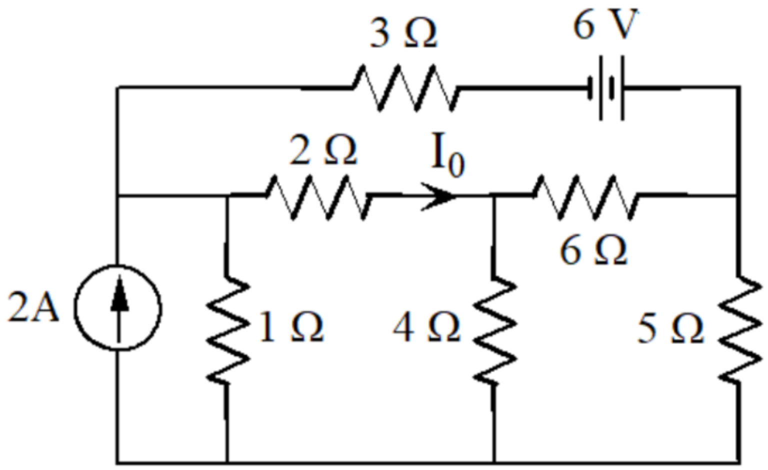
Type: DES

11A. Using superposition principle, determine the current I_0 as shown. 4M



With 6 V source alone

$$\begin{bmatrix} 7 & -4 & -2 \\ -4 & 15 & -6 \\ -2 & -6 & 11 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 6 \end{bmatrix}$$

$i_1 = 0.5674\ A,\quad i_2 = 0.5254\ A,\quad i_3 = 0.9352\ A$

$I_{0:6V} = (i_1 - i_3) = -0.3678\ A$ --- 1.5 M

With 2 A source alone

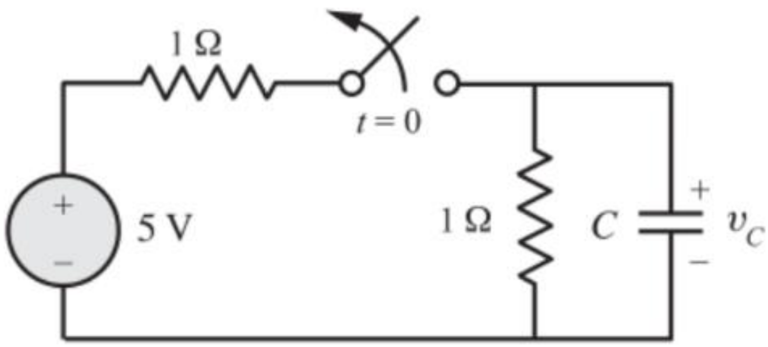
$$\begin{bmatrix} 7 & -4 & -2 \\ -4 & 15 & -6 \\ -2 & -6 & 11 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix}$$

$i_1 = 0.45184\ A,\quad i_2 = 0.19615\ A,\quad i_3 = 0.18914\ A$

$I_{0:2A} = (i_1 - i_3) = 0.2627\ A$ --- 1.5 M

$I_0 = I_{0:6V} + I_{0:2A} = -0.1051\ A$ --- 1 M

11B. For the circuit shown, assume that the switch was in closed state for a long time. At t = 0, it is operated as shown. Obtain Vc(t) for t > 0. Also calculate the time when capacitor voltage becomes 1.25 V. 3M



$$\mathbf{v_c(0^-) = v_c(0) = v_c(0^+) = 2.5\ V \quad --0.5\ M}$$

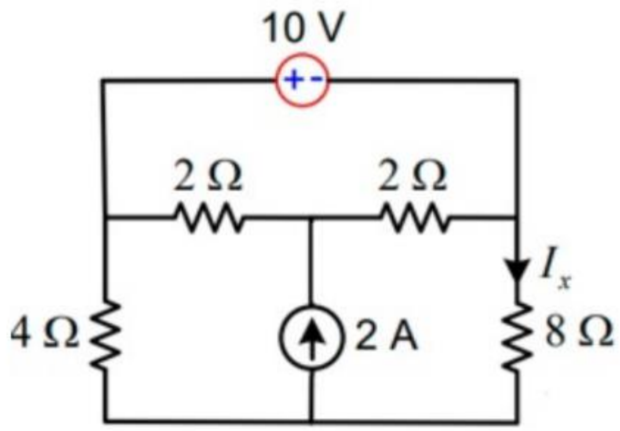
$$\mathbf{v_c(\infty) = 0\ V \quad --0.5\ M}$$

$$\mathbf{\tau = RC = C\ s \quad --0.5\ M}$$

$$\mathbf{v_c(t) = 2.5\ e^{-\ t/c}\ V \quad --0.5\ M}$$

$$\mathbf{t = 0.693\ C\ s\ for\ v_c(t) = 1.25\ V \quad --1\ M}$$

11 C. Determine the current Ix in the given network using nodal analysis 3M



VA – VC = 10.................... (0.5)

(VA-VB)/2 + VA/4 + (VC-VB)/2 + VC/8 = 0 .... (0.5)

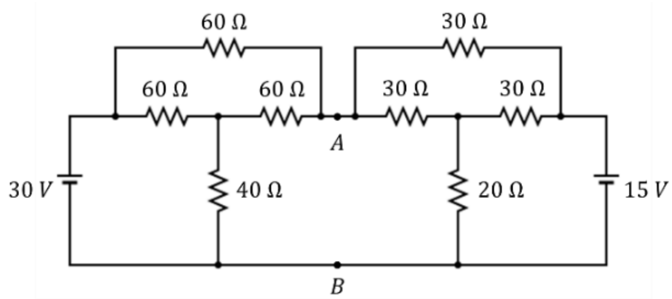
(VB-VA)/2 + (VB-VC)/2 = 2 ....(0.5)

On solving above three equations: ....(0.5)

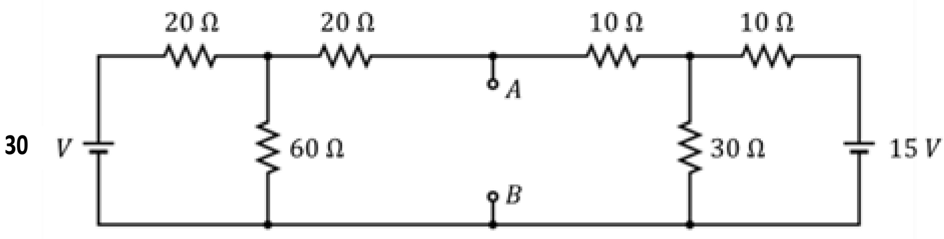
VC = -4/3V ....(0.5)

I = -0.166 A ....(0.5)

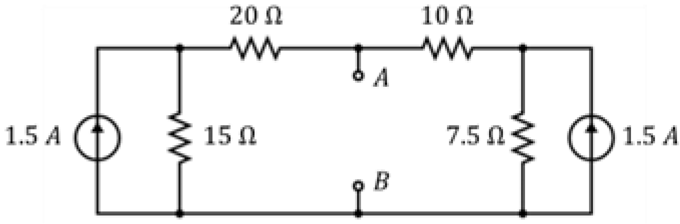
12 A. Find Thevenin's equivalent of the network across terminals A and B. If any value whatsoever may be selected for load resistance across terminals A and B, what is the maximum power that could be dissipated in it? 4M



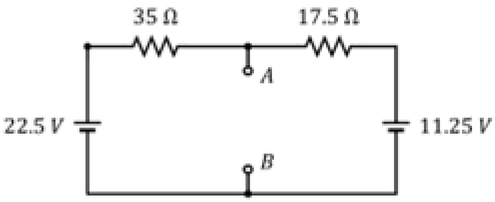
Converting 60 ohm – 60 ohm – 60 ohm delta to star and 30 ohm – 30 ohm – 30 ohm delta to star,



Converting practical voltage sources to practical current sources and simplifying,



Converting practical current sources to practical voltage sources and simplifying,



………. **1M**

Current in the circuit will be,

$$I = \frac{22.5 - 11.25}{35 + 17.5} = 0.2142\ A$$

………. **1M**

Thevenin's voltage and resistance will be,

$$V_{th} = V_{AB} = 11.25 + (17.5 \times 0.2142) = 15\ V$$

$$R_{th} = 11.67\ \Omega$$

………. **1M**

Maximum power dissipated is,

$$P_{max} = \frac{V_{th}^2}{4R_{th}} = 4.82\ W$$

………. **1M**

12 B. A series circuit of resistance of 10 Ω, an inductance of 13 mH are connected in series. A supply of 100 V at 50 Hz is given to the circuit. Find the impedance, current, power factor and power consumed in the circuit. 3M

A series circuit of resistance of **10 Ω**, an inductance of **13 mH** and a capacitance of **150 µF** connected in series. A supply of **100 V** at **50 Hz** is given to the circuit. Find the impedance, current, power factor and power consumed in the circuit.

$$\mathbf{X_L = 2\pi f L = 4.0841\ \Omega}$$

$$\mathbf{X_C = \frac{1}{2\pi f L} = 21.2207\ \Omega}$$

$$\mathbf{Z = R + j\,(X_L - X_C) = 10 - j\,17.1366\ \Omega = 19.8409\angle{-59.7345^o}\ \Omega} \quad --- \ 1\ M$$

$$\mathbf{|I| = \frac{V_s}{|Z|} = 5.0401\ A}$$

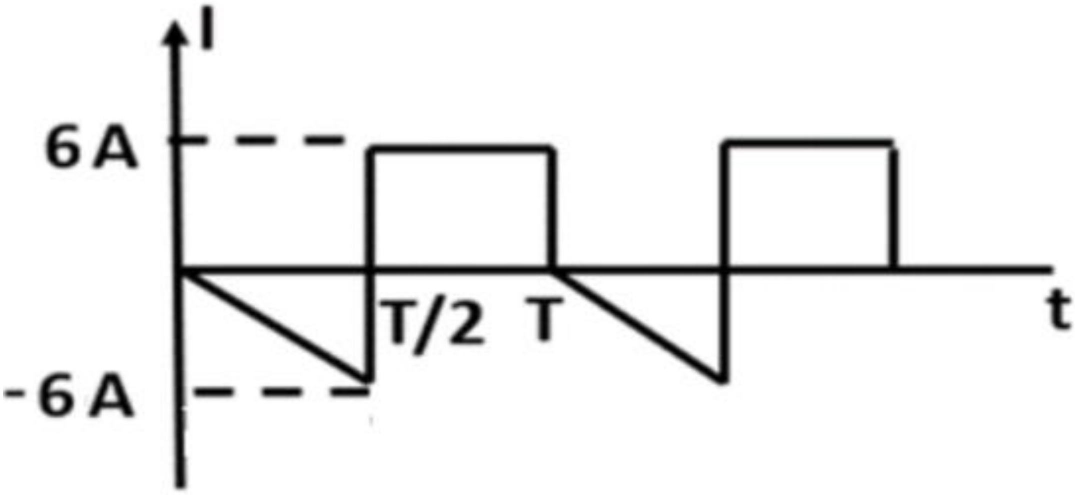
$$\mathbf{\Phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right) = 59.7345^o}$$

$$\mathbf{I = |I|\angle\Phi = 5.0401\angle 59.7345^o\ A = 2.5402 + j\,4.3531\ \ A} \quad --- \ 1\ M$$

$$\mathbf{Power\ factor = \cos\Phi = 0.5040\ (Leading)} \quad --- \ 0.5\ M$$

$$\mathbf{Power\ consumed = |V_S||I|\cos\Phi = 254.0210\ W} \quad --- \ 0.5\ M$$

12 C. Find the average and RMS value of the voltage waveform shown below. 3M



$$\mathbf{i(t) = -\frac{12\,t}{T} \qquad 0 < t < T/2} \qquad \textcolor{red}{\mathbf{---\ 0.5\,M}}$$

$$\mathbf{i(t) = 6 \qquad T/2 < t < T} \qquad \textcolor{red}{\mathbf{---\ 0.5\,M}}$$

$$\mathbf{i_{avg} = \frac{1}{T}\left[\int_0^{T/2} -\frac{12\,t}{T}\,dt + \int_{T/2}^{T} 6\,dt\right] = 1.5\,A} \qquad \textcolor{red}{\mathbf{---\ 1\,M}}$$

$$\mathbf{i_{RMS} = \sqrt{\frac{1}{T}\left[\int_0^{T/2}\left(-\frac{12\,t}{T}\right)^2 dt + \int_{T/2}^{T} 6^2\,dt\right]} = 4.899\,A} \qquad \textcolor{red}{\mathbf{---\ 1\,M}}$$