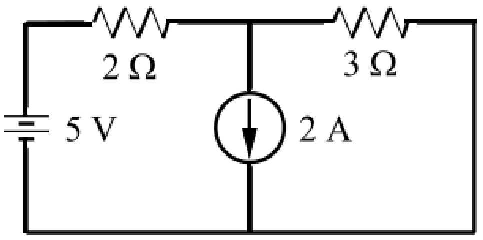
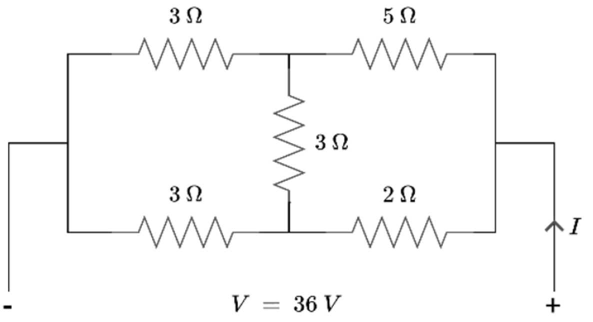
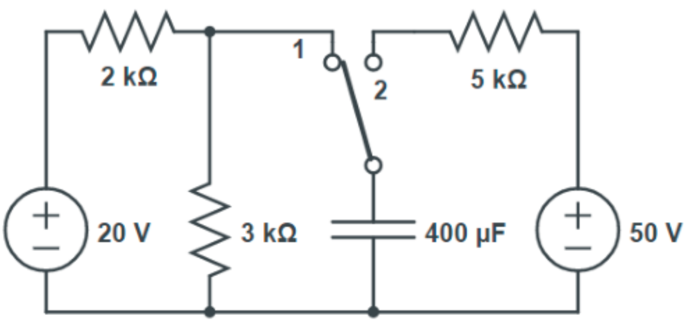
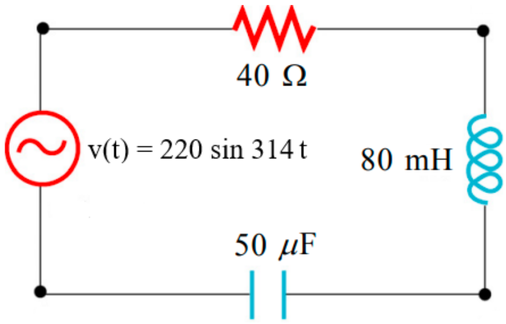
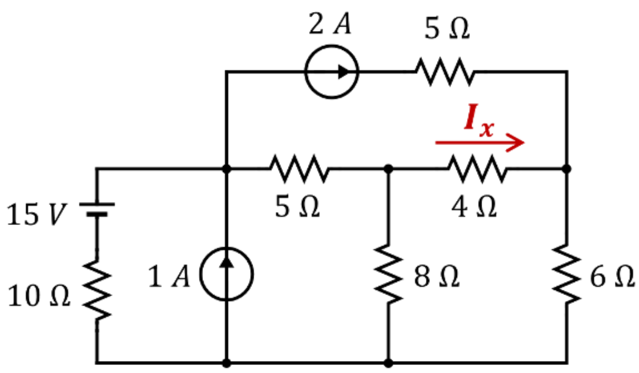
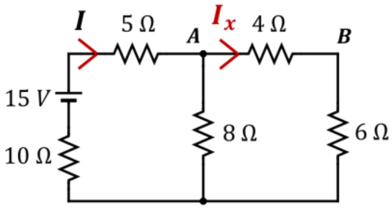
Part A – Objective Questions

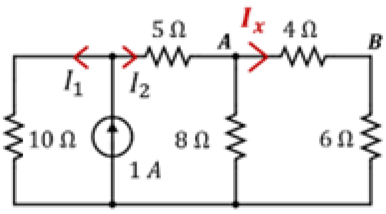
Q. No.	Question	Marks	BTL	CO
1	The power dissipated in **2 Ω** resistor in the given circuit is:  a) 0.18 W b) 8 W **c) 9.68 W** d) 12.5 W	1	3	1
2	The current through **5 Ω** resistor in the given interconnection of resistors is:  a) 12 A b) 8 A c) 3.43 A **d) 4 A**	1	3	1
3	Initially switch was at position **1** for a long time. It is moved from position **1** to **2** at **t = 0**. The capacitor voltage at $\mathbf{V_c(t=0)}$ and $\mathbf{V_c(t=\infty)}$ are respectively,  **a) 12 V & 50 V** b) 20 V & 50 V c) 0 V & 0 V d) 12 V & 0 V	1	3	1
4	A single-phase AC circuit is represented by the following voltage and current equations: $\mathbf{\bar{V} = 10\ \sin(\omega t + 10°)\ V}$ $\mathbf{\bar{I} = 3\cos(\omega t - 20°)\ A}$ The average power consumed by the circuit is: a) 26 W b) 1.5198 W c) 13 W **d) 7.5 W**	1	3	2

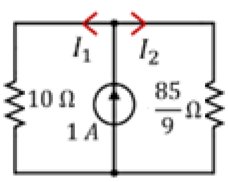
<table>
<tr><td>5</td><td>The resulting RMS current in the given circuit is:


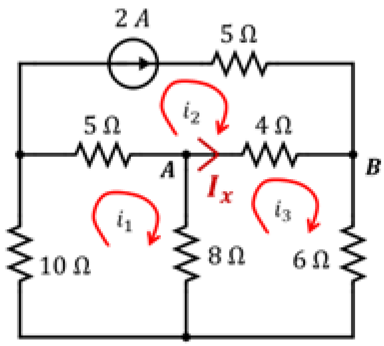
<table>
<tr><td>a) 3.96 A
(Leading)</td><td>b) 2.8 A
(Leading)</td><td>c) 2.8 A
(Lagging)</td><td>d) 3.96 A
(Lagging)</td></tr>
</table></td><td>1</td><td>3</td><td>2</td></tr>
</table>

Part B – Descriptive Questions

<table>
<tr><th>Q. No.</th><th>Question</th><th>Marks</th><th>BTL</th><th>CO</th></tr>
<tr><td>6</td><td>Using superposition principle, determine the current I_x as shown.

</td><td>5</td><td>3</td><td>1</td></tr>
<tr><td colspan="2">






</td><td colspan="3">

$R_{eq} = ((6+4)\,||\,8) + 5 + 10 = 19.444\ \Omega$

$I = \dfrac{15}{19.444} = 0.77145\ A$

$I_x|_{15\,V} = \dfrac{0.77145 \times 8}{8+10} = 0.3429\ A\ (A\ to\ B)$ --- 1 M

$I_2 = \dfrac{1 \times 10}{10 + 9.444} = 0.51428\ A$

Or $I_x|_{1\,A} = \dfrac{(I_2)(8)}{8+10} = 0.2286\ A\ \ (A\ to\ B)$ --- 1 M

$i_2 = 2$ (i)

$-23i_1 + 5i_2 + 8i_3 = 0$ (ii)

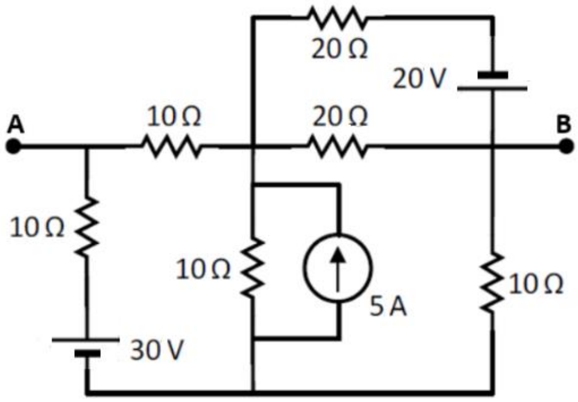
$8i_1 + 4i_2 - 18i_3 = 0$ (iii) --- 1.5 M

$i_3 = 0.7542\ A$

$I_x|_{2\,A} = i_3 - i_2 = -1.2457\ A\ (A\ to\ B)$ --- 1 M

$I_x = I_x|_{15\,V} + I_x|_{1\,A} + I_x|_{2\,A} = -\,0.6742\ A$ --- 0.5 M

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

7	Obtain **Thevenin's** equivalent across the open terminals **A** & **B** of the circuit shown. Also determine the maximum possible power available across a load resistance if connected between terminals **A** & **B.** 	4	3	1	

One Y − Δ or Δ − Y conversion − − − 0.5 M

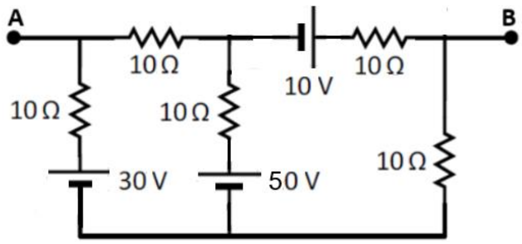
$\mathbf{R_{TH} = 10\ \Omega}$ − − − 1 M

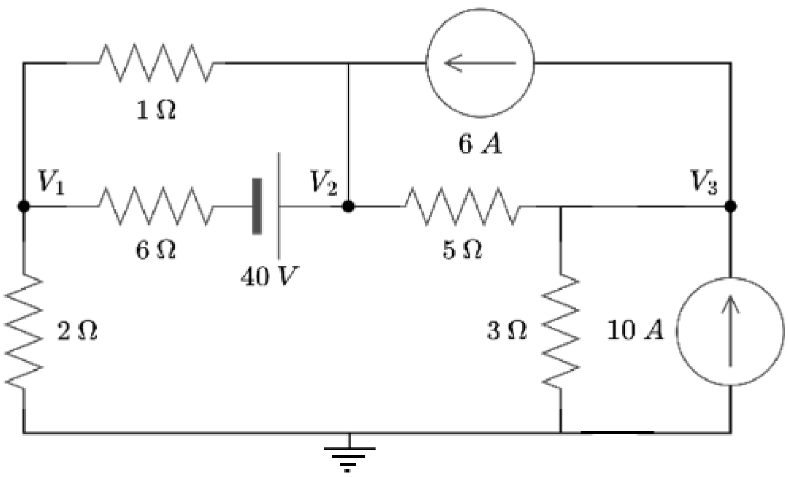
$$\begin{bmatrix} 30 & -10 \\ -10 & 30 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} -20 \\ 60 \end{bmatrix} \quad --- \ 1\ \mathrm{M}$$

$\mathbf{i_1 = 0\ A}$ **and** $\mathbf{i_2 = 2\ A}$ − − − 0.5 M

$\mathbf{V_{TH} = V_{AB} = (2 \times 10) - 10 = 10\ V}$ − − − 0.5 M

$$\mathbf{P_{Max} = \frac{10^2}{4 \times 10} = 2.5\ W} \quad --- \ 0.5\ \mathrm{M}$$



8	Determine the node voltages **V₁, V₂, V₃** and power supplied by **6 A** source in the given circuit. 	4	4	1	

Source transformation − − − 0.5 M

$$V_1\left(\frac{1}{6}+\frac{1}{2}+\frac{1}{1}\right) - V_2\left(\frac{1}{6}+\frac{1}{1}\right) = -\frac{40}{6} \quad --- \ 1\ \mathrm{M}$$

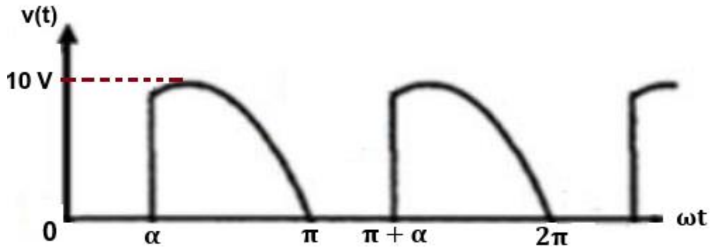
$$-V_1\left(\frac{1}{6}+\frac{1}{1}\right) + V_2\left(\frac{1}{6}+\frac{1}{1}+\frac{1}{5}\right) - V_3\left(\frac{1}{5}\right) = \frac{40}{6} + 6 \quad --- \ 1\ \mathrm{M}$$

$$-V_2\left(\frac{1}{5}\right) + V_3\left(\frac{1}{5}+\frac{1}{3}\right) = 10 - 6 \quad --- \ 1\ \mathrm{M}$$

$\mathbf{V_1 = 10\ V,\quad V_2 = 20\ V,\quad V_3 = 15\ V}$ − − − 0.5 M

$\mathbf{P_{6\,A} = (V_2 - V_3) \times 6 = 30\ W}$

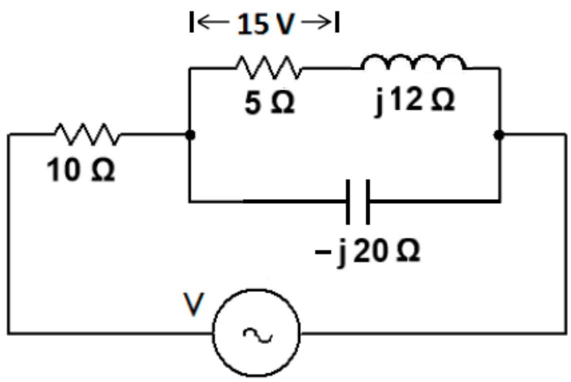
9	The output voltage waveform of a single-phase full wave controlled rectifier with **sinusoidal** input is as shown. Determine the **RMS** and **Average** values waveform considering **α = π / 3** radians.	4	3	2	



$$V_{AVG} = \frac{1}{\pi}\int_{\pi/3}^{\pi} 10\ \sin(\omega t)\ d(\omega t) = 4.755\ V \quad --- \ 1.5\ M$$

$$V_{RMS} = \sqrt{\frac{1}{\pi}\int_{\pi/3}^{\pi} (10\ \sin(\omega t))^2\ d(\omega t)} = 6.342\ V \quad --- \ 2.5\ M$$

10	Obtain the **supply voltage (V)**, **total current**, and **power factor** for the given single-phase AC circuit.	4	3	2	



$$\bar{I}_1 = \frac{15}{5} = 3\angle 0°\ A \quad --- \ 0.5\ M$$

$$\bar{V}_{BC} = 3\angle 0° \times (5 + j\,12) = 3\angle 0° \times 13\angle 67.38° = 39\angle 67.38°\ V \quad --- \ 0.5\ M$$

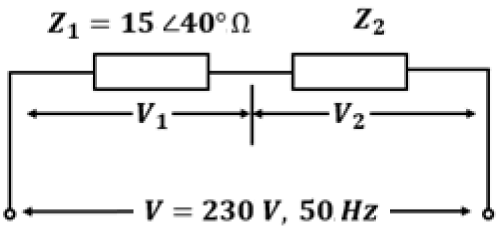
$$\bar{I}_2 = \frac{39\angle 67.38°}{20\angle -90°} = 1.95\angle 157.38°\ A \quad --- \ 0.5\ M$$

$$\bar{I} = \bar{I}_1 + \bar{I}_2 = 1.415\angle 32°\ A \quad --- \ 1\ M$$

$$\bar{V}_{AB} = 1.415\angle 32° \times 10\angle 0° = 14.15\angle 32°\ V \quad --- \ 0.5\ M$$

$$\bar{V} = 14.15\angle 32° + 39\angle 67.38° = 51.197\angle 58.171°\ V \quad --- \ 0.5\ M$$

$$PF = \cos(58.171 - 32)° = 0.8975\ \text{Lagging} \quad --- \ 0.5\ M$$

11	Two impedances **Z_1** and **Z_2** are connected in series across **230 V**, **50 Hz**, single phase AC supply as shown. If the voltage **V_1** across **Z_1** is $\mathbf{120 \angle 30°}$, determine a) The value of impedance **Z_2** b) Net resistance, and inductance & capacitance of the circuit. c) Power factor of the circuit. d) Reactive power drawn by the circuit.  	**4**	**4**	**2**	

$\bar{Z}_1 = 15 \angle 40°\ \Omega = (11.491 + j\,9.642)\ \Omega$

$\bar{I} = \dfrac{120 \angle 30°}{15 \angle 40°} = 8 \angle -10°\ A$ $---$ $0.5\ M$

$\bar{Z} = \dfrac{230 \angle 0°}{8 \angle -10°} = 28.75 \angle 10°\ \Omega = (28.313 + j\,50)\ \Omega$ $---$ $0.5\ M$

$\bar{Z}_2 = 28.75 \angle 10° - 15 \angle 40° = (16.822 - j\,4.649)\ \Omega = 17.453 \angle -15.449°\ \Omega$ $---$ $1\ M$

Net resistance $= \mathrm{Re}(\bar{Z}) = 28.313\ \Omega$

Inductive Reactance $(X_L) = \mathrm{Im}(\bar{Z}_1) = 9.642\ \Omega$ and Inductance $(L) = 30.69\ mH$ $---$ $0.5\ M$

Capacitive Reactance $(X_C) = \mathrm{Im}(\bar{Z}_2) = 4.649\ \Omega$ and Capacitance $(C) = 684.684\ \mu F$ $---$ $0.5\ M$

PF $= \cos 10° = 0.985$ Lagging $---$ $0.5\ M$

$Q = 230 \times 8 \times \sin 10° = 319.513\ VAR$ (Lagging) $---$ $0.5\ M$