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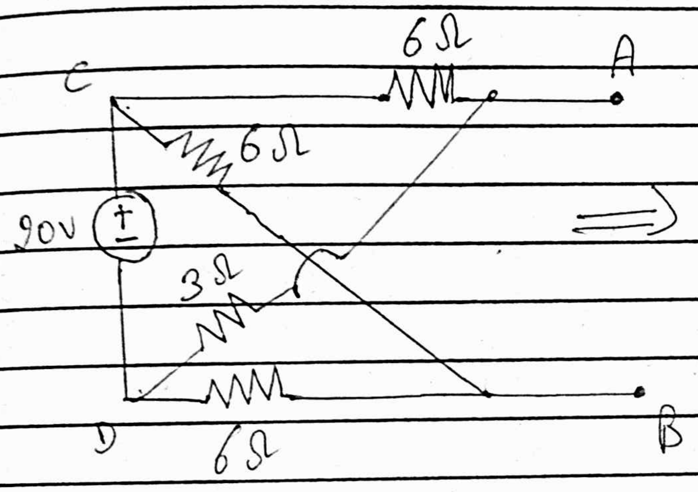
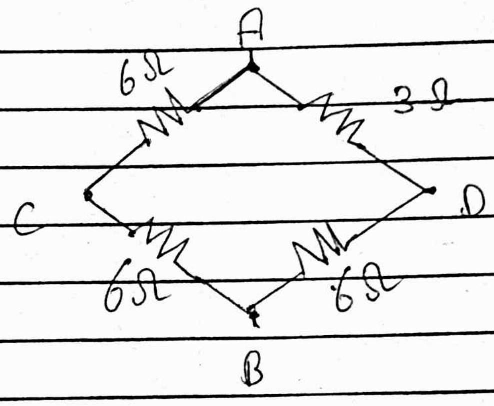
1st Question

First find source V_{TH} & R_{TH} using Thevenin Theorem





Apply Nodal Analysis

Using Nodal Analysis

$$\frac{V_a - 20}{6} + \frac{V_A}{2} = 0 \quad \text{— (1)}$$

$$\frac{V_B - 20}{6} + \frac{V_B}{6} = 0 \quad \text{— (2)}$$

$V_A - 20 + 2V_A = 0$ $\quad\quad$ $2V_B = 20$

$\boxed{V_A = 20/3}$ Volt $\quad\quad$ $\boxed{V_B = 10}$ Volt

$\boxed{V_A = 20/3 \text{ Volts}}$ $\quad$ $\boxed{V_B = 10 \text{ Volts}}$

so $V_A - V_B = \frac{20}{3} - 10 \Rightarrow \left(-\frac{10}{3}\text{ Volts}\right) = V_{TH}$

~~VB - VA~~ $V_{TH} = -\frac{10}{3}$ Volts

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~~P across Load~~

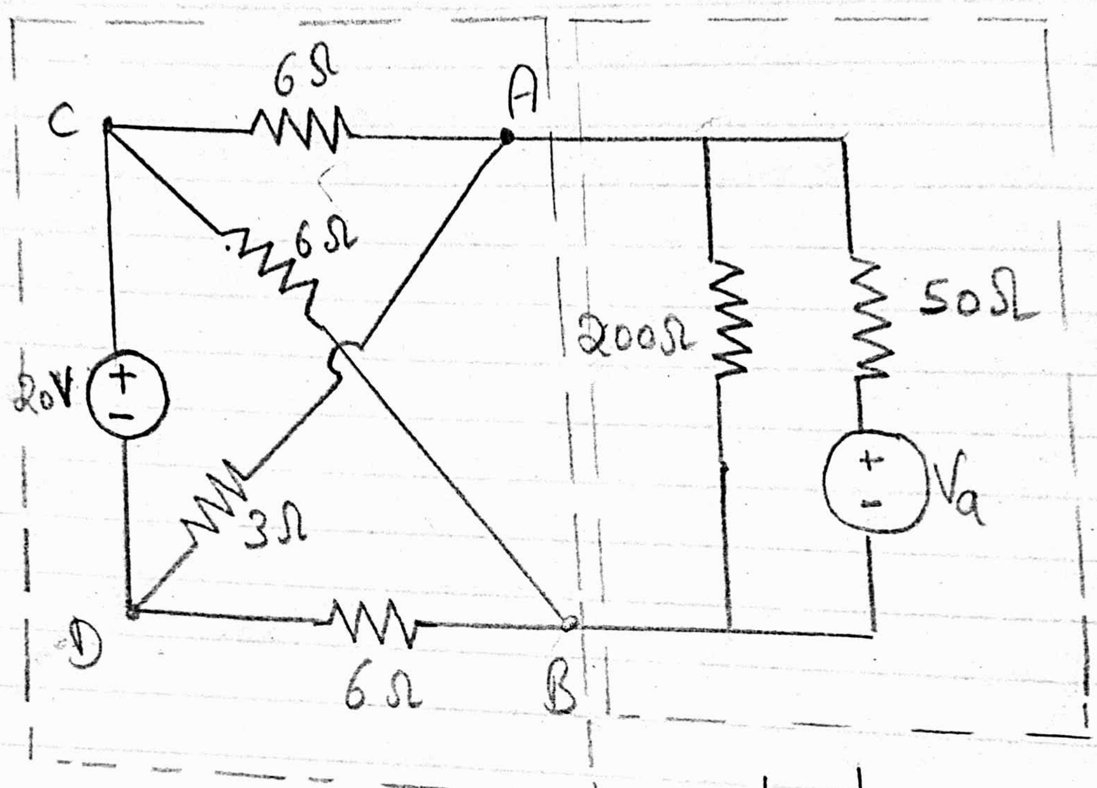
$$P_{across}\ 200\Omega \Rightarrow -\frac{5}{3}\times -\frac{5}{3}\times\frac{1}{200} = \frac{1}{24}\,W = 0.041\,W \quad [V^2/R = P]$$

$$P_{across}\ 50\Omega \Rightarrow I_2^2\times 50 = 169/32 = 5.281\,W \quad [P = i^2R]$$

$$P_{across}\ V_a \Rightarrow I_2\times V_a = \frac{195}{3\times 200}\times 14.58 = 4.738\,W \quad [P = Vi]$$

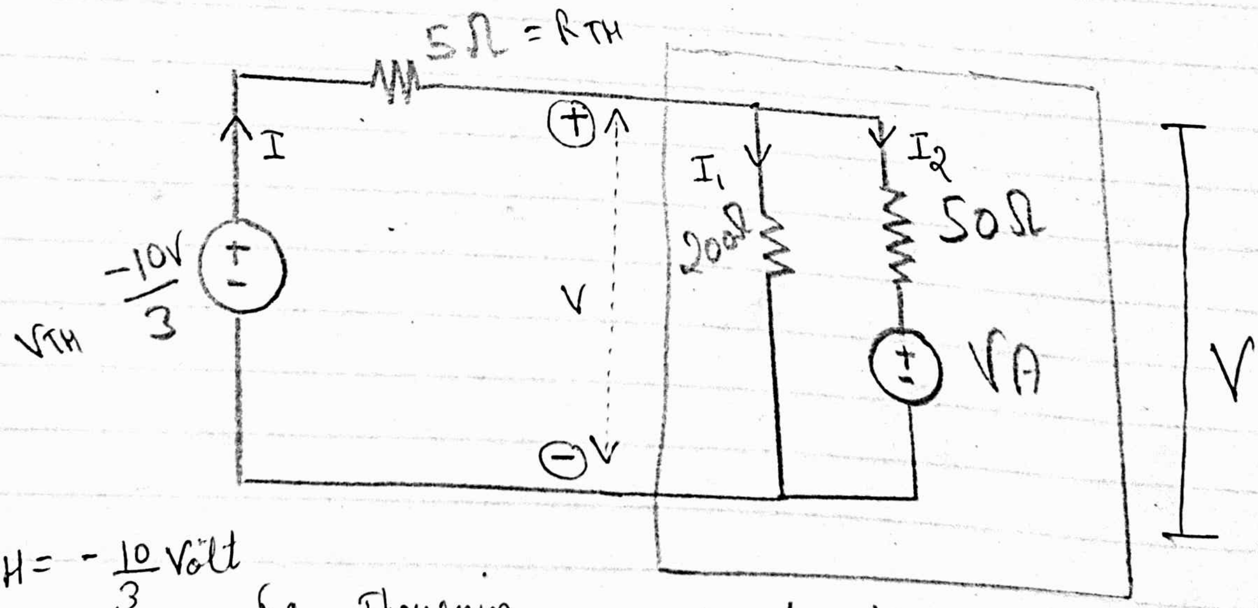
1st **Question**

$$P_{across}\ V_{TH} = V_{TH}\times I = -\frac{10}{3}\times(-1/3) = \frac{10}{9} = 1.11\,W \quad [P = Vi]$$



Source

Load



- $V_{TH} = -\frac{10}{3}$ Volt
- $R_{TH} = 5\Omega$

Eq. Thevenin

Load

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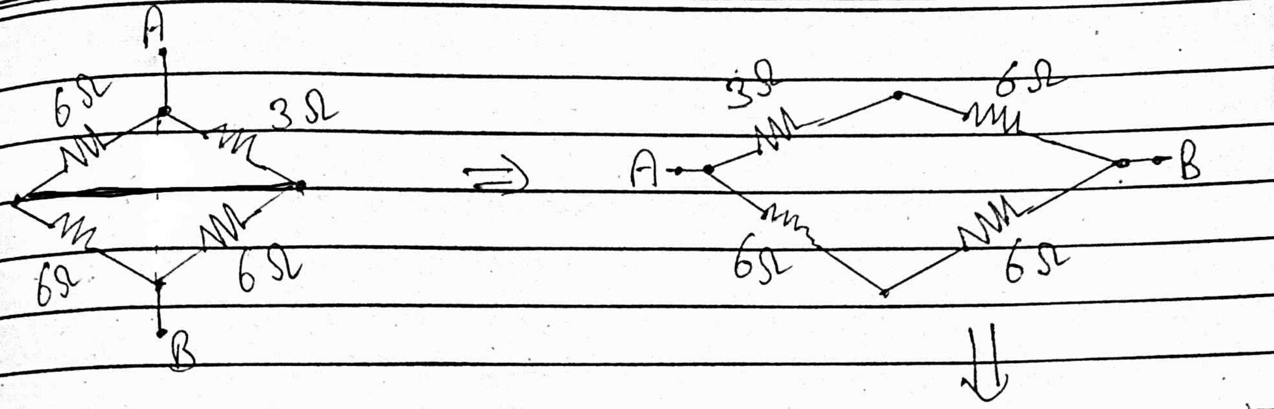
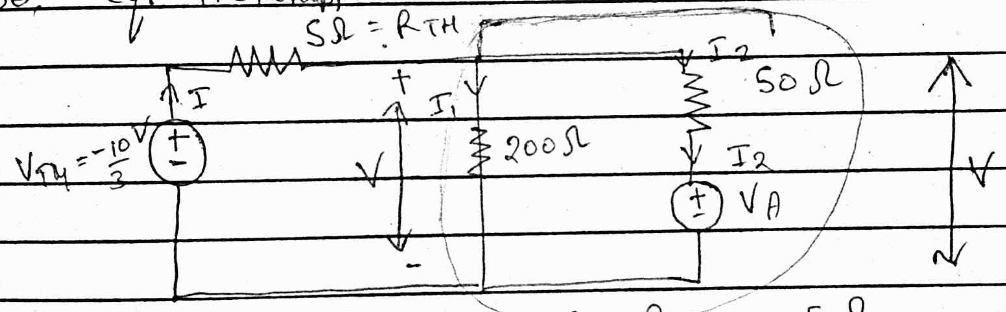


$\Rightarrow (3 \| 6)$ series $(6 \| 6)$

$\boxed{5\Omega} = \frac{18}{2} + 3 \Longleftarrow \frac{3\times 6}{3+6} + \frac{6\times 6}{6+6}$

$\boxed{R_{TH} = 5\Omega}$

so eq. Thevenin Load



V is voltage across Load

$V_{TH} = -10/3$ Volt & $R_{TH} = 5\,\Omega$

∵ when max power is transferred to a Load.

$\Rightarrow V = V_{TH} - I R_{TH}$

Power going into load. $\Rightarrow P_L = V_{TH} I - I^2 R_{TH}$

$\Rightarrow$ To Maximize $P_L \Rightarrow \frac{\partial P_L}{\partial I} = 0$

$\Rightarrow V_{TH} - 2 I R_{TH} = 0 \Rightarrow I = V_{TH}/2R_{TH}$

∵ Let V be voltage across Load $\Rightarrow \boxed{V = V_{TH}/2}$

∵ Max Power is transferred when half of source voltage appears across Load.

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so $V = -10/3 \times 1/2 = -\frac{5}{3}$ Volt

$\Rightarrow I = \dfrac{-\frac{10}{3} - \left(-\frac{5}{3}\right)}{5} = \dfrac{-5/3 \text{ volt}}{5} = -\frac{1}{3}$ Amp ≈ -0.333 Amp

$I_1 = -5/3 \times \frac{1}{200} = \frac{-5}{3\times200}$ Amp ≈ 0.00833 Amp

$I_2 = \dfrac{-1/3 - (-5/3)}{200} = \left(-\frac{1}{3} + \frac{5}{3\times200}\right)$ Amp

≈ 0.325 Amp

Now, $V = 50\times I_2 + V_A$

$V_A = V - 50 I_2$

$= -5/3 - 50\left(-\frac{1}{3} + \frac{5}{3\times200}\right)$

$V_A \Rightarrow \boxed{14.5833 \text{ Volt}} = V_A = 14.58$ Volts

Answer

$\because$ Max Power when $R_{Load} = R_{eq}$

Also $\because$ Max Power Transfered when Half of source voltage appears across Load

$R_{eq} = \boxed{R_{TH} = 5\Omega}$ Answer

$\boxed{V_A = 14.5833 \text{ Volts}}$ Answer

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2^{nd} Question

V_1 (Volt)	V_2 (Volt)	V_3 (V)	I (Amp)
2	0	0	1
0	4	0	5
0	0	5	-6

⟹ 1^{st} Method

∵ We can use superposition theorem to solve this linear Bidirectional circuit & OHM'S Law. $V = IR$

⟹ The current I can be split in three parts, $I = I_1 + I_2 + I_3$

⟹ V_1 Active, V_2 & $V_3 = 0$, Then find I_1
V_2 Active, V_1 & $V_3 = 0$, Then find I_2
V_3 Active, V_2 & $V_1 = 0$, Then find I_3

Then $I_1 + I_2 + I_3 = I$

Here $V_1 = 2, I = 1$ then as $V = IR$ ⟹ $\boxed{2 = R_1}$ ⟹ $R_1 = 2\Omega$

$V_2 = 4$ & $I = 5$ ⟹ $\boxed{4 = 5R_2}$ ⟹ $\boxed{R_2 = 4/5\Omega}$

$V_3 = 5$ $I = -6$ ⟹ $\boxed{5 = -6R_3}$ $\boxed{R_3 = -\frac{5}{6}\Omega}$

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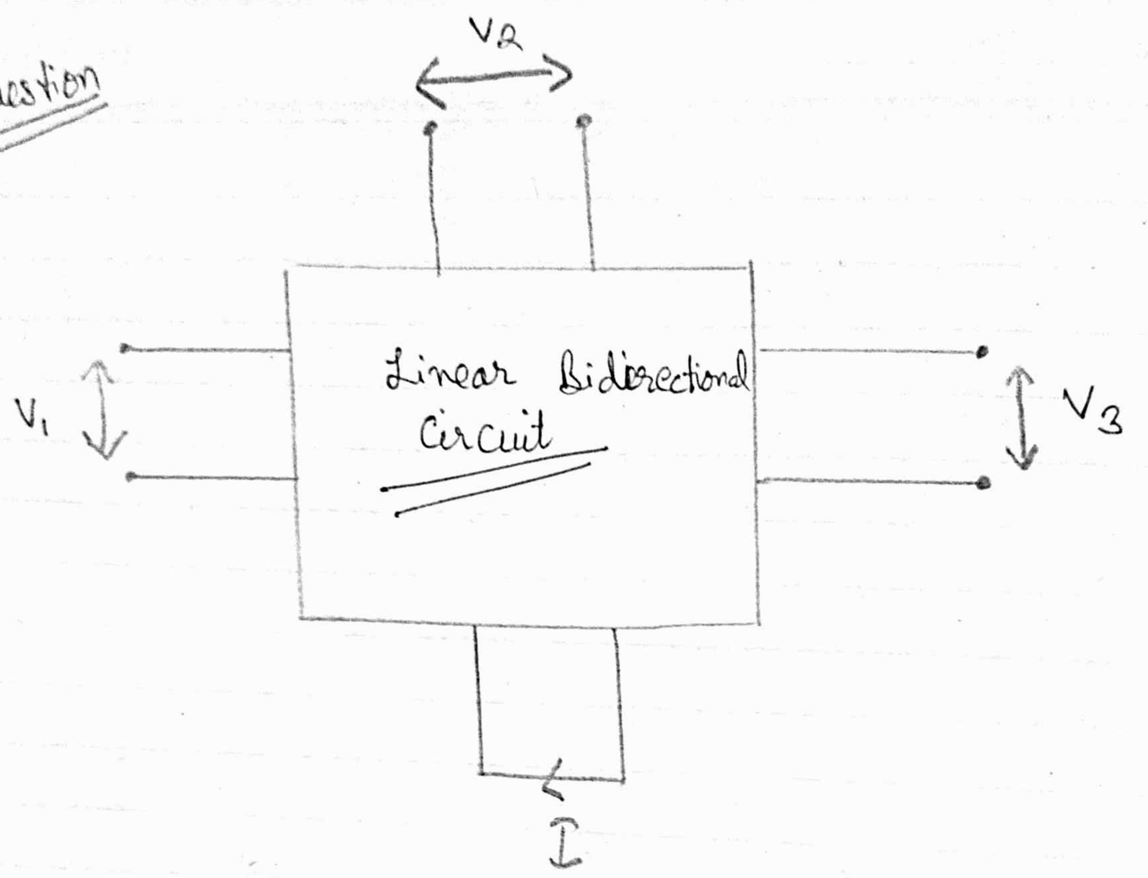
2nd Question



so, if $V_1 = 25V$, $V_2 = 15V$, $V_3 = 20V$

Then, $I_1 = \frac{25}{R_1} = \frac{25}{2} = 12.5$ Amp

$\because R_1 = 2\Omega$

$\because R_2 = 4/5\Omega$

$\because R_3 = -5/6\Omega$

$I_2 = \frac{15}{R_2} = \frac{15}{4/5} = \frac{75}{4} = 18.75$ Amp

$I_3 = \frac{20}{R_3} = \frac{20}{-5/6} = -24$ Amp

$I = I_1 + I_2 + I_3 = (12.5 + 18.75 - 24)A$

$\boxed{I = 7.25 \text{ Amp}}$ Answer

OR we can say, using linearity, if $V = IR$ then $aV = aIR$

Then $\Rightarrow 2 = 1 \times R_1 \Rightarrow 25 = \frac{25}{2} R_1$

$4 = 5 \times R_2 \Rightarrow 15 = \frac{75}{4} R_2$

$5 = -6R_3 \Rightarrow 20 = -24 R_3$

so, $I = \frac{25}{2} + \frac{75}{4} - 24$

$\Rightarrow$ ~~12.5~~ ~~7.5 Amp = I~~

$\boxed{I = 7.25 \text{ Amp}}$ Answer

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Method 2

∴ As system is linear we can also ~~do~~ do by making three eq.

$$\left.\begin{aligned} a x_1 + b y_1 + c z_1 &= d_1 \\ a x_2 + b y_2 + c z_2 &= d_2 \\ a x_3 + b y_3 + c z_3 &= d_3 \end{aligned}\right\} \quad a, b, c, d_1, d_2, d_3 \rightarrow \text{Variables.}$$

$a(2) + 0 + 0 = 1 \Rightarrow a = 1/2$

$0 + b(4) + 0 = 5 \Rightarrow b = 5/4$

$0 + 0 + c(5) = -6 \Rightarrow c = -6/5$

Now, $\frac{1}{2}(25) + \frac{5}{4}(15) - \frac{6}{5}(20) = \boxed{7.25 \text{ Amp}}$ Answer

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Question – 3 ~~Sol~~

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Question 3 : ~~As Question was little unclear, there are two solutions~~

~~Sol 1 ... Sol 2 where ... goes ...~~

∵ The given electronic device seems to be a ~~volt~~ Linear Voltage Regulator (IC-7805)

∵ ~~As~~, $(V_{in} - V_{out}) \geq 2$

∵ so atleast 2 volt is necessary for functioning of this voltage Regulator.

∵ Referecence Node / ~~Quies~~ Quiescent current (I_o) is Negligible so, $I_o \approx 0$.

∵ $(V_{out} - V_{reference}) = 5V$

∵ current source will deliver 0.25 current to 45 Ω, 100w ~~Regist~~ Resistor

∵ $\Rightarrow P = \frac{V^2}{R}$ ∵ $P = 100W$, $R = 45\Omega$

$\Rightarrow 100 = \frac{V^2}{45}$ $\Rightarrow V^2 = 45 \times 100$

$\Rightarrow V = \sqrt{45 \times 100} = 67.08V$

so, ∵ Max voltage that can appear across $R = 45\Omega = 67.08V$

Now Designing current source :

using ~~IC-78~~ IC-7805 Linear Voltage Regulator

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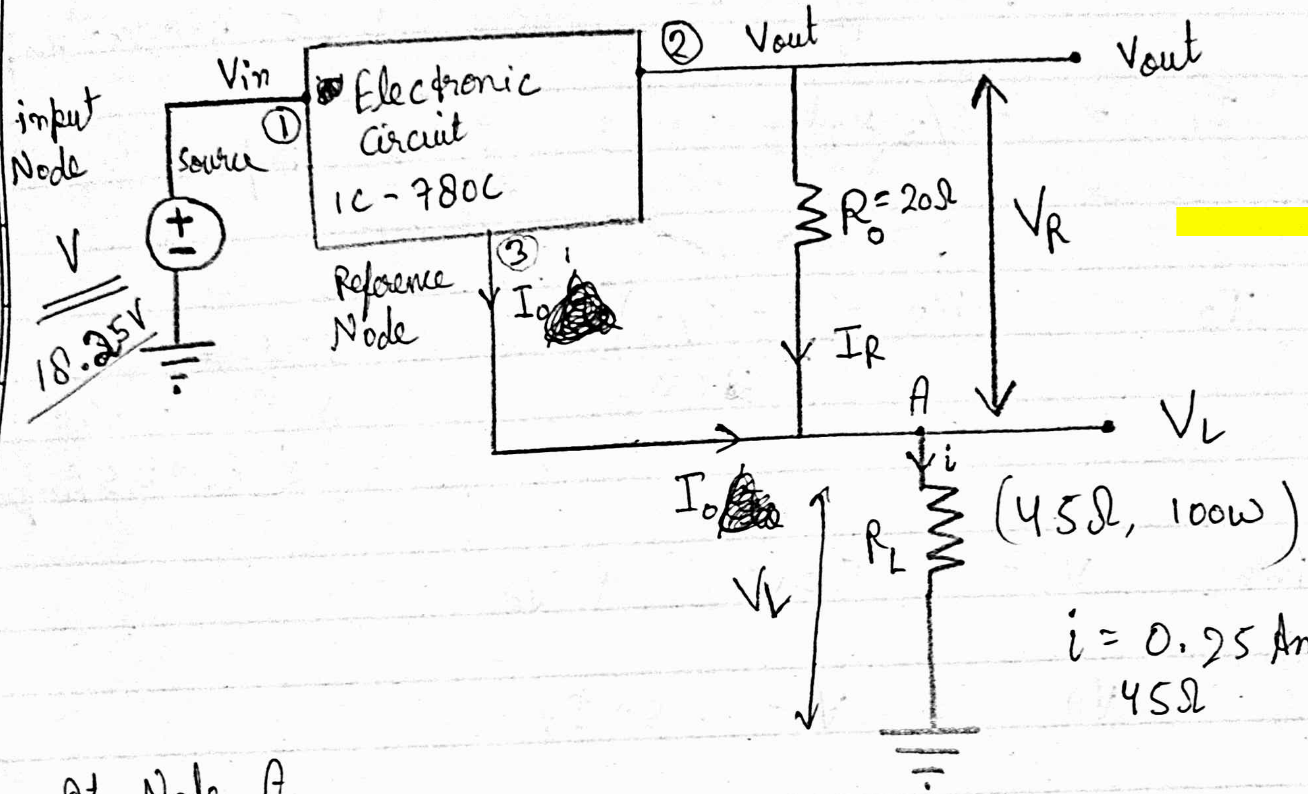
Question 3

Sol! Linear Voltage Regulator IC-7805



$i = 0.25$ Amp across 45Ω

At Node A

Power $= i^2 R_L \Rightarrow \frac{1}{4} \times \frac{1}{4} \times 45$
$= 2.8125W$

Use Nodal Analysis at A

~~$i = I_R + I_0 \cdot I_0$~~

$i = I_R + I_0$ $\quad \because I_0 \approx 0$ (given)

$i = I_R + 0$ $\quad \because V_R = V_{23} = V_2 - V_3 = V_{out} - V_{Reference}$

$i = I_R = \frac{V_R}{R}$ $\quad \because V_R = V_{23} = 5$ Volt

$\because i = 0.25$ Amp (given)

$i = \frac{5}{R_0} = 0.25 = \frac{1}{4}$

$\Rightarrow R_0 = 20\Omega$ $\quad \Rightarrow$ So, $\boxed{R_0 = 20\Omega}$

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So, $R_o = 20\Omega$ for $i = 0.25$ across 45Ω

V_{across} ~~R_L~~ Load R_L

$V_{across}\ 45\Omega = i \times R_L = \frac{1}{4} \times 45 = 11.25V$

as $11.25V < 67.08V$ $\because$ 67.08 Max allowed voltage

Output voltage $V_{out} = V_R + V_L$
$= 5 + 11.25$
$= 16.25\ V$

Also, $(V_{in} - V_{out}) \geq 2$ $\because$ given

$V_{in} \geq V_{out} + 2$

$V_{in} \geq 16.25 + 2$

$V_{in} \geq 18.25\ V$

So, Min ~~voltage~~ input Voltage, $V_{in} \geq$ 18.25 Volt

source referred for Ques 3

https://www.circuitstoday.com/fixed-positive-voltage-regulators

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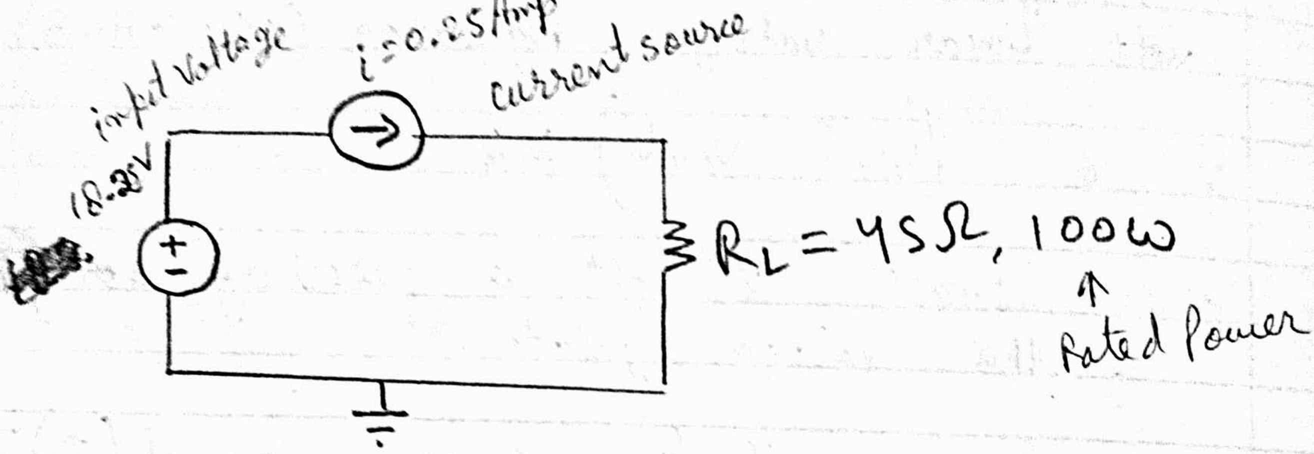
input voltage
18.25V
i=0.25 Amp
current source
R_L = 45Ω, 100W
Rated Power