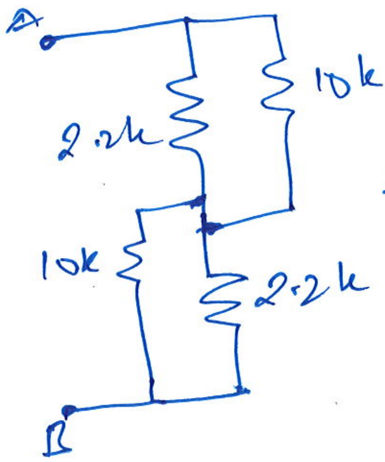
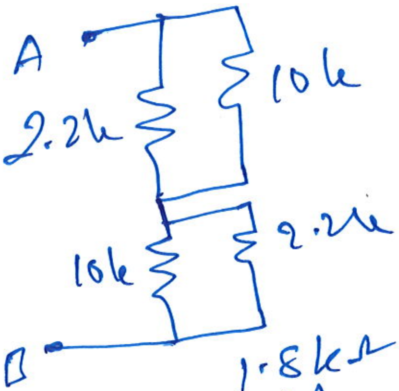
EECE105L TUTORIAL Sheet 3

SOLUTIONS

1) fig-1:



$\Rightarrow$



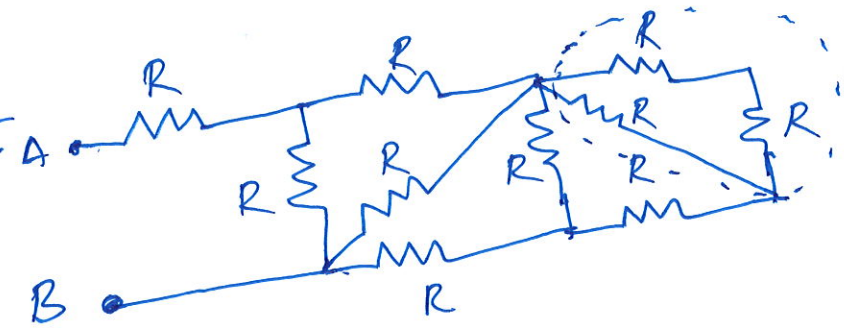
$2.2k \,||\, 10k = \dfrac{1}{(1/2.2k) + (1/10k)} = 1.8\,k\Omega$

$\Rightarrow$

$\Rightarrow$

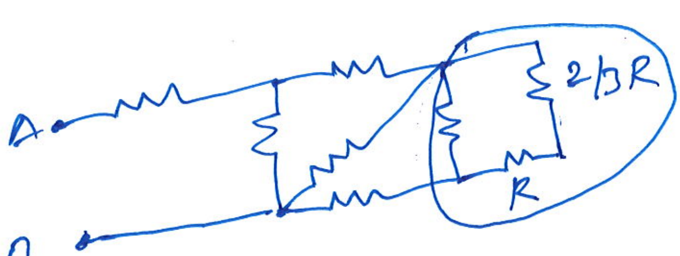
$R_T = 3.6\,k\Omega$

Fig. 2



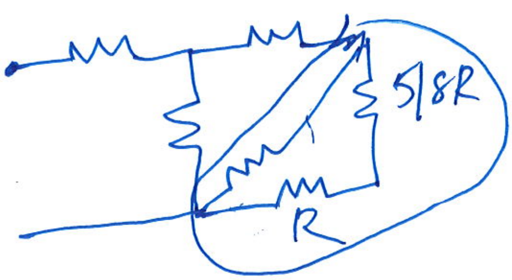
$R \,||\, 2R = \frac{2}{3}R$

$\Rightarrow$

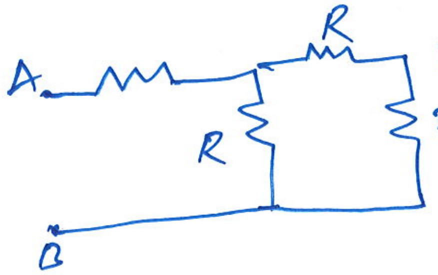


$\frac{2}{3}R + R = \frac{5}{3}R$; $R \,||\, \frac{5}{3}R = 5/8R$

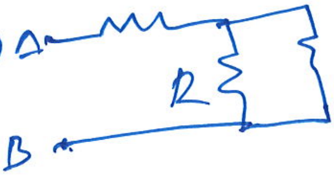
$\Rightarrow$



$\frac{5}{8}R + R = \frac{13}{8}R$; $\frac{13}{8}R \,||\, R$ $= \cancel{21/13}\,R$ $= (8/21)\,R$



$R+\left[R \,\|\, \left(R+\frac{13}{21}R\right)\right]$

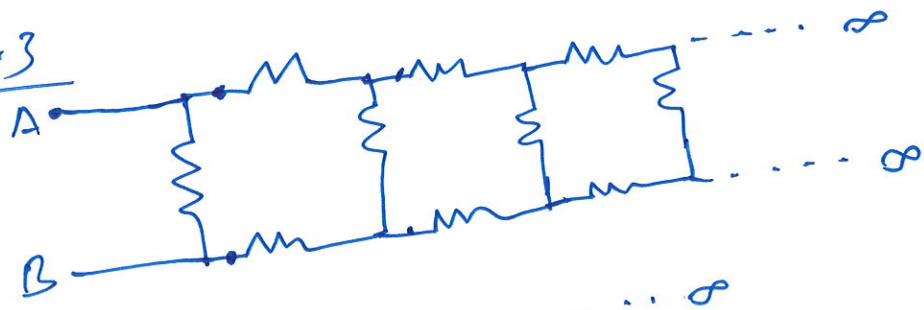
$\Rightarrow$ 

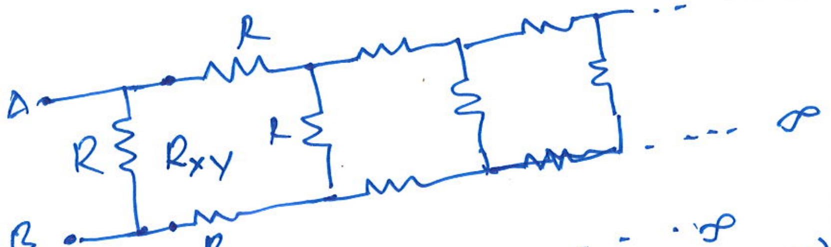
$\frac{34}{55}R \,\|\, R = \frac{89}{55}R$

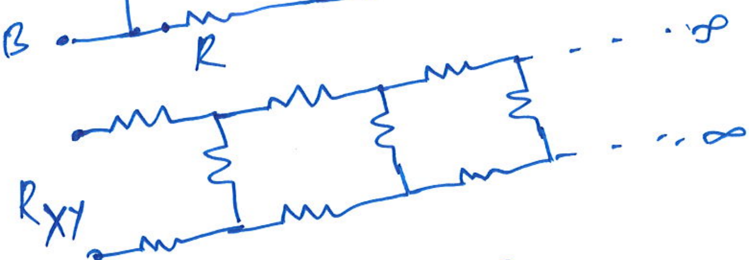
$= 1.62R$

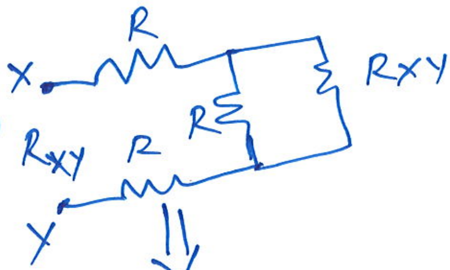
$R = 1k\Omega \Rightarrow \underline{R_{AB} = 1.62\,k\Omega}$

Fig. 3

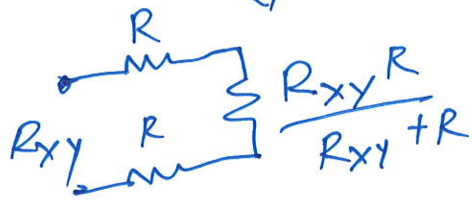






$\Rightarrow$ 

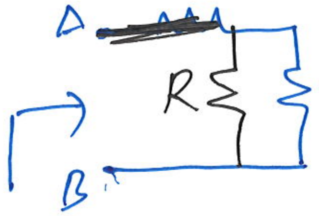
$\Downarrow$



$$R \,\|\, R_{xy} = \frac{R_{xy}R}{R_{xy}+R}$$

$$R_{xy} = 2R + \frac{R_{xy}R}{R_{xy}+R} \Rightarrow R_{xy}^2 - 2RR_{xy} - 2R^2 = 0$$

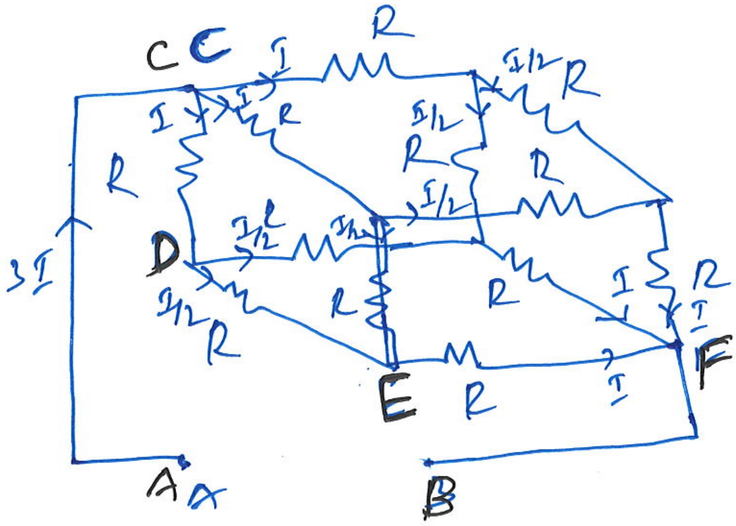
solving for R_{xy}: $R_{xy} = (\sqrt{3}+1)R$



$$\cancel{R_{AB} = (\sqrt{3}+2)R}$$

$$R_{AB} = R \,||\, (\sqrt{3}+1)R = \left(\frac{\sqrt{3}+1}{\sqrt{3}+2}\right)R$$

Fig. 4 Cuboid



Let $V_{AB} = V$
Current through circuit be $3I$.

KVL for loop ACDEFBA :

$$IR + \frac{I}{2}R + IR = V$$

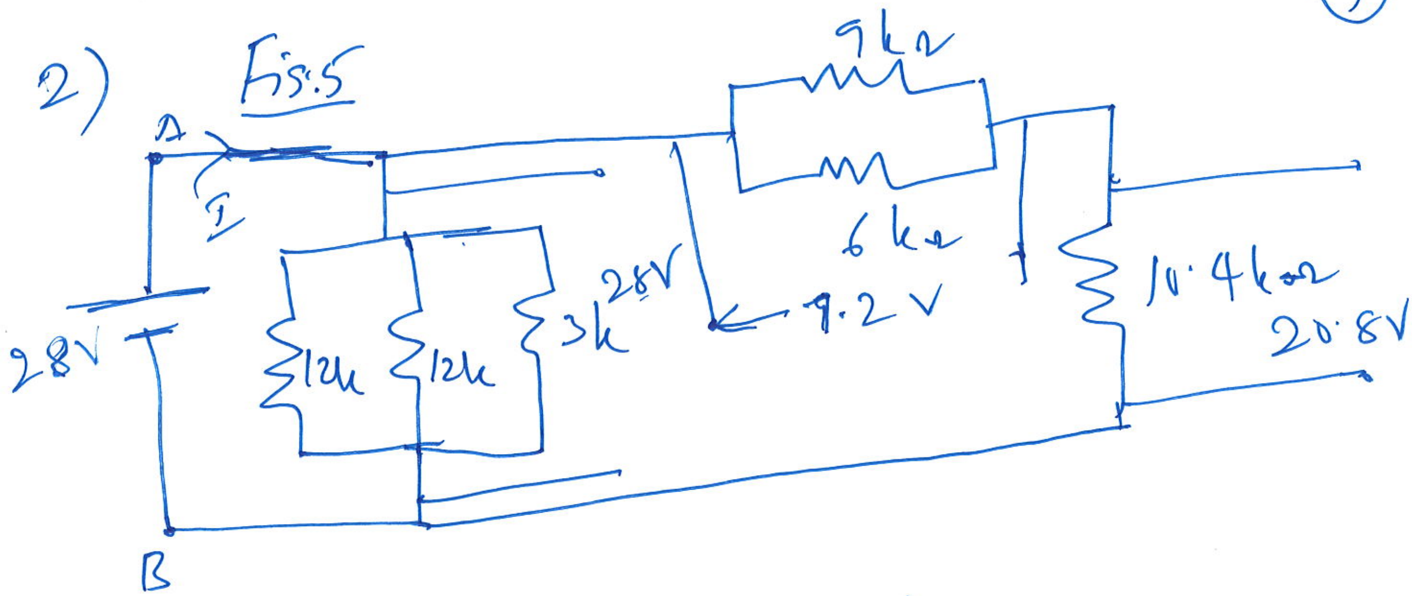
$$\frac{5IR}{2} = V \quad \text{— (1)}$$

Let the resistance between AB be R_{AB}.

$$R_{AB} \cdot 3 \cdot I = V \quad \text{— (2)}$$

from (1) & (2) $\boxed{R_{AB} = \frac{5}{6}R}$

2) Fig. 5



$R_1 = 12k \| 12k \| 3k = 2k\Omega$

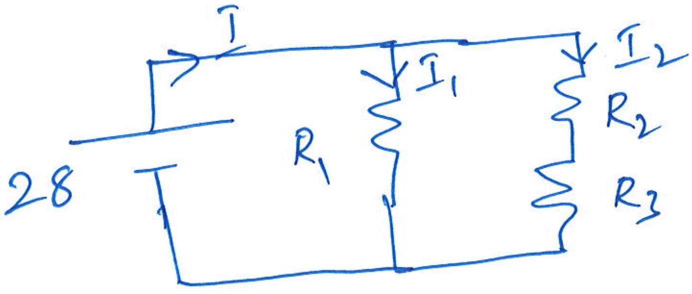
$R_2 = 9k\Omega \| 6k\Omega = 3.6k\Omega$

$R_3 = 10.4k\Omega$

$R_{AB} = R_1 \| (R_2 + R_3) = 2k\Omega \| (14k\Omega)$

$= 1.75 k\Omega$

$I = \frac{V}{R_{AB}} = \frac{28}{1.75k} = 16 mA$



$I_1 = \frac{28}{R_1} = 14 mA$

$I_2 = I - I_1 = 2 mA$

Current through R_3: 2mA, $V_{R3} = 20.8V$

Voltage across $R_2 = 28 - 20.8 = 7.2V$

$I_{9k\Omega} = \frac{2 \times 6}{9+6} = 0.8 mA$ $V_{9k\Omega} = 7.2V$

(5)

$I_{6k\Omega} = \frac{2 \times 9}{9+6} = 1.2mA$ $\quad V_{6k\Omega} = 7.2V$

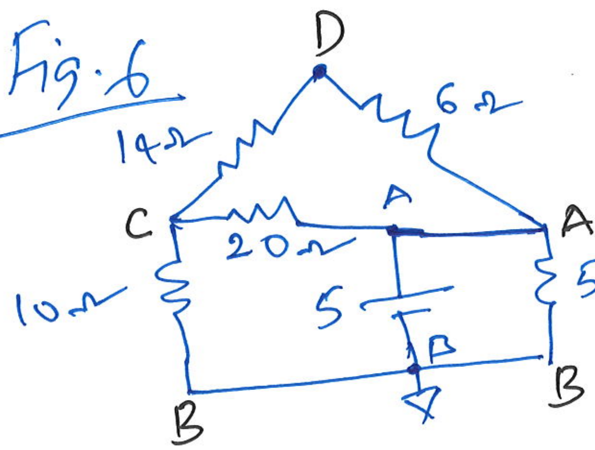
$I_{12k\Omega} = \frac{V_{12k\Omega}}{12k\Omega} = \frac{28}{12} = 2.33 \ mA$

$I_{3k\Omega} = \frac{28}{3} = 9.34 \ mA$

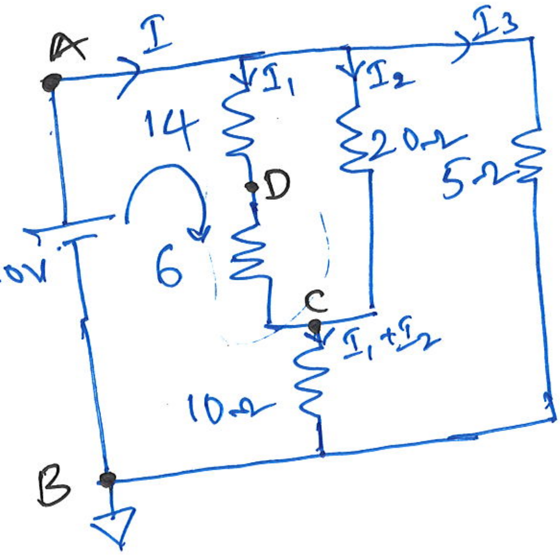
$I_{12k\Omega} + I_{12k\Omega} + I_{3k\Omega} = 2.33 + 2.33 + 9.34$

$= \underline{\underline{14mA}}$

Fig. 6



$\Rightarrow$



$R_{AB} = [[(14+6)//20] + 10] // 5$

$= ((20//20) + 10)//5 = (10+10)//5 = 20//5 = 4\Omega$

$I = \frac{20}{4} = 5A$ $\quad I_3 = \frac{20V}{5\Omega} = 4A$ $\quad \underline{V_{5\Omega} = 20V}$

$\underline{I_{5\Omega} = 4A}$

$I_1 + I_2 = I - I_3 = 5 - 4 = \underline{1A}$

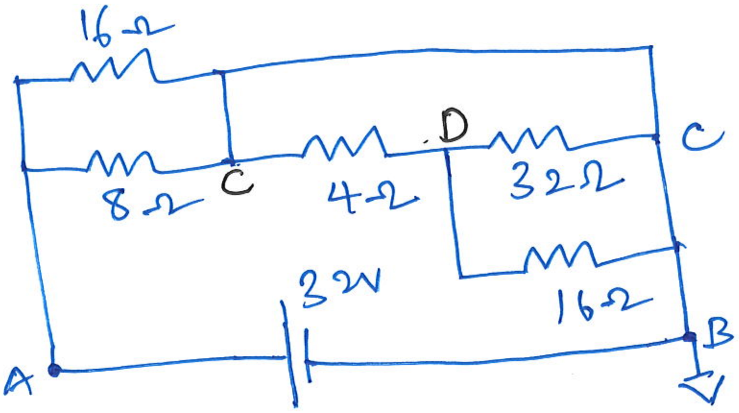
$I_1 = I_2 = 0.5A$ $\quad \underline{V_{20\Omega}} = 10V$ $\quad \underline{V_{14\Omega}} = 7V$ $\quad \underline{V_{6\Omega}} = 3V$

(by KVL) $\underline{V_{10\Omega}} = 20 - 10 = 10V$ (or) Ohm's law $10\Omega \times 1A = \underline{10V}$

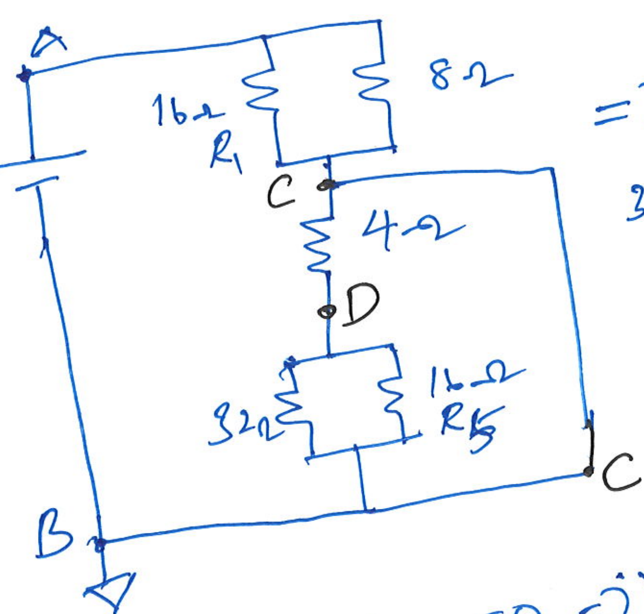
$\underline{I_{14\Omega}} = \underline{I_{6\Omega}} = 0.5A$ $\quad \underline{I_{20\Omega}} = 0.5A$

$\underline{I_{10\Omega}} = 1.A$

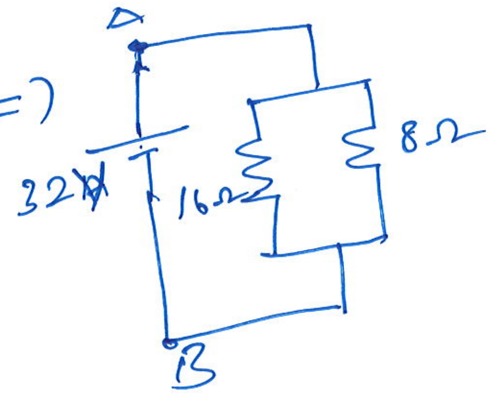
Fig. 7



$\Rightarrow$



$\Rightarrow$



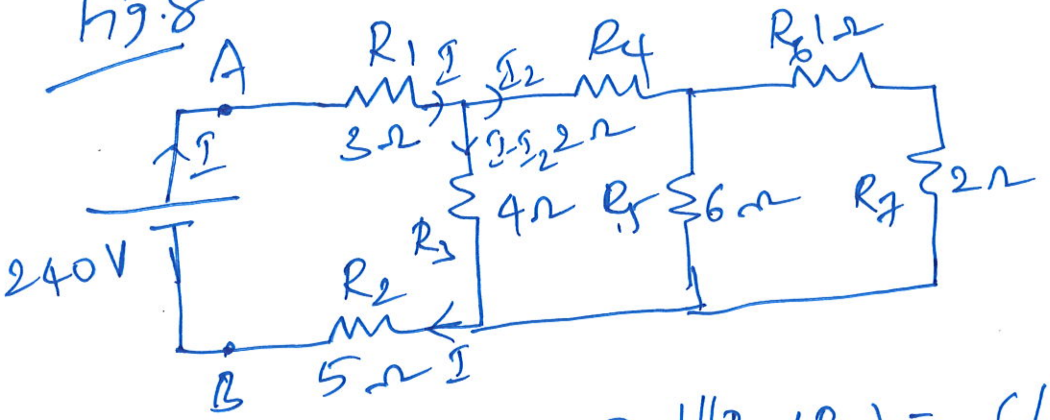
$$I_{4\Omega} = 0 \quad I_{32\Omega} = 0 \quad \underset{(R5)}{I_{16\Omega}} = 0 \Rightarrow V_{4\Omega} = 0,\ V_{32\Omega} = 0$$

$$V_{16\Omega}(R5) = 0$$

$$R_{AB} = (16 \parallel 8) = \frac{16}{3}\,\Omega \qquad I = \frac{32}{16/3} = 6A$$

$$I_{16\Omega} = \frac{6 \times 8}{16+8} = 2A \qquad I_{8\Omega} = 6 - 2 = \underline{4A}$$

Fig.8



$R_6 + R_7 = 3\Omega \quad R_5 || (R_6 + R_7) = 6 || 3 = 2\Omega$

$R_4 + [R_5 || (R_6 + R_7)] = 4\Omega$

$R_3 || [R_4 + (R_5 || (R_6 + R_7))] = 4 || 4 = 2\Omega$

$R_1 + [R_3 || [R_4 + [R_5 || (R_6 + R_7)]]] + R_2 = 3 + 2 + 5 = 10\Omega$

$I = \frac{240V}{10\Omega} = 24 A.$

$I_{R1} = 24A \quad \cancel{I_{R1} = 72V} \quad V_{R_1} = 24 \times 3 = 72V$

$I_{R2} = 24A \quad \cancel{I_1} \quad V_{R2} = 24 \times 5 = 120V$

3. Fig.9 $\cancel{I_{R_4} = I_{R_1} R_5} =$

$I_{R_1} = 40mA$

$I_{R2} = 40 - 10 = 30mA$

$I_{R3} = 30 - 20 = 10mA$

$I_{RL1} = 10mA \quad I_{RL2} = 20mA$

$I_{R5} = 40mA \quad I_{R4} = 40 - 4 = 36mA$

$$R_1 = \frac{V_{R1}}{I_{R1}} = \frac{120-100}{40\,mA} = 0.5\,k\Omega$$

$$R_2 = \frac{V_{R2}}{I_{R2}} = \frac{100-40}{30\,mA} = 2\,k\Omega$$

$$R_3 = \frac{V_{R3}}{I_{R3}} = \frac{40}{10\,mA} = 4\,k\Omega$$

$$R_4 = \frac{V_{R4}}{I_{R4}} = \frac{36\,V}{36\,mA} = 1\,k\Omega$$

$$R_5 = \frac{V_{R5}}{I_{R5}} = \frac{180-20-60-40-36}{36\,mA}$$

$$= \frac{24}{36}\,k\Omega = 0.67\,k\Omega$$

Power :

$P_{R_1} : V_{R_1} I_{R_1} = 20 \times 40\,mA = 0.8\,W$

$P_{R_2} \quad 60V \cdot 30\,mA = 1.8\,W$

$P_{R_3} : 40V \cdot 10\,mA = 0.4\,W$

$P_{R_4} = 36V \cdot 36\,mA = 1.296\,W$

$P_{R_5} = 24\,V \cdot 36\,mA = 0.864\,W$

Fig. 10

$V_s = 40\,mA \cdot 1.6\,k\Omega = \underline{64V}$

$R_{L2} = \frac{48V}{12mA} = 4\,k\Omega$ $\quad V_{RL1} = V_s$

$R_{L3} = \frac{24V}{8mA} = 3\,k\Omega$

$I_{R1} = 72 - 40 = \cancel{68mA}\ 32\,mA$

$I_{R2} = 32 - 12 = 20\,mA$

$I_{R3} = 20 - 8 = 12\,mA$

$R_1 = \frac{V_{R1}}{I_{R1}} = \frac{64 - 48}{32mA} = 0.5\,k\Omega$

$R_2 = \frac{V_{R2}}{I_{R2}} = \frac{48}{20m} = 1.2\,k\Omega$

$R_3 = \frac{V_{R3}}{I_{R3}} = \frac{24}{12m} = 2\,k\Omega$

Power $P_{R1} = I_{R1} V_{R1} = 16 \times 32\,mA = 0.512\,W$

$P_{R2} = I_{R2} V_{R2} = 48 \times 20\,mA = 0.96\,W$

$P_{R3} = V_{R3} I_{R3} = 24 \times 12\,mA = 0.288\,W$

$P_{RL1} = 64 \times 40\,mA = 2.56\,W$

$P_{RL2} = V_{RL2} I_{RL} = 48 \times 12\,mA = 0.576\,W$

$P_{RL3} = V_{RL3} \cdot I_{RL3} = 24 \times 8\,mA = 0.192\,W$