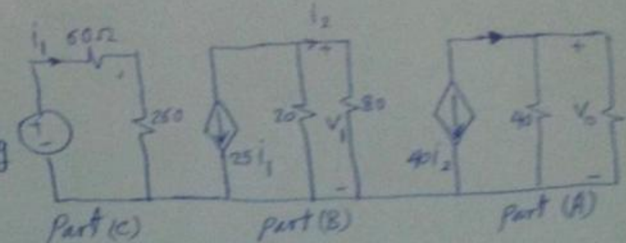
Question(1):



Given: $V_o = 5V$

Required: V_g & V_1

Solution:

*** Part (A)**

$\because V_o = 5\ V$

$\therefore i_{10\Omega} = 5/10 = 0.5\ A$

$\therefore i_{40\Omega} = 5/40 = 0.125\ A$

$\therefore 40 i_2 = -(i_{10\Omega} + i_{40\Omega}) = -0.625 \longrightarrow i_2 = -0.015625\ A = -15.625\ mA$

*** Part (B)**

$\because i_2 = -15.625\ mA$

$\therefore V_1 = i_2 * 80 = -1.25\ V$

$\therefore i_{20\Omega} = V_1/20 = -1.25/20 = -62.5\ mA$

$\therefore 25 i_1 = -(i_2 + i_{20\Omega}) = -(-15.625m - 62.5m) = 78.125m \longrightarrow i_1 = 3.125\ mA$

*** Part (C)**

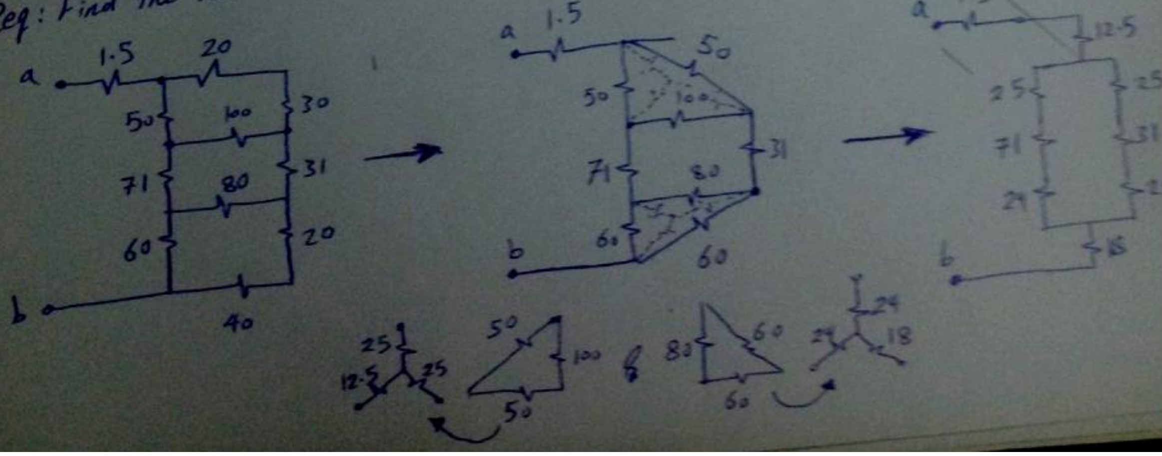
$\because i_1 = 3.125\ mA$

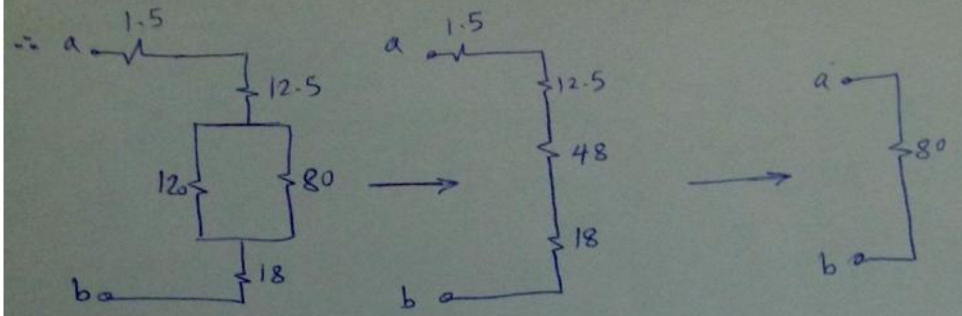
$\therefore V_g = i_1(60 + 260) = 3.125m * 320 = 1000\ mV = 1V$

$\therefore V_g = 1V$ & $V_1 = -1.25V$ ...... Req #

Question(2):

Req: Find the Resistance seen by the Source

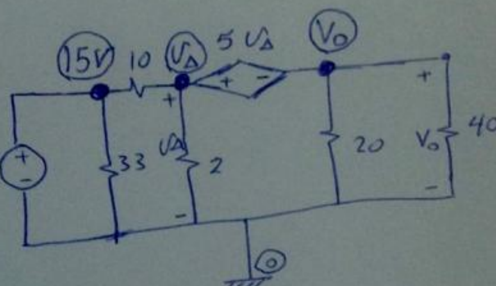




∴ $R_{ab} = 80\,\Omega$

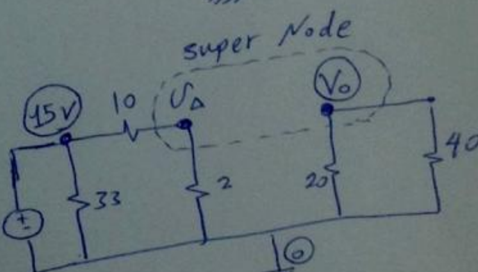
Question(3):

Using Node-Voltage to find V_o:



Solution:

Firstly: If there is Voltage Source between two unknown node Voltages then (**Super Node**) is used



① $V_\Delta - V_o = 5V_\Delta$ ...... ①

② Apply KCL at the superNode:

$$\frac{V_\Delta}{2} + \frac{V_\Delta - 15}{10} + \frac{V_o}{20} + \frac{V_o}{40} = 0 \quad *(40)$$

$$\therefore 20V_\Delta + 4V_\Delta - 60 + 2V_o + V_o = 0$$

$$\therefore 24V_\Delta + 3V_o = 60 \quad \text{.....} ②$$

From ①, ② : $24V_\Delta + 3(-4V_\Delta) = 60$

$$\therefore V_\Delta = 5\,V$$

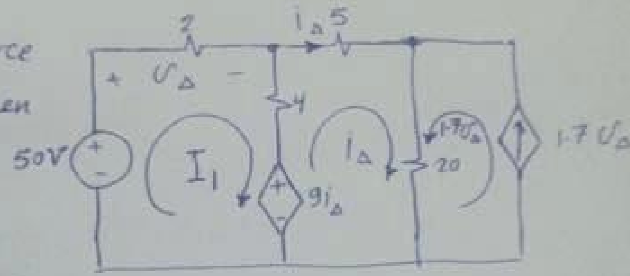
$$V_o = -20\,V \quad \text{.....} \quad \text{Req. \#}$$

Question (4):

Using Mesh current

Firstly: If there is current source between two unknown meshes then (super mesh) is used.

Ans: None



① Apply KVL at I_1:

$$-50 + 2I_1 + 4(I_1 - i_\Delta) + 9i_\Delta = 0$$

$$6I_1 + 5i_\Delta = 50 \quad \ldots\ldots ①$$

② Apply KVL at i_Δ:

$$-9i_\Delta + 4(i_\Delta - I_1) + 5i_\Delta + 20(i_\Delta + 1.7\,v_\Delta) = 0$$

$$-4I_1 + 20\,i_\Delta + 34\,v_\Delta = 0 \quad \ldots\ldots ②$$

③ $v_\Delta = 2I_1 \quad \ldots\ldots ③$

From ②, ③: $-4I_1 + 20\,i_\Delta + 34 * 2I_1 = 0$

$$64\,I_1 + 20\,i_\Delta = 0 \quad \ldots ④$$

From ①, ④:

$$24\,I_1 + 20\,i_\Delta = 200 \quad ①$$

$$-\;64\,I_1 + 20\,i_\Delta = 0 \quad ④$$

$$-\,40I_1 = 200$$

$$\therefore\; I_1 = -5A \quad \& \quad i_\Delta = 16A$$

$\therefore P_{50V} = \ominus\, 50 * I_1 = +250\,W$ .... absorping

$P_{9i_\Delta} = \oplus\, 9i_\Delta * (I_1 - i_\Delta) = -3024\,W$ .... generating

$P_{1.7v_\Delta} = \ominus\, 1.7\,v_\Delta * (20(i_\Delta + 1.7v_\Delta)) = -(-17) * (-20) = -340\,W$ .... generatin

∴ The sources that generating power are the dependent sources $9i_\Delta$ & $1.7\,v_\Delta$ ..... Req.(1) #

$P_{dissipated} = P_{2\Omega} + P_{4\Omega} + P_{5\Omega} + P_{20\Omega} + P_{50V}$

$= (I_1^2 * 2) + [(I_1 - i_\Delta)^2 * 4] + (i_\Delta^2 * 5) + [(i_\Delta + 1.7 v_\Delta)^2 * 20]$

$+ P_{50V}$

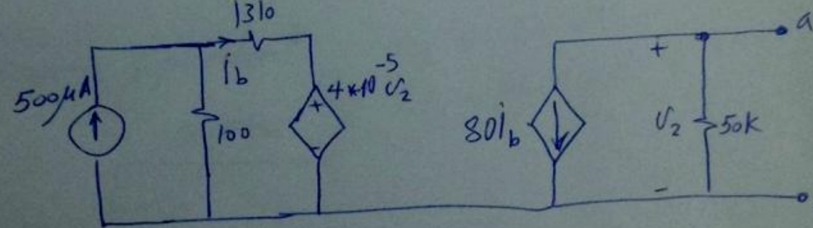
$= 50 + 1764 + 1280 + 20 + 250 =$

$P_{dissipated} = 3364\ W$ .... Req.(2) #

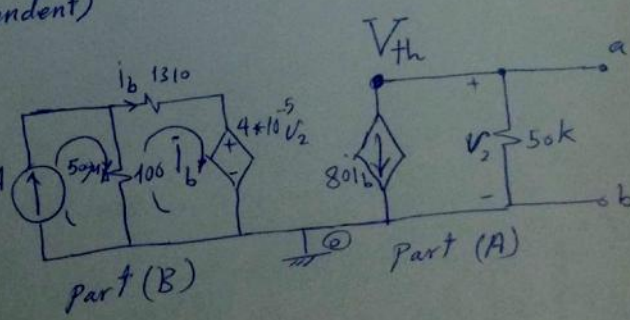
$P_{generating} = -3024 - 340 = -3364\ W$ ..... For check

Question(5):

Find thevenin eq.



Solution: (Dependent + Independent)



① $V_{th} = V_{o.c}|_{ab}$

Part (A)

$V_{th} = V_2 = -(80 i_b * 50k)$ ---①

Part (B)

*using Mesh current method:

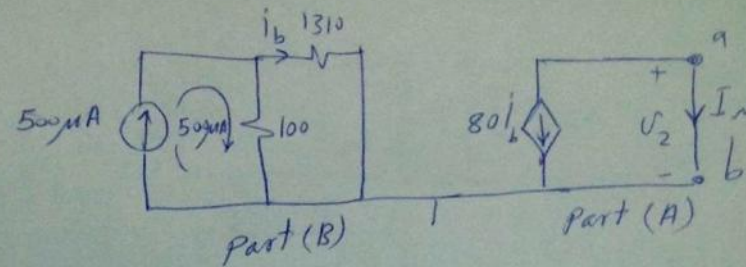
*Apply KVL at i_b:

$100(i_b - 500\mu) + 1310\, i_b + 4*10^{-5}\, v_2 = 0$ ---②

Apply ① in ②: $100 i_b - 0.05 + 1310 i_b + (4*10^{-5} * -80 i_b * 50k) =$

∴ $1250\, i_b = 0.05$ ∴ $i_b = 40\,\mu A$ ∴ $V_{th} = -160\ V$

② $I_N = I_{s.c}\Big|_{ab}$



Part (A):

$I_N = -80\, i_b$

$V_2 = 0$

part (B):

$\because V_2 = 0 \quad \therefore$ Source $(4 * 10^{-5}\, V_2) = 0$

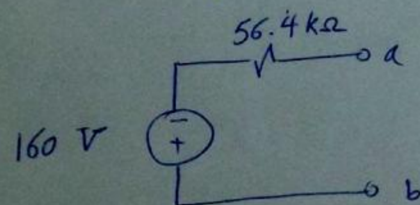
$\therefore i_b = 500\mu * \frac{100}{100 + 1310} = 35.461\ \mu A$

$\therefore I_N = \underline{\underline{-2.8369\ mA}}$

③ $R_{th} = V_{th} / I_N = \underline{\underline{56.4\ k\Omega}}$

$\therefore$ Thevenin Equivalent $\quad V_{th} = -160\ V$

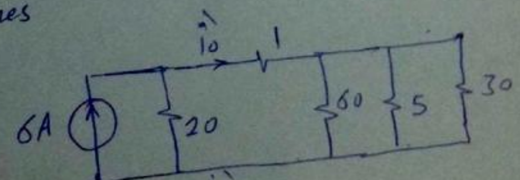
$R_{th} = 56.4\ k\Omega$



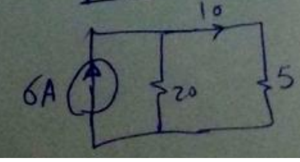
Question (6):

using superposition find $\underline{i_o}$:

① using ⑥A source and cancel the other ones

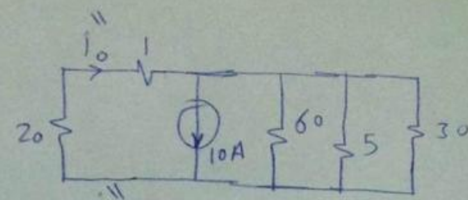


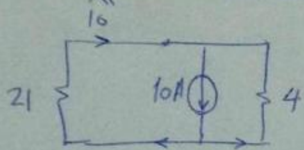
$\therefore i_o' = 6 * \frac{20}{20+5} = 4.8\ A$



② Using (10 A) Source

$\therefore i_o'' = 10 * \frac{4}{4+21} = 1.6A$

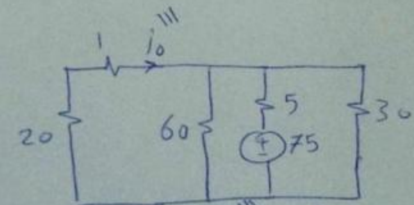


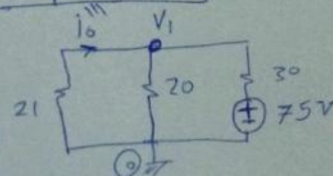


③ using (75V) Source

using Node voltage:

$\frac{V_1}{20} + \frac{V_1}{21} + \frac{V_1 - 75}{30} = 0$





$\therefore \frac{3}{2} V_1 + \frac{10}{7} V_1 + V_1 - 75 = 0$

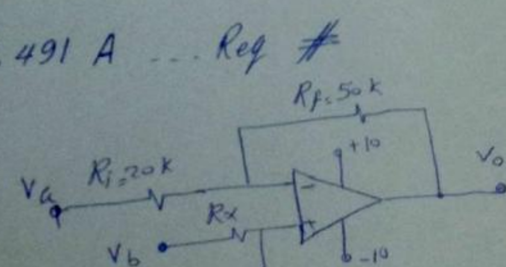
$\therefore \frac{55}{14} V_1 = 75 \qquad \therefore V_1 = 19.091\ V$

$\therefore i_o''' = \frac{-V_1}{21} = -0.9091\ A$

$\therefore$ From ①, ②, ③: $\quad i_o = i_o' + i_o'' + i_o'''$

$\therefore i_o = 5.491\ A$ ... Req #

Question (7):



Saturation occurs when:
$10 \leq V_o \leq -10$

$V_o = \pm V_{cc} = \pm 10\ V$

$V_o = (1 + \frac{R_f}{R_i})(\frac{50k}{R_x + 50k}) V_b - \frac{R_f}{R_i} V_a$

$V_o = (1 + 2.5)(\frac{50k}{R_x + 50k}) V_b - 2.5 V_a$

$V_o = (\frac{175k}{R_x + 50k}) V_b - 2.5 V_a$

$\therefore (R_x + 50k) = \frac{175k * V_b}{V_o + 2.5 V_a}$

$\therefore \boxed{R_x = \frac{175K * V_b}{\pm 10 + 2.5 V_a} - 50K}$