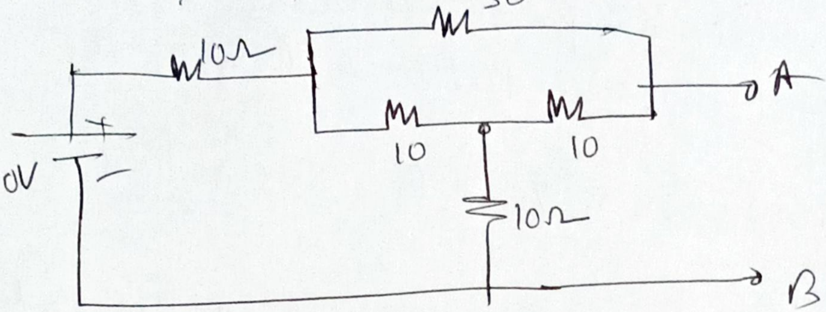
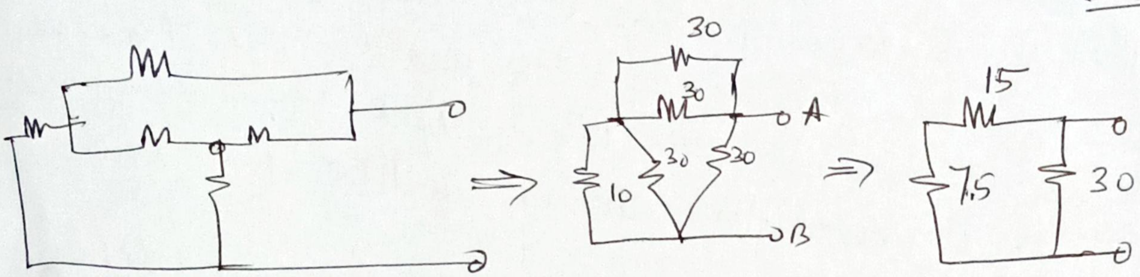
Problem 3.

Find Thevenin Equivalent Circuit across AB of the Circuit shown.

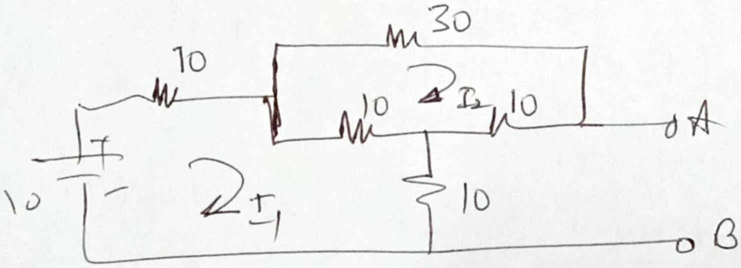


Ans: 4.28 V
12.8 Ω



⇒ 12.85 Ω

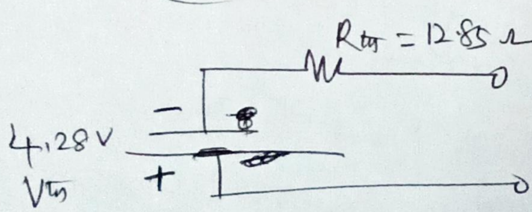
To find V_{th}

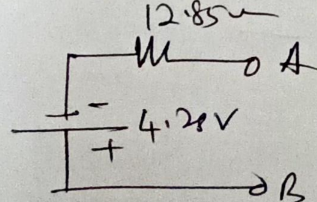


By Matrix Method
$$\begin{bmatrix} 30 & -10 \\ -10 & 50 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$$

$I_1 = 0.35\,A$, $I_2 = 0.071\,A$

$$V_{th} = (-10 \times 0.071) - (10 \times 0.35) = -4.28\,V$$





5. Maximum Power Transfer Theorem:— (MPTT)

— In many applications of the circuits, requires the maximum power available from a source to be transferred to Load Resistor R_L

— Maximum of 50% of the power can be transferred to R_L.

— Consider a signal received at the antenna of FM-Radio Receiver from a distant station. The Receiver Circuit is designed so that Maximum power is available at the output of amplifier circuit connected to antenna of the FM-Radio.

— Thus we represent FM antenna and amplifier by Thevenin's Equivalent Circuit.

Statement :- The Maximum power transfer theorem states that the, maximum power delivered by a source represented by its Thevenin's equivalent circuit is attained by Load Resistance R_L equal to Thevenin's resistance R_{Th}.

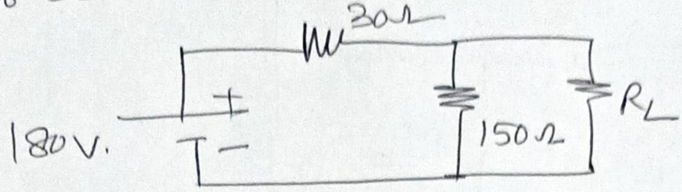
Steps to be followed

— The given circuit represented in Thevenin's Equivalent Circuit

— Equate Thevenin's resistance = Load Resistance R_L

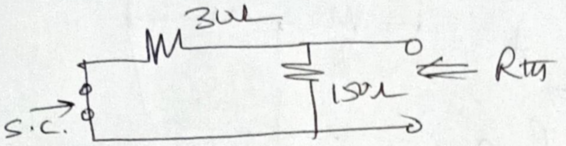
— Calculate Maximum power using the formula $P_{max} = I_L^2 R_L$ where I_L is Load current.

Problem 1 Find the Load R_L will result in maximum Power deliver to Load for the Circuit shown. Also determine the Maximum Power.



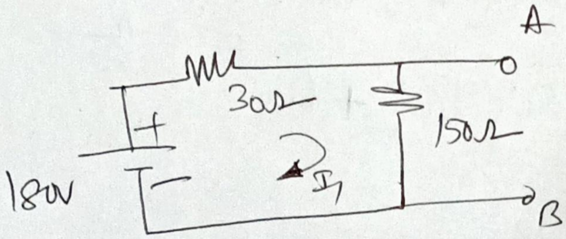
ANS: 25Ω
225 Watt

Solution :- First find Thevenin's Resistance R_{th}.



$$R_{th} = \frac{30 \times 150}{30 + 150} = \underline{\underline{25\Omega}}$$

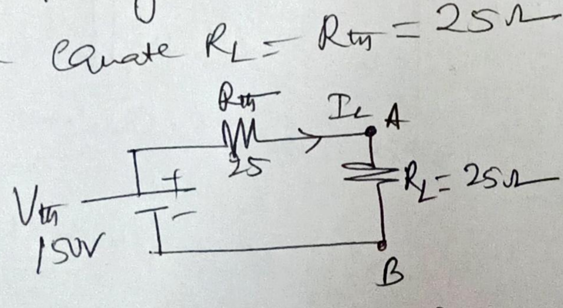
Find open Circuit voltage between A & B.



$$I_1 = \frac{180}{180} = 1A$$

$$\therefore V_{AB} = 150 \times 1 = \underline{\underline{150V}}$$
$$= V_{th}$$

Represent the given Circuit in Thevenin's Circuit.
and equate $R_L = R_{th} = 25\Omega$

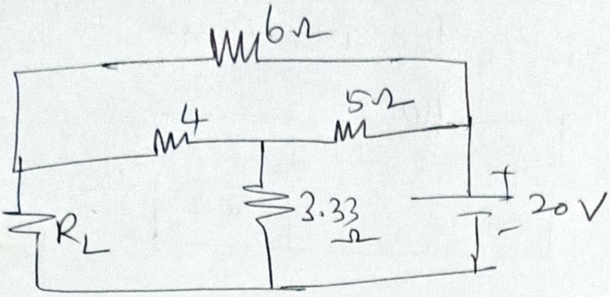


$$I_L = \frac{150}{25 + 25} = \underline{\underline{3A}}$$

$$\therefore P_{max} = I_L^2 R_L = 3^2 \times 25 = \underline{225 \text{ watts}}$$

OR $$P_{max} = \frac{V_{th}^2}{4R_L} = \frac{150 \times 150}{4 \times 25} = \underline{225 \text{ watts}}$$

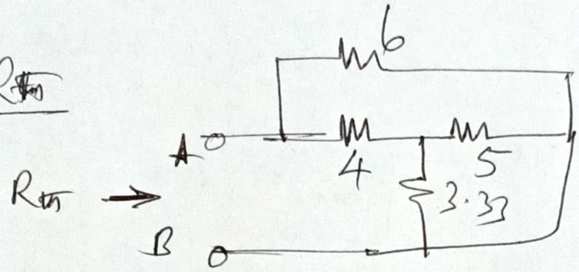
Problem: 2 Find the value of R_L for Maximum power transfer to it. Find the value of max Power



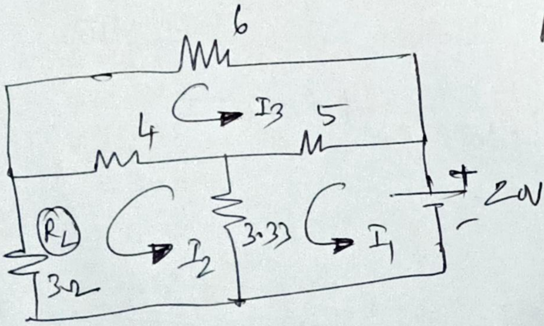
Ans: $3\,\Omega$
16.32 Watts

Solution

To find R_{th}



$$R_{th} = \frac{\left\{\left(\frac{5\times 3.33}{5+3.3}\right)+4\right\}\times 6}{\left\{\left(\frac{5\times 3.33}{5+3.3}\right)+4\right\}+6} = 3\,\Omega$$



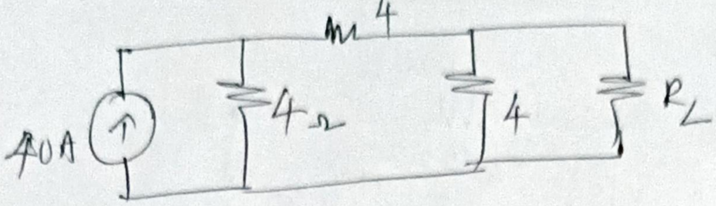
By Mesh Equations

$$\begin{bmatrix} 8.33 & -3.33 & -5 \\ -3.33 & 10.33 & -4 \\ -5 & -4 & 15 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} +20 \\ 0 \\ 0 \end{bmatrix}$$

$I_2 = 2.33\,A$ = is the load current

$\therefore \quad P_{max} = I_L^2 R_L = 2.333^2 \times 3 = 16.328\,W$

Problem 3:- Find R_L and Maximum power Transfer to R_L

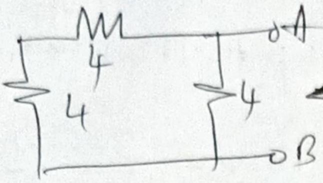


ANSWER

$R_{Th} = 2.67\Omega$

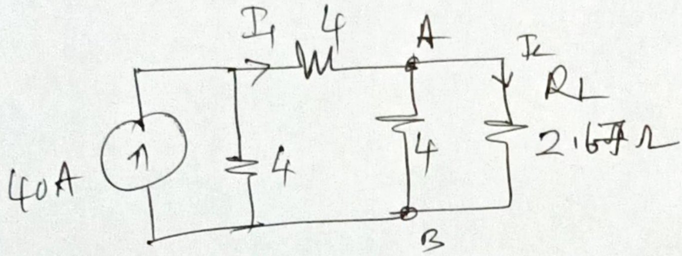
$P_{max} = \underline{267W}$

Solution:-



$$R_{Th} = \frac{8 \times 4}{8+4} = \underline{\underline{2.67\Omega}}$$

Use the formula $\left.\begin{matrix}\text{Branch} \\ \text{Current}\end{matrix}\right\} = \dfrac{\text{Main Current} \times \text{Resistance of other Branch}}{\text{Sum of Resistances}}$

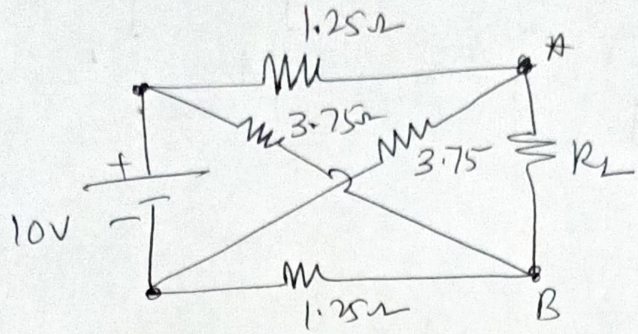


$$I_1 = \frac{40 \times 4}{4 + [4 + (4 \| 2.67)]} = \underline{\underline{16.66A}}$$

$$I_L = \frac{16.66 \times 4}{4 + 2.67} = \underline{\underline{10A}}$$

$$P_{max} = I_L^2 R_L = 10^2 \times 2.67 = \underline{\underline{267W}}$$

Problem no 4 Home work



Find R_L for Max Power. Also compute the value of Max Power.

Ans:- $R_{th} = 1.875\Omega$, $P_{max} = 3.33W$