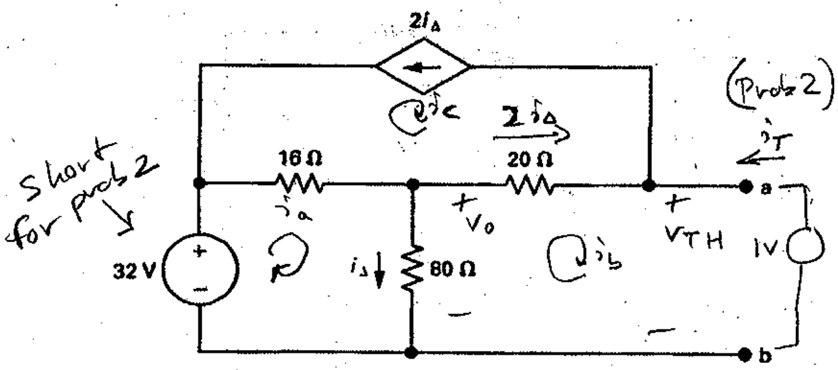
ENGR 12 TEST 2 5(0 NAME SOLUTIONS

1) Use the **node voltage method** to find the Thevenin voltage of this circuit at a-b. The answer is a whole number.

NV

$$\frac{V_0 - 32}{16} + \frac{V_0}{80} + 2i_\Delta = 0$$

$$i_\Delta = \frac{V_0}{80}$$



$$\frac{V_0 - 32}{16} + \frac{3V_0}{80} = 0$$

$$5V_0 + 3V_0 = 160$$

$$V_0 = 20, \quad i_\Delta = \frac{1}{4}$$

KVL: $-V_0 + 40i_\Delta + V_{TH} = 0$

$$V_{TH} = V_0 - 10 = \underline{\underline{10\,V}}$$

2) Now, for the same circuit above, turn off the **independent** source, connect a 1V Test power supply to terminals a-b and use the **mesh current method** to find the Thevenin Resistance. (Hint: this reduces quickly to 2 eqs, 2 unknowns that are not hard to solve. The answer for Rth is a whole number).

$\boxed{I_A}$

$$16(i_a - i_c) + 80(i_a - i_b) = 0$$

$$i_c = -2i_\Delta = -2(i_a - i_b)$$

$$16(i_a + 2i_a - 2i_b) + 80(i_a - i_b) = 0$$

$$128 i_a = 112 i_b$$

$$\underline{i_a = .875 i_b}$$

$\boxed{I_B}$

$$80(i_b - i_a) + 20(i_b - i_c) + 1 = 0$$

$$80(i_b - i_a) + 20(i_b + 2i_a - 2i_b) + 1 = 0$$

$$60 i_b - 40 i_a = -1$$

$$60 i_b - 40(.875) i_b = -1$$

$$i_b(60 - 35) = -1$$

$$i_b = -\frac{1}{25}$$

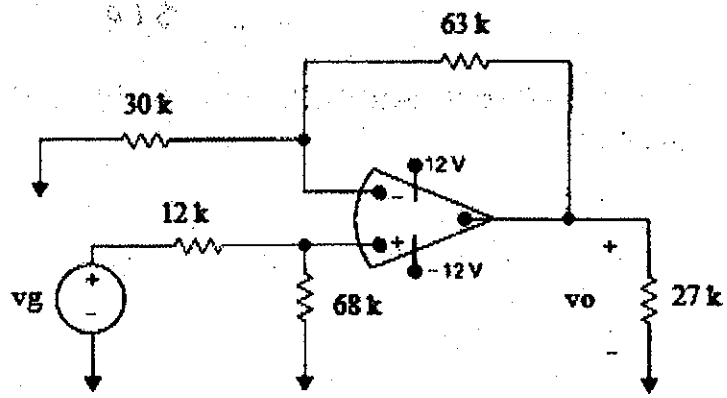
$$i_T = \frac{1}{25}, \quad \therefore R_{TH} = \frac{V_T}{i_T} = \frac{1}{\frac{1}{25}} = \underline{\underline{25\,\Omega}}$$

3) The op-amp in the circuit shown is ideal.

a) Calculate Vo when Vg = 4 V

b) Specify the range of values of Vg so that the op-amp remains in linear mode.

c) Assume that Vg = 2V and that the 63k resistor is replaced with a variable resistor. What value of the variable resistor will cause the op-amp to saturate?



a) neg feedback, assume Vo linear, $V+ \equiv V-$

$$V_+ = \frac{V_g\ 68}{12+68} = V_g(.85) = 4(.85) = 3.4$$

$\therefore V_- = 3.4$

<u>NV at V_-:</u> $\frac{3.4}{30} + \frac{3.4 - V_o}{63} = 0$

$$V_o = \frac{63(3.4)}{30} + 3.4 = \underline{10.54\ V}$$

b) $V_o = \left(\frac{63}{30} + 1\right) V_- = \left(\frac{63}{30} + 1\right)(.85)V_g = 2.635\ V_g$

when $V_o = 12$, $V_g = \frac{12}{2.635} = 4.55$

$V_o = -12$, $V_g = -4.55$

$$-4.55 < V_g < 4.55$$

c) $V_o = \left(\frac{R}{30} + 1\right) .85\ V_g = 12$

$V_g = 2$

$\therefore \left(\frac{R}{30} + 1\right) = \frac{12}{(.85)2} = \frac{6}{.85}$

$$R = \left(\frac{6}{.85} - 1\right) 30 = \underline{181.76\ k\Omega}$$