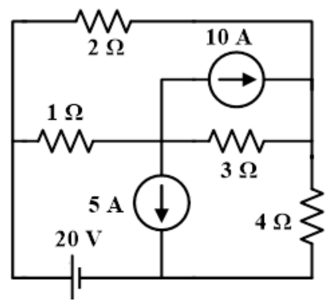
Basic Electrical Technology (ELE 1071)

Part A – Objective Questions

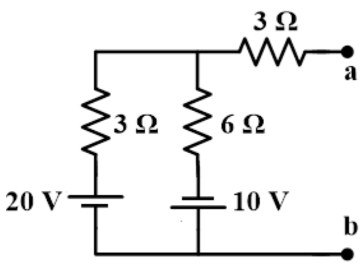
Q. No.	Question	Marks

1 The current in the **2 Ω** resistor when only the **20 V** source is acting alone is: **1**



A. 3.75 A
B. 1.25 A
C. 3.33 A
D. 2.5 A

2 The circuit across terminals **a** and **b** can be represented by a single voltage source (**V_{ab}**) in series with a resistance (**R_{ab}**) with the following values: **1**



A. 10 V and 5 Ω
B. – 30 V and 5 Ω
C. 20 V and 6 Ω
D. – 10 V and 9 Ω

3 A certain **50 Hz** ac circuit draws a current of **(– 5 + j 10) A** when the applied voltage is **(50 + j 200) V**. The power factor of the circuit is: **1**

A. 0.21 Leading B. 0.76 Lagging
C. Zero D. 0.76 Leading

4 Two separate tests were carried out on a coil. First, when the coil is connected to a **48 V dc** supply, the current flowing through the coil was **4 A**. Then, it was connected to **48 V**, **50 Hz ac** supply, and the current flowing was **1.6 A**. The resistance and the inductance of the coil are, respectively: **1**

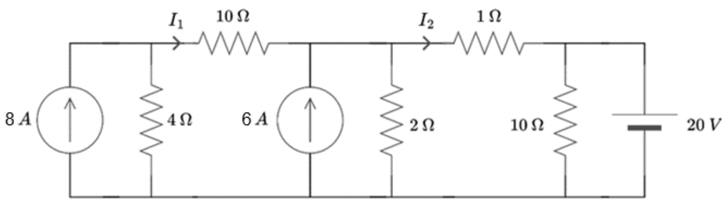
A. 30 Ω and 27.5 H B. 12 Ω and 87.5 mH
C. 12 Ω and 95.5 mH D. 27.5 Ω 38.2 mH

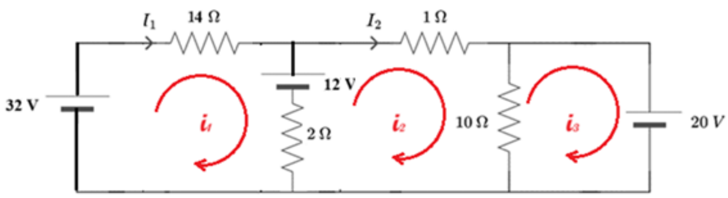
5 A **310 μF** capacitor is connected across a **230 V**, **50 Hz** ac system. With supply voltage as the reference phasor, the equation of the circuit current is: **1**

A. 31.7 sin(314t) A B. 22.4 sin(314t + 90°) A
C. 31.7 sin(314t + 90°) A D. 31.7 sin(314t – 90°) A

Part B – Descriptive Questions

Q. No.	Question	Marks
6	Determine the currents I_1 and I_2 in the given network.	5



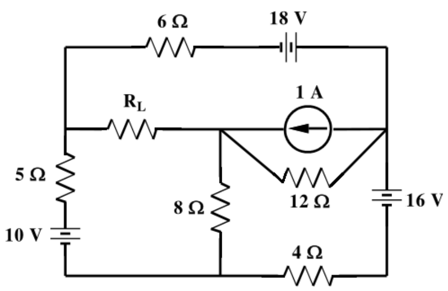


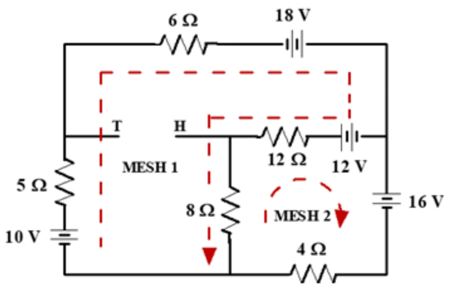
--- 1 M

$$\begin{bmatrix} (14+2) & -2 & 0 \\ -2 & (10+1+2) & -10 \\ 0 & -10 & (10) \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 32-12 \\ 12 \\ -20 \end{bmatrix}$$ --- 3 M

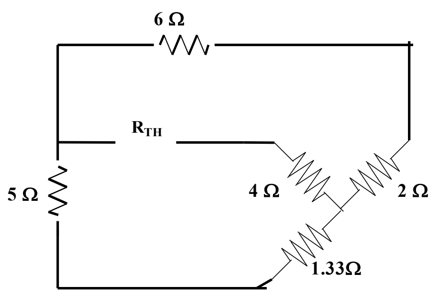
$I_1 = 1\,A$ $\quad I_2 = -2\,A$ $\quad I_3 = -4\,A$ --- 1 M

Q. No.	Question	Marks
7	Obtain the value of load resistance R_L for maximum power dissipation, and then calculate the maximum power.	5





--- 0.5 M



--- 1 M

$$\begin{bmatrix} 31 & -20 \\ -20 & 24 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 40 \\ -28 \end{bmatrix}$$ --- 1.5 M

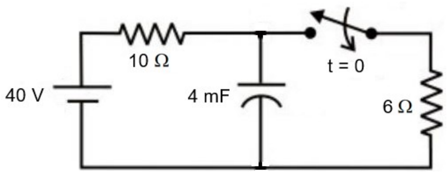
$i_1 = 1.1628\,A$ and $i_2 = -0.1976\,A$ --- 0.5 M

$V_{Th} = -12(i_2 - i_1) - 12 - 18 + 6i_1 = -6.69\,V$ --- 0.5 M

$$R_{Th} = \frac{8 \times 6.33}{8 + 6.33} + 4 = 7.53\,\Omega = R_L$$ --- 0.5 M

$$P_{max} = \frac{(6.69)^2}{4 \times 7.53} = 1.486\,W$$ --- 0.5 M

8 In the given circuit, the switch has been open for a long time and is closed at **t = 0**. Obtain the expression for capacitor voltage for **t > 0**. Determine the time at which the capacitor voltage reaches **25 V**. **4**



$$\mathbf{V_c(0^-) = V_c(0) = V_c(0^+) = 40\ V} \quad --- \ 0.5\ M$$

$$\mathbf{V_c(Final) = V_{6\,\Omega} = \left(\frac{40 \times 6}{10 + 6}\right) = 15\ V} \quad --- \ 0.5\ M$$

$$\mathbf{\tau = [0.004 \times (10 \parallel 6\ (= 3.75))] = 15\ ms} \quad --- \ 1\ M$$

$$\mathbf{v_c(t) \ = 15 + 25\ e^{-66.67\,t}} \quad --- \ 1\ M$$

$$\mathbf{t\ for\ v_c(t) \ = 25\ V \Rightarrow 25 \ = \ 15 + 25\ e^{-66.67\,t}} \quad --- \ 0.5\ M$$

$$\mathbf{t \ = 13.744\ ms\ for\ v_c(t) \ = \ 25\ V} \quad --- \ 0.5\ M$$

9 An impedance coil in parallel with a **100 μF** capacitor is connected across a **200 V**, **50 Hz**, single-phase ac supply. The coil takes a current of **4 A** and the power loss in the coil is **600 W**. Calculate (i) the resistance of the coil, (ii) the inductance of the coil, (iii) the current drawn by the entire circuit, and (iv) the power factor of the entire circuit. **5**

$$\mathbf{Z_{coil} = \frac{200}{4} = 50\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{R_{coil} = \frac{600}{4^2} = 37.5\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{X_{coil} = \sqrt{50^2 - 37.5^2} = 33.072\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{L = \frac{33.072}{2\ \pi\ 50} = 105.27\ mH} \quad --- \ 0.5\ M$$

$$\mathbf{\bar{Z}_{coil} = (37.5 + j\,33.072)\ \Omega = 50 \angle 41.41°\ \Omega} \quad --- \ 0.5\ M$$

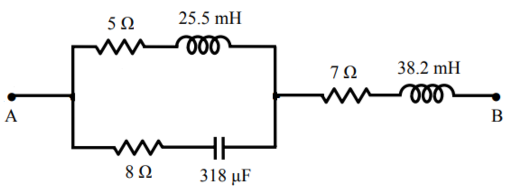
$$\mathbf{\bar{Z}_c = -j\left(\frac{1}{2\ \pi\ 50\ \times 100 \times 10^{-6}}\right)\ \Omega = 31.831 \angle -90°\ \Omega} \quad --- \ 0.5\ M$$

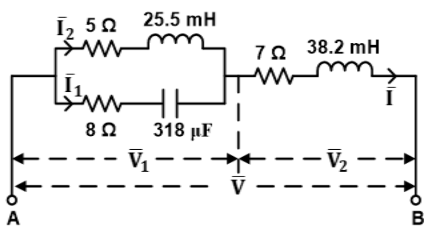
$$\mathbf{\bar{Z}_{Total} = \frac{50 \angle 41.41° \times 31.831 \angle -90°}{50 \angle 41.41° + 31.831 \angle -90°} = (26.99\ -\ j\,32.724)\ \Omega = \ 42.418 \angle -50.485°\ \Omega} \quad --- \ 1\ M$$

$$\mathbf{\bar{I} = \frac{200 \angle 0°}{42.418 \angle -50.485°} = 4.715 \angle 50.485°\ A} \quad --- \ 0.5\ M$$

$$\mathbf{PF_{circuit} = \cos 50.485° = 0.636\ leading} \quad --- \ 0.5\ M$$

10 Determine the input voltage at **50 Hz** to be applied to the circuit across terminals **A** and **B**, such that the current in the capacitor is **8 A**. **6**





$$\mathbf{\bar{Z}_1 = 8 - j\left(\frac{1}{2\ \pi\ 50 \times 318 \times 10^{-3}}\right) = (8 - j\,10)\ \ \Omega = 12.806 \angle -51.34°\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{\bar{Z}_2 = 5 + j\,(2\ \pi\ 50 \times 0.0255)) = (5 + j\,8)\ \ \Omega = 9.434 \angle 58°\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{\bar{Z} = 7 + j\,(2\ \pi\ 50 \times 0.03852)) = (7 + j\,12)\ \ \Omega = 13.892 \angle 59.744°\ \Omega} \quad --- \ 0.5\ M$$

$$\mathbf{\bar{V}_1 = 8 \angle 0° \times 12.806 \angle -51.34° = 102.448 \angle -51.34°\ \ V} \quad --- \ 1\ M$$

$$\mathbf{\bar{I}_2 = \frac{102.448 \angle -51.34°}{9.434 \angle 58°} = 10.859 \angle -109.34°\ \ A} \quad --- \ 1\ M$$

$$\mathbf{\bar{I} = \ 8 \angle 0° + \ 10.859 \angle -109.34° \ \ = 11.153 \angle -66.74°\ \ A} \quad --- \ 1\ M$$

$$\mathbf{\bar{V}_2 = 11.153 \angle -66.74°\ \ A \times 13.892 \angle 59.744° = 154.937 \angle -7°\ \ V} \quad --- \ 1\ M$$

$$\mathbf{\bar{V} = 102.448 \angle -51.34° + 154.937 \angle -7° = (217.78\ \ -j\,98.88)\ V = 239.18 \angle -24.42°\ \ V} \quad --- \ 0.5\ M$$