Benha University | **1st Term 2013-2014**
Benha Faculty of Engineering | **Electrical Department**
Electrical Engineering and Circuit Analysis(a) (E1101) | **1st Year Electrical**
Dr.Wael Abdel-Rahman Mohamed | **Time: 3 Hrs**

Model Answer

Question (1): **[12 Marks]**

$$40i_2 + \frac{5}{40} + \frac{5}{10} = 0; \quad i_2 = -15.625 \text{ mA}$$

$$v_1 = 80i_2 = -1.25 \text{ V}$$

$$25i_1 + \frac{(-1.25)}{20} + (-0.015625) = 0; \quad i_1 = 3.125 \text{ mA}$$

$$v_g = 60i_1 + 260i_1 = 320i_1$$

Therefore, $v_g = 1$ V.

Question (2): **[12 Marks]**

Convert the upper delta to a wye.

$$R_1 = \frac{(50)(50)}{200} = 12.5\,\Omega$$

$$R_2 = \frac{(50)(100)}{200} = 25\,\Omega$$

$$R_3 = \frac{(100)(50)}{200} = 25\,\Omega$$

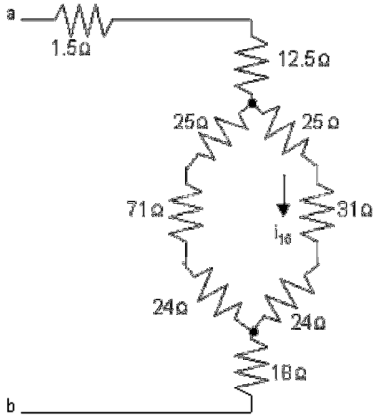
Convert the lower delta to a wye.

$$R_4 = \frac{(60)(80)}{200} = 24\,\Omega$$

$$R_5 = \frac{(60)(60)}{200} = 18\,\Omega$$

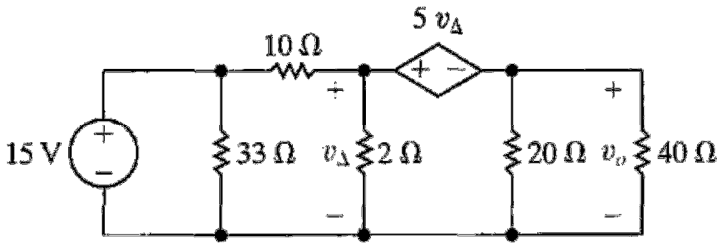
$$R_6 = \frac{(80)(60)}{200} = 24\,\Omega$$

Now redraw the circuit using the wye equivalents.



$$R_{ab} = 1.5 + 12.5 + \frac{(120)(80)}{200} + 18 = 14 + 48 + 18 = 80\,\Omega$$

Question (3): **[15 Marks]**



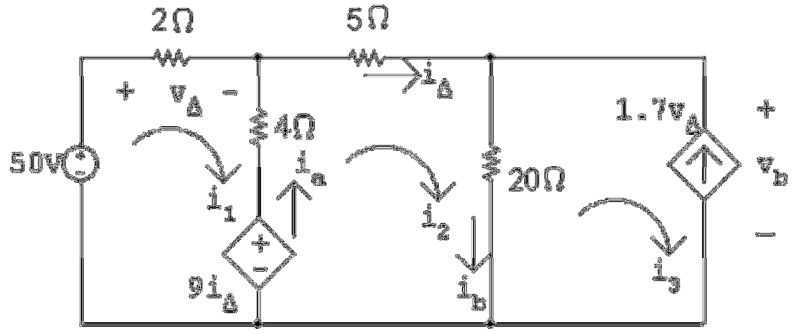
Place $5v_\Delta$ inside a supernode and use the lower node as a reference. Then

$$\frac{v_\Delta - 15}{10} + \frac{v_\Delta}{2} + \frac{v_\Delta - 5v_\Delta}{20} + \frac{v_\Delta - 5v_\Delta}{40} = 0$$

$$12v_\Delta = 60; \qquad v_\Delta = 5 \text{ V}$$

$$v_o = v_\Delta - 5v_\Delta = -4(5) = -20 \text{ V}$$

Question (4): **[15 Marks]**



Mesh equations:

$$-50 + 6i_1 - 4i_2 + 9i_\Delta = 0$$

$$-9i_\Delta - 4i_1 + 29i_2 - 20i_3 = 0$$

Constraint equations:

$$i_\Delta = i_2; \qquad i_3 = -1.7v_\Delta; \qquad v_\Delta = 2i_1$$

Solving, $i_1 = -5$ A; $i_2 = 16$ A; $i_3 = 17$ A; $v_\Delta = -10$ V

$$9i_\Delta = 9(16) = 144 \text{ V}$$

$$i_\text{a} = i_2 - i_1 = 21 \text{ A}$$

$$i_\text{b} = i_2 - i_3 = -1 \text{ A}$$

$$v_\text{b} = 20i_\text{b} = -20 \text{ V}$$

$$p_{50\text{V}} = -50i_1 = 250 \text{ W (absorbing)}$$

$$p_{9i_\Delta} = -i_\text{a}(9i_\Delta) = -(21)(144) = -3024 \text{ W (delivering)}$$

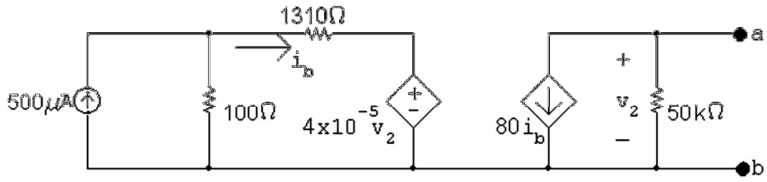
$$p_{1.7\text{V}} = -1.7v_\Delta v_\text{b} = i_3 v_\text{b} = (17)(-20) = -340 \text{ W (delivering)}$$

$$\sum P_\text{dev} = 3024 + 340 = 3364 \text{ W}$$

$$\sum P_\text{dis} = 250 + (-5)^2(2) + (21)^2(4) + (16)^2(5) + (-1)^2(20)$$

$$= 3364 \text{ W}$$

Question (5): **[14 Marks]**



OPEN CIRCUIT

$v_2 = -80i_b(50 \times 10^3) = -40 \times 10^5 i_b$

$4 \times 10^{-5} v_2 = -160 i_b$

$1310 i_b + 4 \times 10^{-5} v_2 = 1310 i_b - 160 i_b = 1150 i_b$

So $1150 i_b$ is the voltage across the $100\,\Omega$ resistor.

From KCL at the top left node, $\quad 500\,\mu\text{A} = \dfrac{1150 i_b}{100} + i_b = 12.5 i_b$

$$\therefore \quad i_b = \frac{500 \times 10^{-6}}{12.5} = 40\,\mu\text{A}$$

$$v_{\text{Th}} = -40 \times 10^5 (40 \times 10^{-6}) = -160 \text{ V}$$

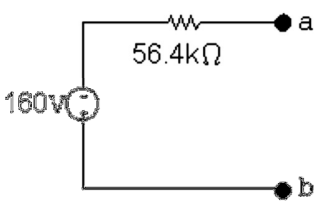
SHORT CIRCUIT

$v_2 = 0; \qquad i_{\text{sc}} = -80 i_b$

$$i_b = \frac{100}{100 + 1310}(500 \times 10^{-6}) = 35.46\,\mu\text{A}$$

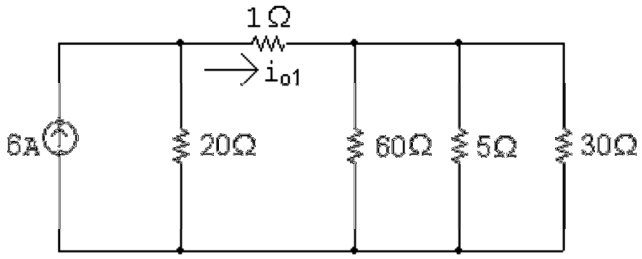
$$i_{\text{sc}} = -80(35.46) = -2837\,\mu\text{A}$$

$$R_{\text{Th}} = \frac{-160}{-2837 \times 10^{-6}} = 56.4 \text{ k}\Omega$$



Question (6): **[12 Marks]**

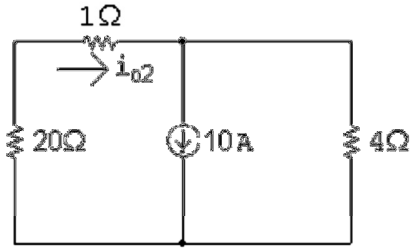
6 A source:



$$30\,\Omega \| 5\,\Omega \| 60\,\Omega = 4\,\Omega$$

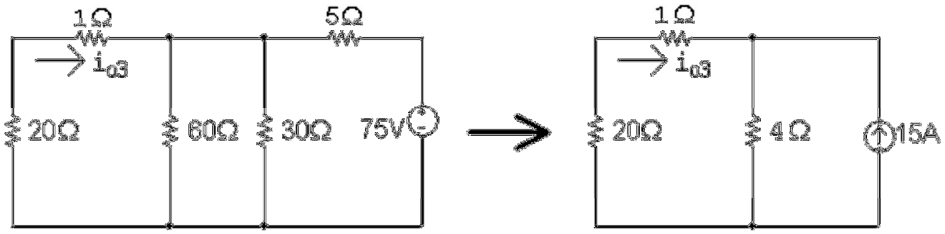
$$\therefore \quad i_{o1} = \frac{20}{20+5}(6) = 4.8 \text{ A}$$

10 A source:



$$i_{o2} = \frac{4}{25}(10) = 1.6 \text{ A}$$

75 V source:



$$i_{o3} = -\frac{4}{25}(15) = -2.4 \text{ A}$$

$$i_o = i_{o1} + i_{o2} + i_{o3} = 4.8 + 1.6 - 2.4 = 4 \text{ A}$$

Question (7): **[10 Marks]**

In the difference amplifier shown in Fig.7, what range of values of R_x yields saturation in both directions?

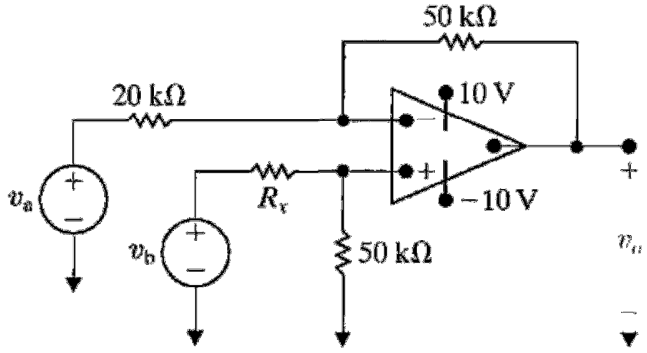
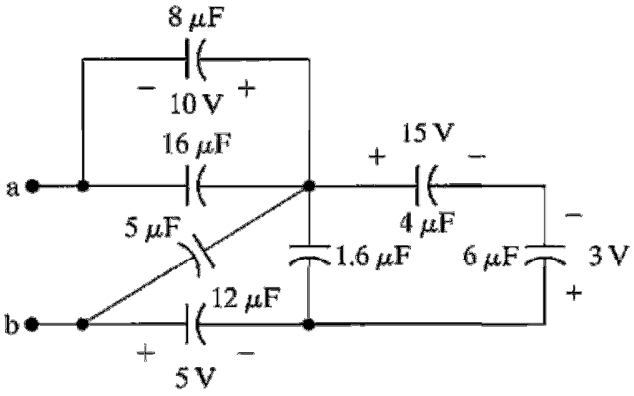


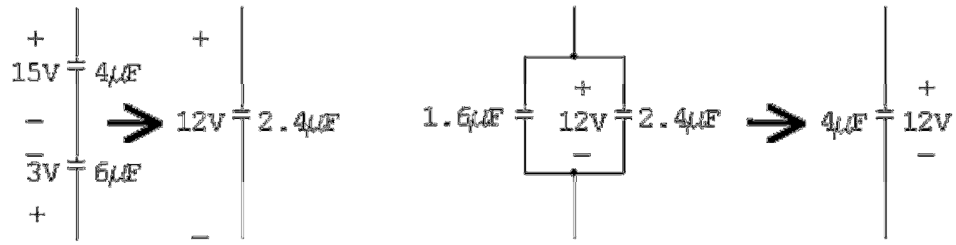
Fig.7

Solve by yourself.

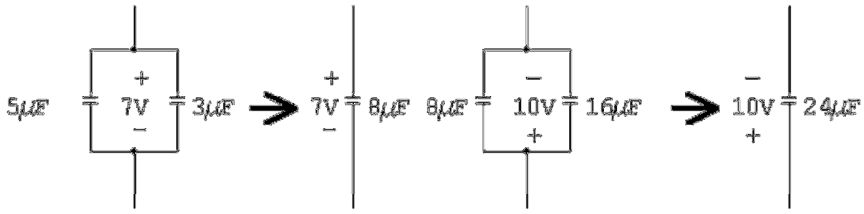
Question (8): **[10 Marks]**



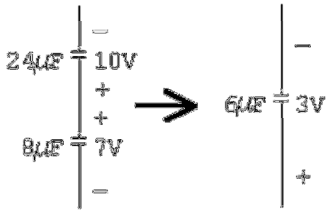
$$\frac{1}{4}+\frac{1}{6}=\frac{5}{12} \quad \therefore \quad C_{\text{eq}}=2.4\,\mu\text{F}$$



$$\frac{1}{4}+\frac{1}{12}=\frac{4}{12} \quad \therefore \quad C_{\text{eq}}=3\,\mu\text{F}$$



$$\frac{1}{24}+\frac{1}{8}=\frac{4}{24} \quad \therefore \quad C_{\text{eq}}=6\,\mu\text{F}$$



Complete your solution using $Q = \frac{1}{2} CV^2$

With best wishes