MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

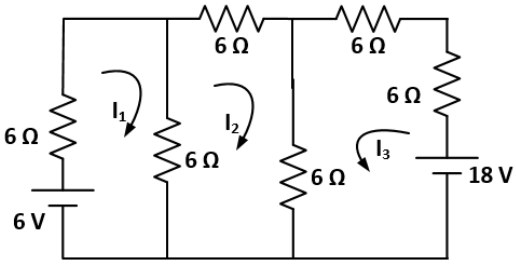
Mid Semester Test – Answer Scheme	
Course: Fundamentals of Electrical Engineering	**Date & Time:** 7 March 2025, 04:30 – 06:00 PM
Course Code: ELE 1072	

Part A – Objective Questions

1. **C**. 63.2, final
2. **B.** (6.5 – j18.9) Ω
3. **A.** 100 V
4. **B.** K
5. **C.** 90°

Part B – Descriptive Questions

6. The circuit is redrawn as shown:



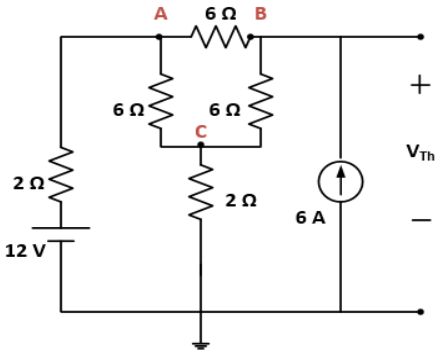
$$\begin{bmatrix} 12 & -6 & 0 \\ -6 & 18 & 6 \\ 0 & 6 & 18 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 6 \\ 0 \\ 18 \end{bmatrix}$$ ---------- 3x1 = 3 marks

Solving we get, $\mathbf{I_1 = 0.3846\ A}$ ---------- 1 mark

$\therefore \mathbf{P_{6V}} = 6 \times I_1 = \mathbf{2.3076\ W}$ ---------- 1 mark

7. To find V_{Th},

Applying node voltage method,

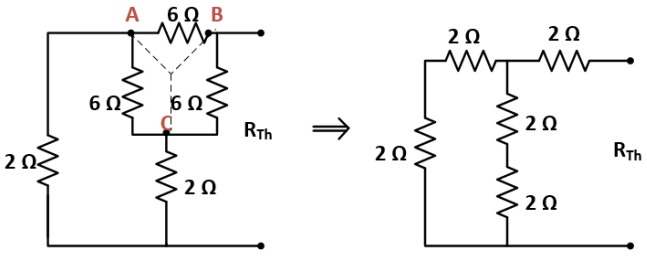


$$\begin{bmatrix} \left(\frac{1}{6}+\frac{1}{6}+\frac{1}{2}\right) & \frac{-1}{6} & \frac{-1}{6} \\ \frac{-1}{6} & \left(\frac{1}{6}+\frac{1}{6}\right) & \frac{-1}{6} \\ \frac{-1}{6} & \frac{-1}{6} & \left(\frac{1}{2}+\frac{1}{6}+\frac{1}{6}\right) \end{bmatrix} \begin{bmatrix} V_A \\ V_B \\ V_C \end{bmatrix} = \begin{bmatrix} 6 \\ 6 \\ 0 \end{bmatrix}$$

---------- 3x0.5 = 1.5 marks

Solving we get, $\mathbf{V_B = V_{Th} = 30\ V}$ ---------- 0.5 mark

To find R_{Th}



$\Rightarrow \mathbf{R_{Th} = 4\ \Omega}$ ---------- 2 marks

$\therefore \mathbf{P_{max}} = \frac{V_{Th}^2}{4R_{Th}} = \mathbf{56.25\ W}$ ---------- 1 mark

8. Voltage leading the current by 45° ⇒ $\angle \mathbf{Z} = \mathbf{45°}$ ---------- **1 mark**

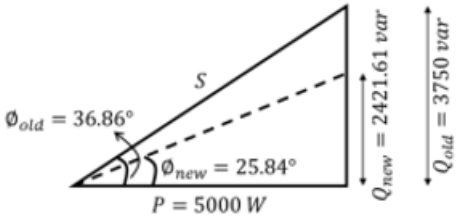
Total impedance = $\mathbf{Z} = \mathrm{R} + (\mathrm{jX_L}||-\mathrm{jX_C}) = \mathbf{R} + \mathbf{j}\frac{\mathbf{X_L X_C}}{\mathbf{X_L - X_C}}$ ---------- **1 mark**

$\therefore 45 = \tan^{-1}\left(\frac{X_L X_C}{R(X_L - X_C)}\right) \Longrightarrow \boldsymbol{X_C = 8.5714\ \Omega}$ ---------- **2 marks**

$\therefore \mathbf{C = 116.66\ \mu F}$ ---------- **1 mark**

9. From the power triangle,

$\tan(\emptyset_{\mathrm{old}}) = \frac{\mathrm{Q_{old}}}{\mathrm{P}} \Rightarrow \mathbf{Q_{old} = 3750\ var}$ ----- **2 marks**



Similarly,

$$\tan(\emptyset_{\mathrm{new}}) = \frac{\mathrm{Q_{new}}}{\mathrm{P}} \Rightarrow \mathbf{Q_{new} = 2421.61\ var}$$

---------- **1 mark**

$\therefore \mathrm{Q_c} = \mathrm{Q_{old}} - \mathrm{Q_{new}} \Rightarrow \mathbf{Q_C = 1328.38\ var}$

---------- **1 mark**

$\mathrm{Q_C} = \frac{\mathrm{V^2}}{\mathrm{X_C}} \Rightarrow \mathbf{X_C = 36.43\ \Omega} \Rightarrow \mathbf{C = 87.36\ \mu F}$

--------- **1 mark**

10. Given, $\overline{\mathrm{V}}_{\mathrm{L}} = 400\angle 0°\ \mathrm{V} \Longrightarrow \mathbf{\overline{V}_{ph} = 230.94\angle -30°\ V}$

$\therefore \hat{\mathrm{Z}} = \frac{230.94\angle -30°}{10\angle -66.86°} \Longrightarrow \boldsymbol{\hat{Z} = 23.09\angle 36.86°\ \Omega}$ ---------- **1 mark**

$\therefore \boldsymbol{R} = |Z|\cos\theta = \mathbf{18.474\ \Omega}$ ---------- **0.5 mark**

$\boldsymbol{X_L} = |Z|\sin\theta = \mathbf{13.85\ \Omega} \Rightarrow \boldsymbol{L = 44.08\ mH}$ ---------- **0.5 mark**

Power factor = $\mathbf{\cos\theta = 0.8\ lagging}$ ---------- **0.5 mark**

$\boldsymbol{P} = 3V_{ph}I_{ph}\cos\theta = \mathbf{5542.56\ W}$ ---------- **1 mark**

$\boldsymbol{Q} = 3V_{ph}I_{ph}\sin\theta = \mathbf{4155.96\ var}$ ---------- **1 mark**

$\boldsymbol{S} = 3V_{ph}I_{ph} = \mathbf{6928.2\ VA}$ ---------- **0.5 mark**