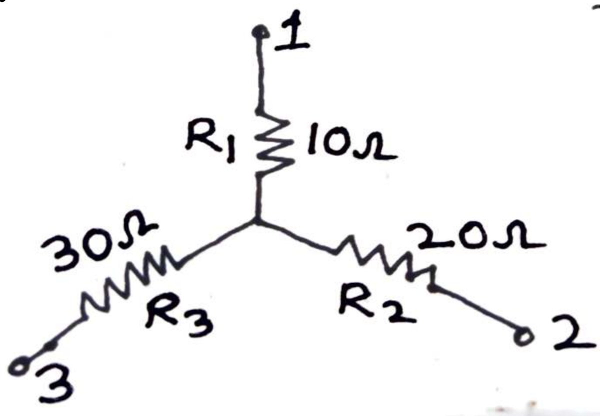
	Step 4 Obtain Norton's equivalent circuit by re-connecting 5 ohm resistor across terminals A and B 	1		
	Step 5 By current division rule , current through 5 ohm resistor **,** = $IAB = 1 \times \frac{5}{5+5} = \underline{\underline{0.5A}}$	1		
V	<u>**Procedure to Nortonize a given circuit.**</u> 1. Remove the resistance (if any) across the two given terminals and put a short- circuit across them 2. Compute the short circuit current 3. Remove all voltage and current sources 4. Find Norton's resistance 5. Join the current source in parallel across the Norton's resistance 6. Complete the equivalent circuit	7	7	7
VI	**a)Maximum power transfer theorem** A resistive load will abstract maximum power from a network when the load resistance is equal to the resistance of the network as viewed from the output terminals with all energy sources(emfs) removed with their internal resistances	3.5	7	7

	b)Reciprocity theorem In any linear bilateral network, if a source of emf, E in any branch produces a current I in any other branch, then the same emf E acting in the second branch would produce the same current I in the first branch	3.5		
VII	**Resonance frequency in RLC series circuit-** is defined as the frequency at which electrical resonance happens.	2	7	7
	At resonance the net reactance X = 0. $X_L - X_c = 0$ $X_L = X_c$ $2\pi f_r L = \frac{1}{2\pi f_r C}$ $f_r = \frac{1}{2\pi\sqrt{LC}}$	5		
VIII	Derive the equation of active power in an R-C series circuit			
	$if\ v = V_m \sin \omega t$ $i = I_m \sin \omega t + \phi$ $Power\ p = vi$ $p = V_m \sin \omega t\ \ I_m \sin(\omega t + \phi)$ $= V_m I_m \left[\frac{1}{2}\{\cos(\omega t - \omega t - \phi) - \cos(\omega t + \omega t + \phi)\}\right]$ $= \frac{V_m I_m}{2}[\cos(-\phi) - Cos\ 2\omega t + \phi]$ $= \frac{V_m I_m}{2}[\cos \phi - Cos\ 2\omega t + \phi]$	7	7	7

	Average value of double frequency component $Cos\ 2\omega t + \phi$ over a complete cycle is Zero $P = \frac{V_m I_m}{2}[\cos\phi]$ $= \frac{V_m}{\sqrt{2}}\frac{I_m}{\sqrt{2}} cos\phi$ $= V_{rms}\, I_{rms}\, cos\phi$ ***(Each main step -1 mark each)***			
IX	A circuit consists of two branches connected in parallel across a 100V, 50Hz supply. Branch-1-a resistor of 200 Ω, Branch-2- a 50 Ω resistor in series with a 30μF capacitor. Calculate the branch currents and total current.			
	For branch I $I_1 = V/R = 100/200 = 0.5$ A $\text{Cos } \emptyset = 1, \emptyset = 0°$	2		
	For branch II $XC = 1/2\pi f\, C = 106.33\ \Omega$ $Z_2 = \sqrt{{R_2}^2 + {X_C}^2}$ $= 117.3\ \Omega$ $I_2 = V/Z_2 = 100/117.3 = 0.853$ A $\emptyset_2 = \cos^{-1}\frac{R_2}{Z_2}$ $\emptyset_2 = \cos^{-1}\frac{50}{117.3}$ $\emptyset 2 = 64.77°$	2		

	Total X components $= 0.5*\cos 0° + 0.853* \cos 64.77° = 0.8634$ Total Y components $= 0.5*\sin 0° + 0.853* \sin 64.77° = 0.772$ Total Current, $I = \sqrt{X^2 + Y^2}$ $= 1.158$ A	1+ 1+ 1		
X	Draw the vector diagram of the given circuit .  		7	7

	For Branch 1 $Z_1 = \sqrt{R_1^2 + X_{L1}^2}$ $= \sqrt{10^2 + 5^2} = 11.18\ \Omega$ $I_1 = \frac{V}{Z_1} = \frac{200}{11.18} = 17.9\ A = 18\ A$ $Phase\ angle = \phi_1 = \cos^{-1}\left(\frac{R_1}{Z_1}\right)$ $= \cos^{-1}\left(\frac{10}{11.18}\right) = 26.56^0$	1+ 0.5+ 1		
	For branch 2 $Z_2 = \sqrt{R_2^2 + X_{L2}^2}$ $= \sqrt{8^2 + 6^2} = 10\Omega$ $I_2 = \frac{V}{Z_2} = \frac{200}{10} = 20\ A$ $Phase\ angle = \phi_2 = \cos^{-1}\left(\frac{R_2}{Z_2}\right)$ $= \cos^{-1}\left(\frac{8}{10}\right) = 36.87^0$	1+ 0.5+ 1		

		2			
XI	For the given star system , find the equivalent values in delta system 				

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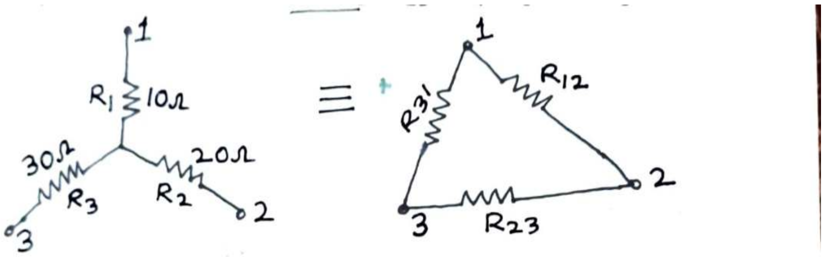
<td>
We know, $R_{12} = R_1 + R_2 + \frac{R_1 R_2}{R_3}$
$= 10 + 20 + \frac{10 \times 20}{30} = 36.67\Omega$
$R_{23} = R_2 + R_3 + \frac{R_2 R_3}{R_1} = 20 + 30 + \frac{20 \times 30}{10} = 110\Omega$
$R_{31} = R_1 + R_3 + \frac{R_1 R_3}{R_2} = 10 + 30 + \frac{10 \times 30}{20} = 55\Omega$
(Figure -1 mark
Calculations- 2 marks each)</td>
<td>1+
2+
2+
2</td>
<td>7</td>
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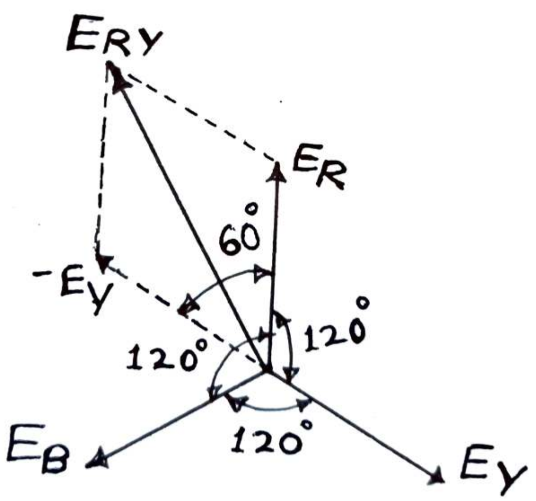
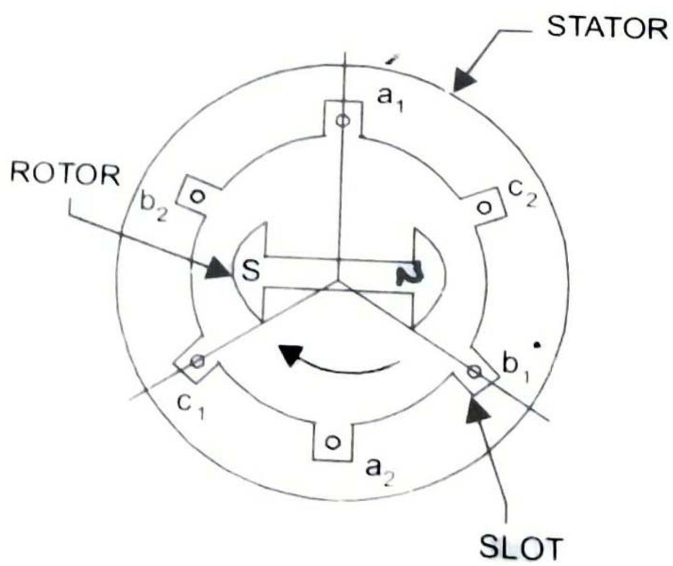
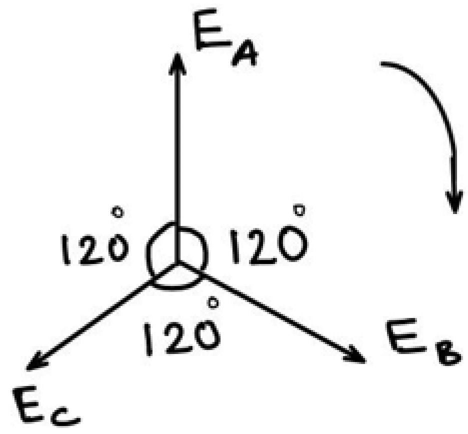
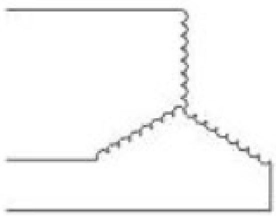
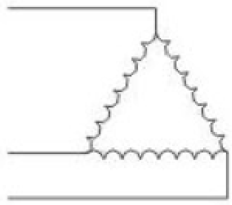
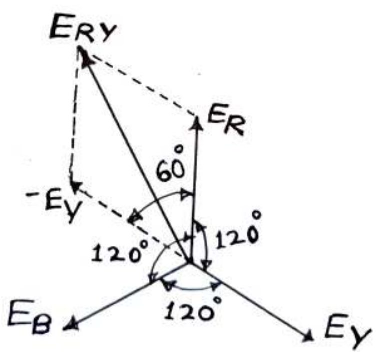
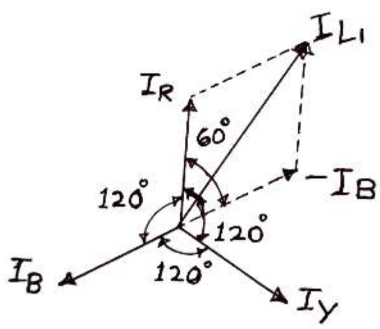
<tr>
<td>XII</td>
<td>
Let $E_R = E_Y = E_B = E_{ph}$ are the phase values of voltage
Let $E_{RY} = E_L$ be the line value of voltage

By parallelogram law method,
$E_{RY} =$
$\sqrt{(E_{ph}^2 + E_{ph}^2 + 2 * E_{ph}^2 * \cos 60)}$
ie , $E_L = \sqrt{3E_{ph}^2} = \sqrt{3} * E_{ph}$
(Diagram-1 mark,
For each main step -1 mark)</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</table>

<table>
<tr><td rowspan="4">XIII</td><td>A 2-pole alternator has three distinct windings displaced by 120° apart from one another. When the N-pole of the rotor comes under the influence of the conductors at 0°,120° and 240°, the emf's induced are maximum. The emf's are equal in magnitude and of same frequency</td><td>2.5</td><td rowspan="4">7</td><td rowspan="4">7</td></tr>
<tr><td></td><td>2.5</td></tr>
<tr><td></td><td>1</td></tr>
<tr><td>$e_{a1} = E_m \sin \omega t$
$e_{b1} = E_m \sin(\omega t - 120^0)$
$e_{c1} = E_m \sin(\omega t - 240^0)$</td><td>1</td></tr>
<tr><td>XIV</td><td><u>Comparisons between star and delta systems</u></td><td></td><td></td><td></td></tr>
</table>

Star Connection	Delta connection
Differences	
Open system	Closed system
 This connection is obtained by joining together similar ends at common points.	 This connection is obtained by joining the dissimilar ends.
Suitable for 3 phase , 4 wire distribution system	Suitable for 3 phase , transmission system
Neutral point is available	Not available
$V_L = \sqrt{3}\ V_P$	$V_L = V_P$
$I_L = I_P$	$I_L = \sqrt{3}\ I_P$
	
Line voltages are displaced 30 degrees ahead of phase voltages	Line currents are displaced 30 degrees behind phase currents
Similarities	

7 * 1 mark	7

Line currents or phase currents are 120 degree apart	Line voltages or phase voltages are 120 degree apart
$Active\ power = \sqrt{3}\ V_L I_L\ \cos\phi$	$Active\ power = \sqrt{3}\ V_L I_L\ \cos\phi$
$Rective\ power = \sqrt{3}\ V_L I_L\ \sin\phi$	$Rective\ power = \sqrt{3}\ V_L I_L\ \sin\phi$
$Apparent\ \ power = \sqrt{3}\ V_L I_L$	$Apparent\ \ power = \sqrt{3}\ V_L I_L$

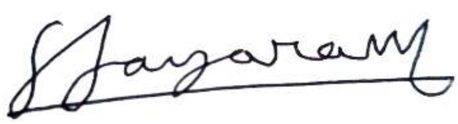
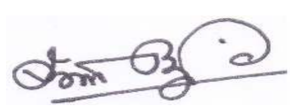
(Write any 7 comparisons)

Module wise question analysis

Question No	Module				No of questions
	I	II	III	IV	
Part A (1 Mark)	3	2	2	2	9
Part B (3 Marks)	2	3	2	3	10
Part C (7 Marks)	4	2	2	4	12
Total questions	**9**	**7**	**6**	**9**	**31**
Total (Marks)=123	**37**	**25**	**22**	**39**	

Cognitive level wise question analysis

Question No	Cognitive level			No of questions
	Remember	Understand	Apply	
Part A (1 Mark)	3	6	0	9
Part B (3 Marks)	3	6	1	10
Part C (7 Marks)	0	6	6	12
Total questions	**6**	**18**	**7**	**31**
Total (Marks)=123	**12**	**66**	**45**	**123**

Prepared By :	Scrutinised By :
 Jayaram S Head Of Department Electrical & Electronics Engineering Govt. Polytechnic College Attingal	 Binu B. R Head Of Department Govt. Polytechnic College Pala