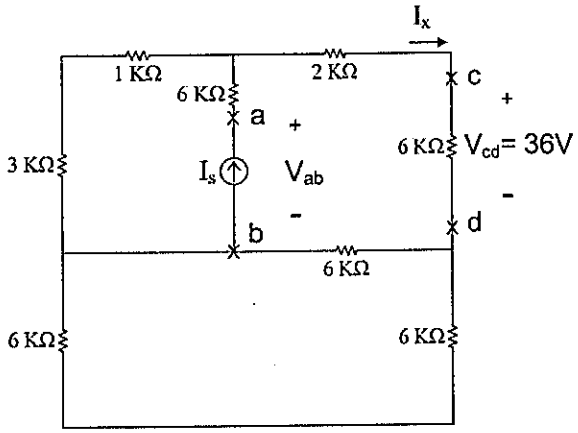
1. [10 marks] For the circuit shown below, use circuit reduction, voltage division, current division, KCL, KVL and Ohm's law to calculate:

(a) Current I_x. **(1 mark)**

(b) Current I_s. **(4 marks)** (***Hint:*** ***You may need to simplify the circuit first)***

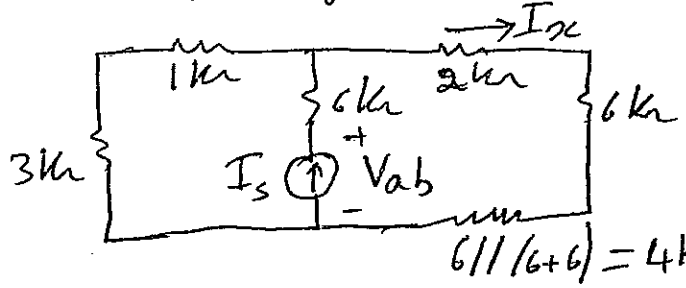
(c) Voltage V_{ab}. **(3 marks)**

(d) R_{ab}, the equivalent resistance between the two points a and b seen by the current source. **(2 marks)**



(a) $I_x = \frac{V_{cd}}{6} = \frac{36}{6} = 6\,mA$

(b)



By Current division : $I_x = I_s \frac{4}{4+2+6+4}$ so $I_s = 4I_x = 24\,mA$

(c) $V_{ab} = 6I_s + (2+6+4)I_x = 6I_s + 12I_x = 216\,V$

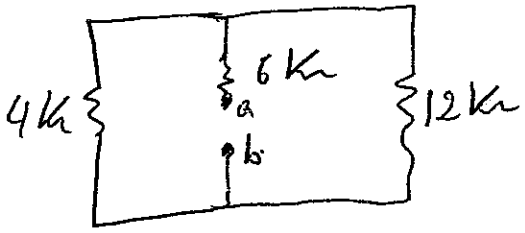
By KVL

(d) $R_{ab} = \frac{V_{ab}}{I_s} = \frac{216}{24} = 9k\Omega$

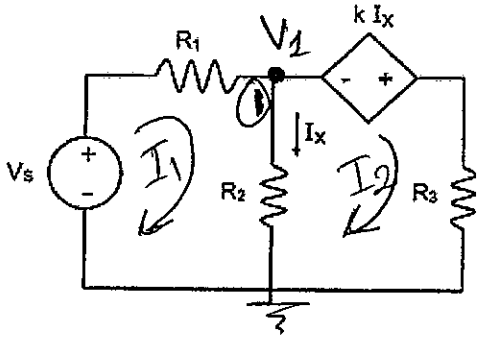
or

$R_{ab} = 6 + (4 // 12)$

$= 9k\Omega$



2. [10 marks] For the circuit shown where V_S, k, R_1, R_2 and R_3 are constants:
   (a) Write the equations for nodal analysis. **(5 marks)**
   (b) Write the equations for mesh (loop) analysis. **(5 marks)**



(a) $\frac{V_1 - V_S}{R_1} + \frac{V_1}{R_2} + \frac{V_1 + kI_x}{R_3} = 0$ (KCL at node ①)

$I_x = \frac{V_1}{R_2}$ (Dependent variable equation)

(b) $-V_S + I_1 R_1 + (I_1 - I_2) R_2 = 0$ (KVL$_1$)

$-kI_x + I_2 R_3 + (I_2 - I_1) R_2 = 0$ (KVL$_2$)

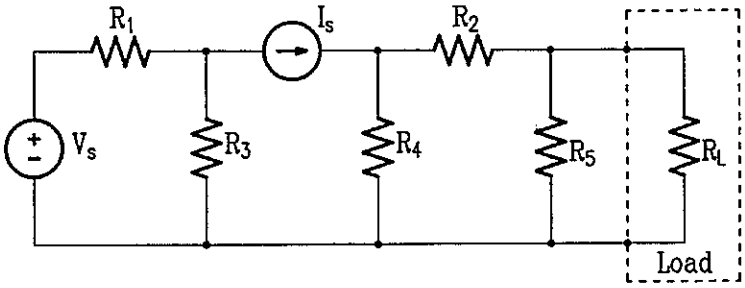
$I_x = I_1 - I_2$ (Dependent variable equation)

3. [10 marks] Consider the circuit below. Known parameters are: $R_1 = 50\ \Omega$, $R_2 = 20\ \Omega$, $R_3 = 50\ \Omega$, $R_4 = 100\ \Omega$, $R_5 = 80\ \Omega$, $V_s = 20$ V, and $I_s = 20$ A. Determine the following:

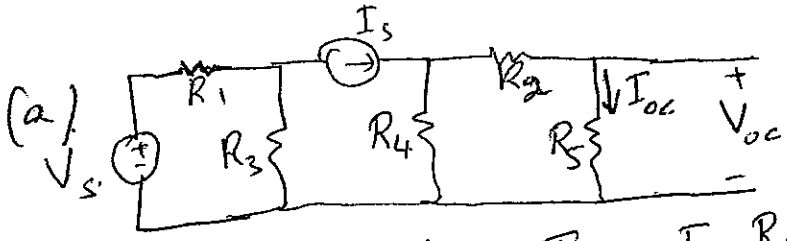
(a) Thevenin equivalent voltage seen by the load. **(4 marks)**

(b) Thevenin equivalent resistance seen by the load. **(3 marks)**

(c) What is the power transferred to the load, if the load resistance is $R_L = 32\ \Omega$. **(3 marks)**



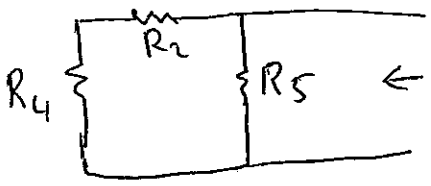
(a)



By current Division $I_{oc} = \frac{I_s R_4}{R_4 + R_2 + R_5} = 20\ \frac{100}{100+100} = 10A$

so $V_{th} = V_{oc} = I_{oc} R_5 = (10)(80) = 800V$

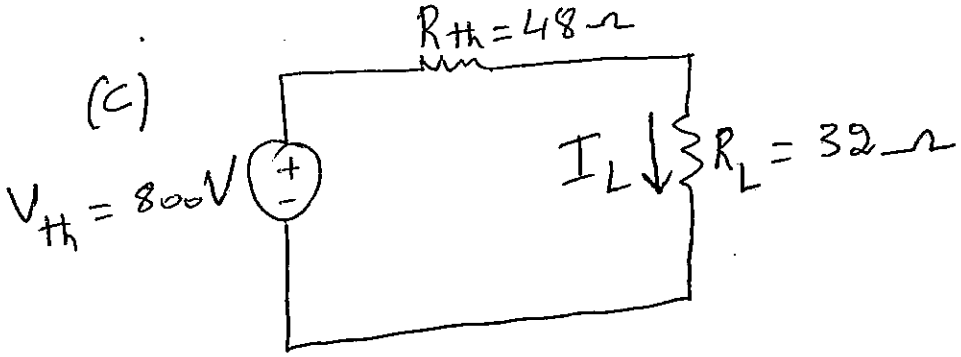
(b)



$\leftarrow R_{th} = R_5 // (R_2 + R_4) = \frac{(80)(120)}{80+120}$

$= \frac{(80)(120)}{200} = 48\ \Omega$

(c)



$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{800}{48+32} = 10A$

$P_L = I_L^2 R_L = (10)^2 (32) = 3200\ W$