VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

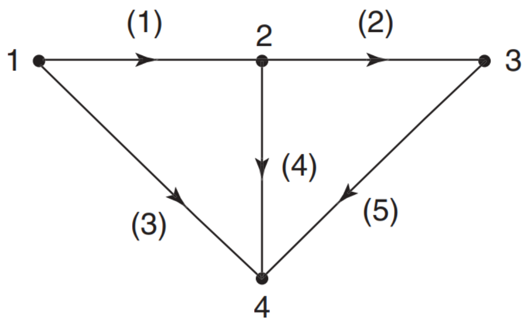
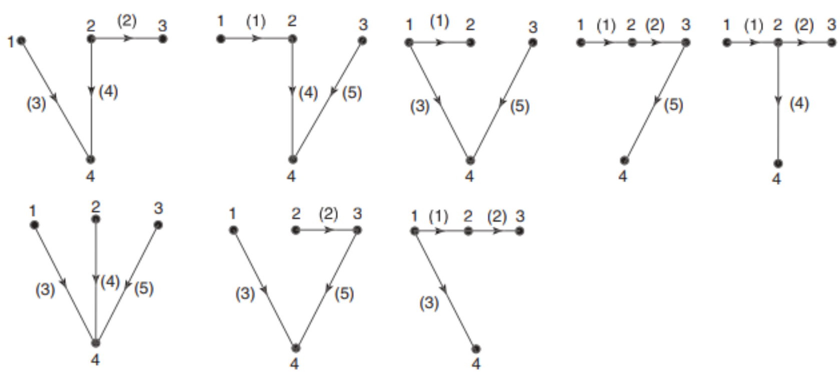
Vellore – 632014, Tamil Nadu, India

SCHOOL OF ELECTRICAL ENGINEERING
FALL SEMESTER 2025-2026
CAT-I

SLOT: A2+TA2+TAA2

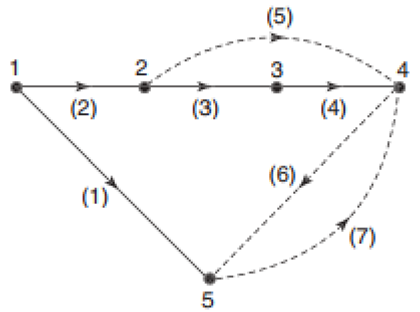
Programme Name & Branch:	**B.Tech (EEE,BECS & EIE)**	Course Code:	**BEEE203L**
Course Name:	**Circuit Theory**	Class Number(s):	
Faculty Members:	**Dr. Vijayakumar D, Dr. Janaki M, Dr. Belwin Edward**	Duration:	**90 Mins**
Date of the Examination:		Max. Marks:	**50**

General Instructions: Answer all the questions

Q. No	Questions	Marks	CO	BL
1.	a). Figure below shows a graph of the network. Show all the tress of this graph.   b). Draw the oriented graph from the complete incidence matrix given below.	5+5		

<table>
<tr>
<td></td>
<td>

$$A = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & -1 & 1 & -1 \end{bmatrix}$$



</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>

For the network shown in figure below, draw the oriented graph and write the (a) incident matrix (b) tie-set matrix and (c) f-cutset matrix.

$$\text{Incidence matrix} = \begin{matrix} 1 & -1 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & -1 \\ -1 & 0 & 1 & 0 & 0 & 1 \end{matrix}$$

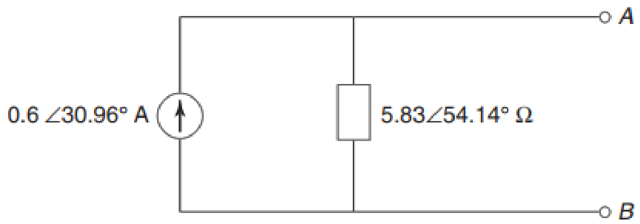
$$B = \begin{matrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & -1 & 0 & -1 \\ 0 & 0 & 1 & 0 & -1 & 1 \end{matrix}$$

$$U = \begin{matrix} -1 & 1 & 0 & 1 & 0 & 0 \\ -1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & -1 & 0 & 0 & 1 \end{matrix}$$

</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>

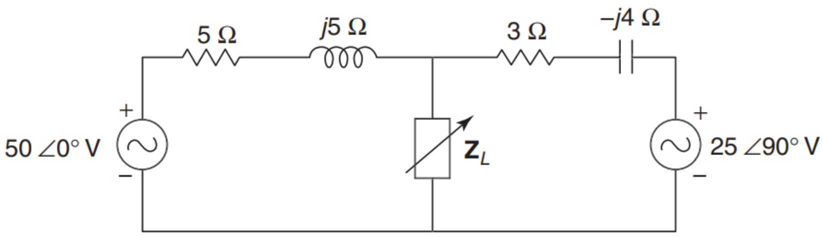
Obtain the current I_o in the figure below using Norton's theorem.

Norton's Equivalent Network (Fig. 3.142)



</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>

In the network shown in figure below, what load Z_L will receive the maximum power using Millman's theorem. Also find maximum power.



</td>
<td></td>
<td></td>
<td></td>
</tr>
</table>

Solution

Step I Calculation of $\mathbf{V}_m$

$$\mathbf{V}_m = \frac{\mathbf{V}_1\mathbf{Y}_1 + \mathbf{V}_2\mathbf{Y}_2}{\mathbf{Y}_1 + \mathbf{Y}_2} = \frac{(50\angle 0^\circ)\left(\frac{1}{5+j5}\right) + (25\angle 90^\circ)\left(\frac{1}{3-j4}\right)}{\frac{1}{5+j5} + \frac{1}{3-j4}} = 9.81\angle -78.69^\circ \text{V}$$

Step II Calculation of $\mathbf{Z}_m$

$$\mathbf{Z}_m = \frac{1}{\mathbf{Y}_m} = \frac{1}{\mathbf{Y}_1 + \mathbf{Y}_2} = \frac{1}{\frac{1}{5+j5} + \frac{1}{3-j4}} = 4.39\angle -15.26^\circ\ \Omega = (4.23 - j1.15)\ \Omega$$

Step III Calculation of $\mathbf{Z}_L$

For maximum power transfer $\mathbf{Z}_L = \mathbf{Z}^*_{\text{Th}} = (4.23 + j1.15)\ \Omega$

Step IV Calculation of P_{max} (Fig. 3.196)

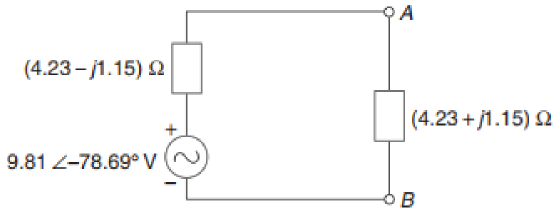
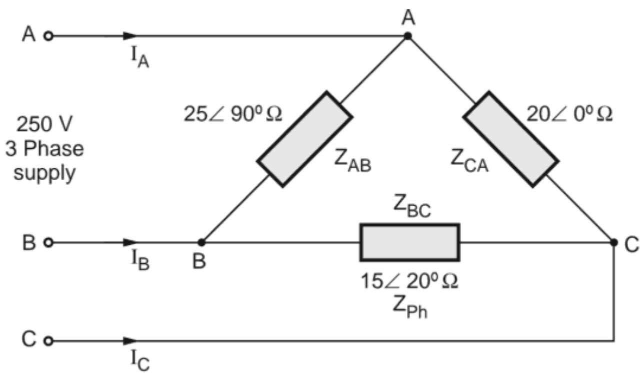


Fig. 3.196

$$P_{\text{max}} = \frac{|\mathbf{V}_m|^2}{4R_L} = \frac{(9.81)^2}{4 \times 4.23} = 5.69 \text{ W}$$

5. A 3-phase supply with the line voltage of 250 V has an unbalanced delta connected load shown in figure below. Determine the line current, total active and reactive power if phase sequence is ABC.



$\overline{V}_{BC} = 250\angle{-120^\circ}$ V, **Fig. 1.8.13**

$\overline{V}_{CA} = 250\angle 120^\circ$ V

$$Z_{AB} = 25\angle 90^\circ\ \Omega = 0 + j\,25\ \Omega$$

$$Z_{BC} = 15\angle 20^\circ\ \Omega = 14.09 + j\,5.13\ \Omega,$$

$$Z_{CA} = 20\angle 0^\circ\ \Omega = 20 + j\,0\ \Omega$$

The phase current are given by,

$$\bar{I}_{AB} = \frac{\overline{V}_{AB}}{Z_{AB}} = \frac{250\angle 0^\circ}{25\angle 90^\circ} = 10\angle{-90^\circ}\ \text{A} = (0 - j\,10)\ \text{A}$$

$$\bar{I}_{BC} = \frac{\overline{V}_{BC}}{Z_{BC}} = \frac{250\angle{-120^\circ}}{15\angle 20^\circ} = 16.67\angle{-140}\ \text{A} = (-12.76 - j\,10.71)\ \text{A}$$

$$\bar{I}_{CA} = \frac{\overline{V}_{CA}}{Z_{CA}} = \frac{250\angle 120^\circ}{20\angle 0^\circ} = 12.5\angle 120^\circ\ \text{A} = (-\,6.25 + j\,10.82)\ \text{A}$$

The line currents are given by,

$$\bar{I}_A = \bar{I}_{AB} + \bar{I}_{CA} = (0 - j\,10) + (-\,6.25 + j\,10.82)$$

$$= -6.25 + j\,0.82 = \mathbf{6.30\angle 172.52^\circ\ A}$$

$$\bar{I}_B = \bar{I}_{BC} + \bar{I}_{AB} = (-\,12.76 - j\,10.71) + (0 - j10)$$

$$= -12.76 - j\,20.71 = \mathbf{24.32\angle{-121.63^\circ}\ A}$$

$$\bar{I}_C = \bar{I}_{CA} + \bar{I}_{BC} = (-\,6.25 + j\,10.82) + (-12.76 - j\,10.71) = -\,19.01 + j\,0.11$$

$$= \mathbf{19.01\ \angle\ 179.66\ A^\circ}$$

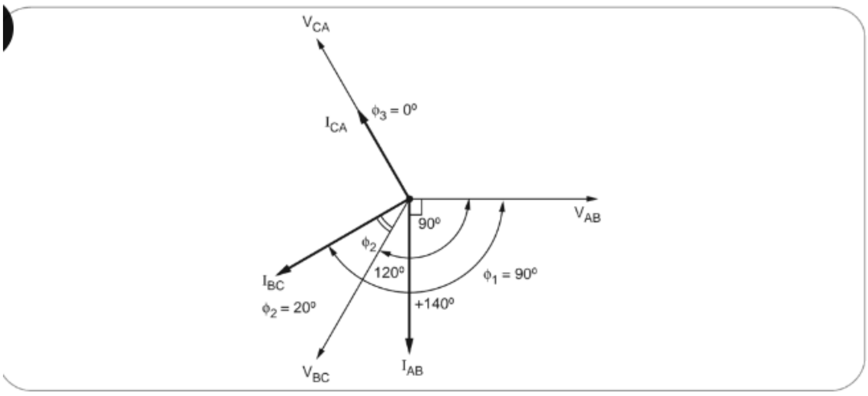


Fig. 1.8.13 (a)

Total active power $= V_{AB} \cdot I_{AB} \cos (V_{AB}\ \hat{}\ I_{AB}) + V_{BC} \cdot I_{BC} \cos (V_{BC}\ \hat{}\ I_{BC}) + V_{CA} \cdot I_{CA} \cos (V_{CA}\ \hat{}\ I_{CA})$

$= (250)\,(10) \cos (+90^\circ) + (250)\,(16.67) \cos(+20^\circ) + (250)\,(12.5) \cos (0^\circ)$

$= 0 + 3916.16 + 3125 = 7041.16$ W $= 7.0\,4$ kW

Total reactive power $= V_{AB} \cdot I_{AB} \sin (V_{AB}\ \hat{}\ I_{AB}) + V_{BC} \cdot I_{BC} \sin (V_{BC}\ \hat{}\ I_{BC}) + V_{CA} \cdot I_{CA} \sin (V_{CA}\ \hat{}\ I_{CA})$

$= (250)\,(10) \sin (+90^\circ) + (250)\,(16.67) \sin (20^\circ) + (250)\,(12.5) \sin (0^\circ)$

$= 2500 + 1425.36 = 3925.36$ VAR $=$ **3.925 kVAR**