BASIC ELECTRONICS
ASSIGNMENT – 1
SOLUTION

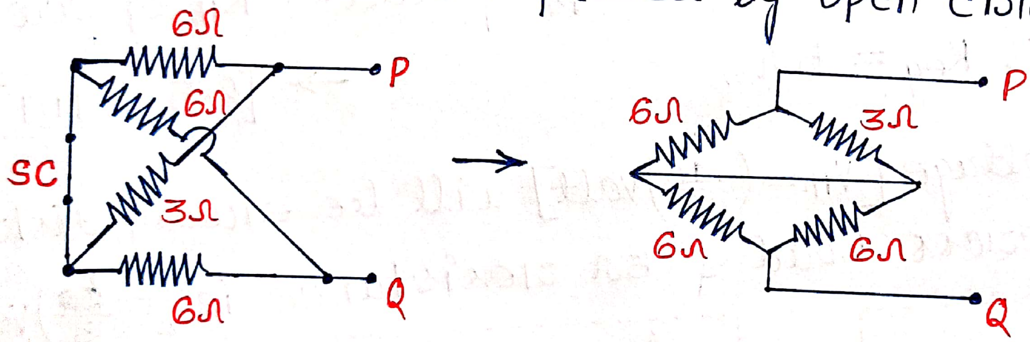
SOL(1): By Maximum Power Transfer Theorem,

For maximum power transfer from Source to Load, the value of equivalent resistance of Load is must be equal to source internal resistance (Thevenin resistance of Source). → [0.5 POINT]

For Thevenin Equivalent circuit of Source—

Case(I): Calculation of Thevenin Resistance (R_{th})

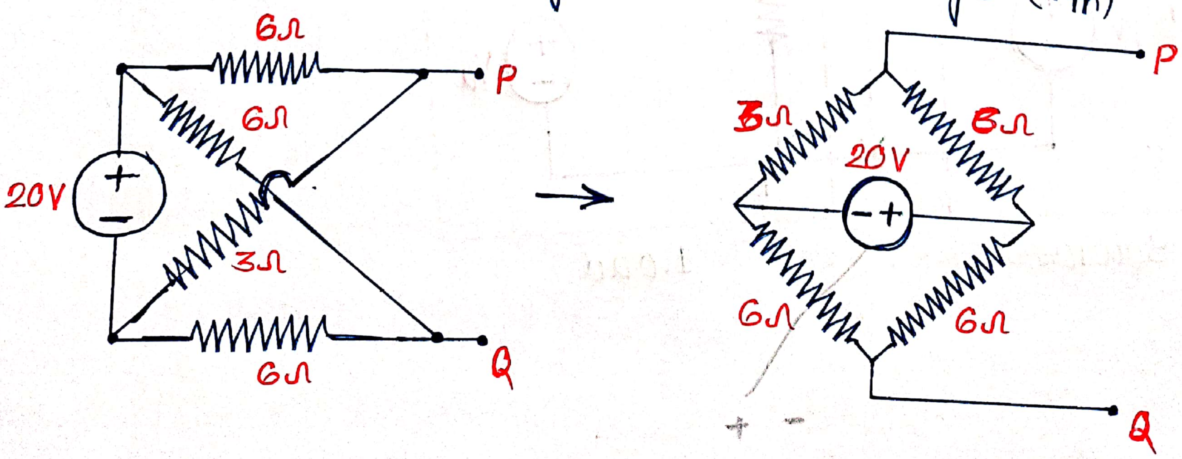
* Voltage source replaced by Short Circuit (SC)
* Current source replaced by Open Circuit (OC)



$$\therefore R_{th} = R_{PQ} = \frac{6\times 3}{6+3} + \frac{6\times 6}{6+6} = 2+3 = 5\Omega$$

→ [2 POINT]

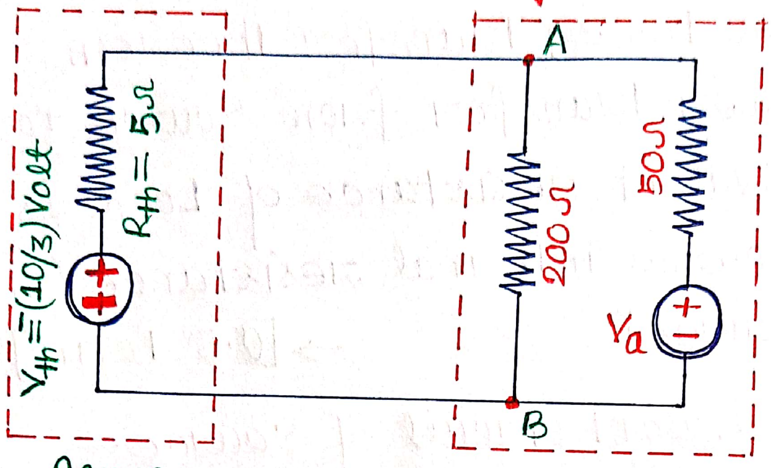
Case(II): Calculation of Thevenin Voltage (V_{th})



$\therefore V_{th} = V_{PQ} = V_P - V_Q = \left(\frac{3}{9}\times 20\right) - \left(\frac{6}{12}\times 20\right) = \left(-\frac{10}{3}\right)$ Volt

→ [2 POINT]

Now reduced circuit diagram—

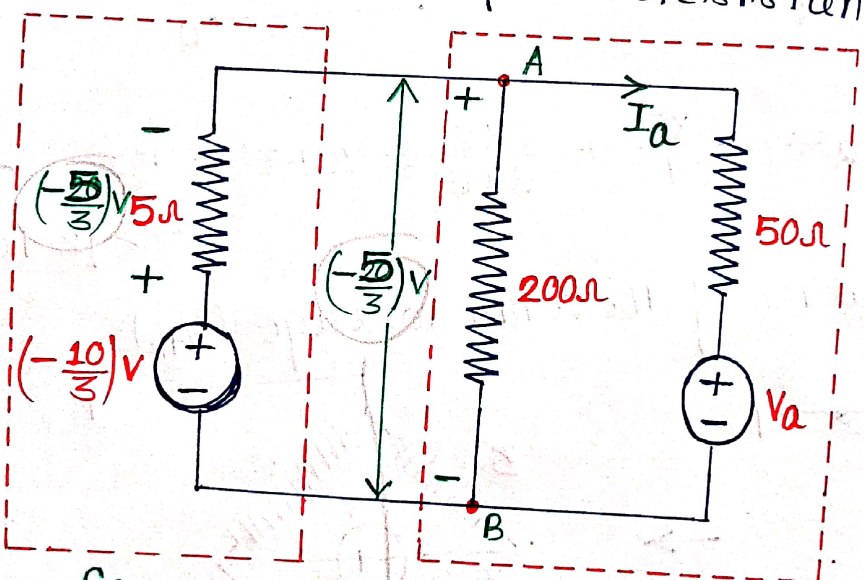


For maximum power transfer from Source to Load,

* Equivalent resistance (R_{eq}) of Load = R_{th} of Source

$\therefore R_{eq} = 5\Omega$ → [2.5 POINT]

* Source voltage [$V_{th} = \left(-\frac{10}{3}\right)$ volt] will be equally distributed across Load & 5Ω resistance ie [$\left(-\frac{5}{3}\right)$ volt].



$-\frac{5}{3}$

$-\frac{5}{3}$

Current through source, $V_a = \frac{(-5/3)}{5} + \frac{(+5/3)}{200}$

$\therefore I_a = \left(\frac{-39}{120}\right) A = ~~-0.34 A~~$

$= -0.325 A$

$\therefore$ Value of voltage source $(V_a) = -\frac{5}{3} - 50 \times \left(-\frac{39}{120}\right)$

~~= 1.325 Volt (= 1.325) Volt~~

$= 14.58$ Volt → [3 POINT]

SOL(2): Given circuit is Linear Bidirectional circuit. According to the given table, we can analysis that the value of current (I) is given when only one source (either V_1 or V_2 or V_3) are active.

Hence by using superposition Theorem & property of Homogeneity, we can find the value of current (I) for the given value of $V_1 = 25$ volt, $V_2 = 15$ Volt, $V_3 = 20$ volt

→ [0.5 POINT]

Step (I):- at $V_1 = 2$ volt, the value of current, $I = 1A$

so $V_1 = 25$ Volt, the value of current, $I' = \left(\frac{25 \times 1}{2}\right)$

$\therefore I' = 12.5 A$

→ [2.5 POINT]

Step (II):- at $V_2 = 4$ volt, the value of current, $I = 5A$

so $V_2 = 15$ volt, the value of current, $I'' = \left(\frac{15 \times 5}{4}\right)$

$\therefore I'' = 18.75 A$

→ [2.5 POINT]

Step (III) :-

at $V_3 = 5$ volt, the value of current, $I = (-6)\,A$

so $V_3 = 20$ volt, the value of current, $I''' = \frac{20 \times (-6)}{5}$

$\therefore I''' = (-24)\,A$

→ [2.5 POINT]

By superposition Theorem,

The value of current, I at $V_1 = 25$ volt, $V_2 = 15$ volt & $V_3 = 20$ volt will be—

$$I = I' + I'' + I'''$$

$$I = 12.5 + 18.75 - 24$$

$$\therefore I = 7.25\,A$$

→ [2 POINT]

SOL(3):

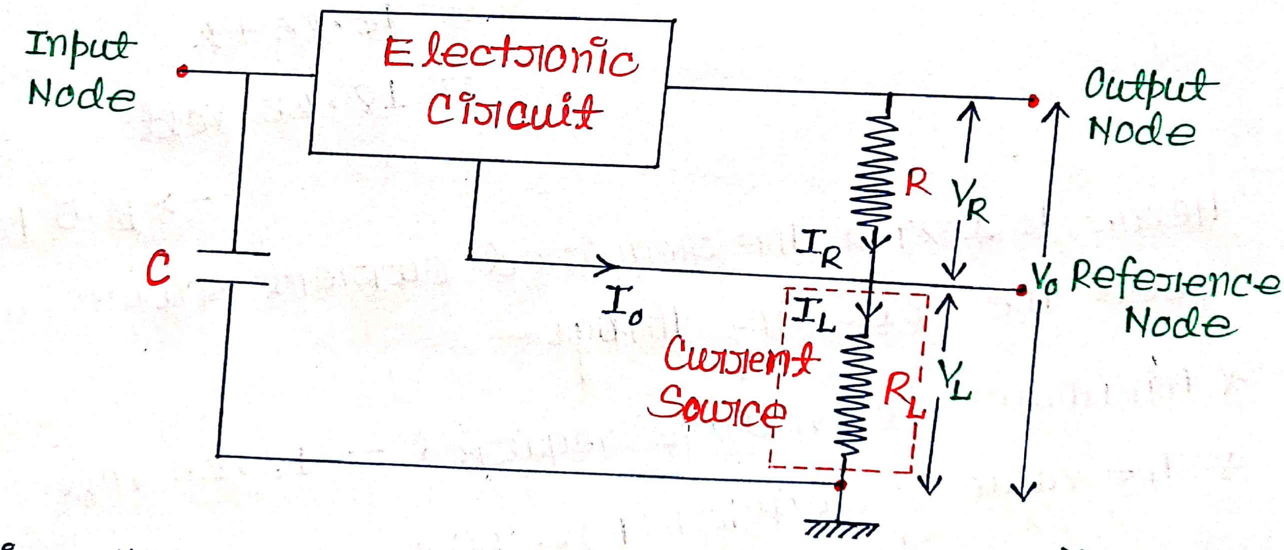
According to the question,

* The value of current source = the value of load current $I_L = 0.25\,A$

* The value of load resistor, $R_L = 45\,\Omega$

* The voltage difference between input node & output node / drop-out voltage $= (V_{in} - V_o) \geq 2$ Volt

* The voltage across output node & reference node is constant $= V_R = 5$ Volt



→ [5 POINT]

Given that – $I_L = 0.25$

$$\frac{V_L}{R_L} = 0.25$$

$$\therefore V_L = 0.25 \times R_L = 0.25 \times 45 = 11.25 \text{ Volt}$$

Output Node voltage, $V_o = V_R + V_L = 5 + 11.25$

$$\therefore V_o = 16.25 \text{ Volt}$$

By given circuit diagram,

$$I_o + I_R = I_L$$

$$I_R \cong I_L \qquad (I_o \text{ is negligible})$$

$$\frac{V_R}{R} \cong I_L$$

$$\therefore R \cong \frac{V_R}{I_L} = \left(\frac{5}{0.25}\right) = 20\Omega$$ → [2.5 POINT]

Given that — $(V_{in} - V_o) \geq 2$ volt

∴ Minimum input voltage required,

$$(V_{in})_{min} = V_o + 2$$

$$= 16.25 + 2$$

$$= 18.25 \text{ volt}$$

→ [2.5 POINT]

Hence, to design the required current source, we need the following things —

* Minimum input voltage required = 18.25 volt
* The value of resistor (R) = 20Ω