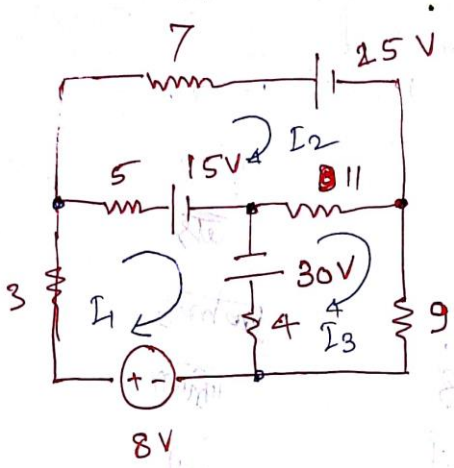
K. J. Somaiya College of Engineering, Mumbai-77
(Autonomous College Affiliated to University of Mumbai)
Semester: July 18 – November 18

Max. Marks: 40 **Duration: 1hr. 30 min.**
Class: FY **Semester: I**
Branch: ALL **Test 1**
Course Name: Elements of Electrical and Electronics Engineering

Q. No	Questions	Marks
Q.1	Use mesh analysis to calculate current flowing through 7 Ω resistance in the following electrical network.	10



Q1

using loop ana. find current thro. 7Ω resis. (10)

In Loop ①

$-3I_1 - 5(I_1 - I_2) - 15 + 30 - 4(I_1 - I_3) + 8 = 0$

$\therefore -12I_1 + 5I_2 + 4I_3 = -23$ — ①

In Loop ②

$-7I_2 - 25 - 11(I_2 - I_3) + 15 - 5(I_2 - I_1) = 0$

$\therefore 5I_1 - 23I_2 + 11I_3 = 10$ — ②

In Loop ③

$-30 - 11(I_3 - I_2) - 9I_3 - 4(I_3 - I_1) = 0$

$\therefore 4I_1 + 11I_2 - 24I_3 = 30$ — ③

From above 3 eqs we get

$I_1 = 1.03\ A$

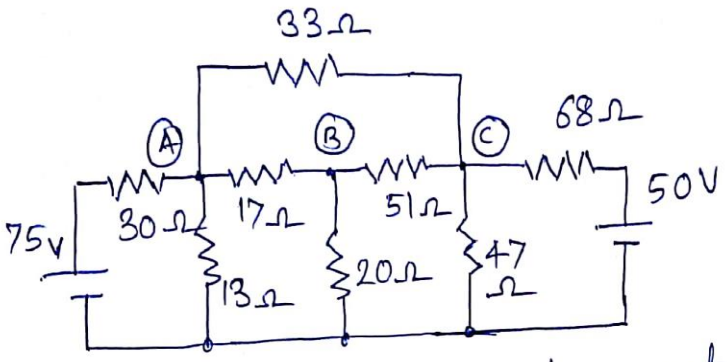
$I_2 = -0.932\ A$

$I_3 = 1.57\ A$

$I_{7\Omega} = I_2 = 0.932\ A\ (\leftarrow)$

OR

Using nodal analysis, calculate power absorbed in 17 Ω resistance in the following electrical circuit



When node (A) is considered, we get

$$\frac{V_A-75}{30}+\frac{V_A}{13}+\frac{V_A-V_B}{17}+\frac{V_A-V_C}{33}=0$$

$$\therefore V_A\left(\frac{1}{30}+\frac{1}{13}+\frac{1}{17}+\frac{1}{33}\right)-\frac{V_B}{17}-\frac{V_C}{33}=\frac{75}{30} \quad -(1)$$

When node (B) is considered, we get

$$\frac{V_B-V_A}{17}+\frac{V_B}{20}+\frac{V_B-V_C}{51}=0$$

$$\therefore -\frac{V_A}{17}+V_B\left(\frac{1}{17}+\frac{1}{20}+\frac{1}{51}\right)-\frac{V_C}{51}=0 \quad -(2)$$

When node (C) is considered, we get

$$\frac{V_C-V_B}{51}+\frac{V_C}{47}+\frac{V_C-50}{68}+\frac{V_C-V_A}{33}=0$$

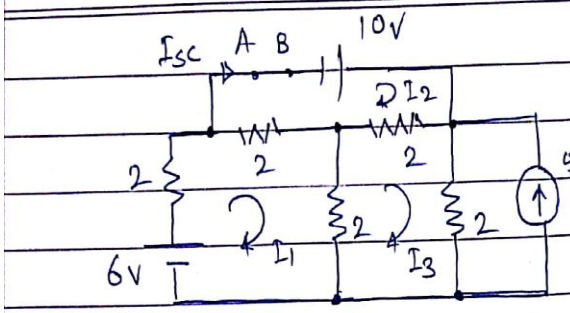
$$\therefore -\frac{V_A}{33}-\frac{V_B}{51}+V_C\left(\frac{1}{51}+\frac{1}{47}+\frac{1}{68}+\frac{1}{33}\right)=\frac{50}{68} \quad -(3)$$

From above three eqs. we get

$V_A = 18.52\,V$, $V_B = 11.18\,V$, $V_C = 17.64\,V$

$$P_{17\Omega}=\frac{(V_A-V_B)^2}{17}=\frac{(18.52-11.18)^2}{17}=3.17\,W$$

Q.2	Calculate current flowing through 4 Ω resistance in the following network by using Norton's theorem.	10



Find I_{sc} after replacing R_L by shortckt

When Loop ① is considered, we get

$$-2I_1-2(I_1-I_2)-2(I_1-I_3)+6=0$$

$$\therefore -6I_1+2I_2+2I_3=-6 \quad -①$$

When Loop ② is considered, we get

$$-2(I_2-I_1)+10-2(I_2-I_3)=0$$

$$\therefore 2I_1-4I_2+2I_3=-10 \quad -②$$

When Loop ③ is considered, we get

$$-2(I_3-I_2)-2(I_3+5)-2(I_3-I_1)=0$$

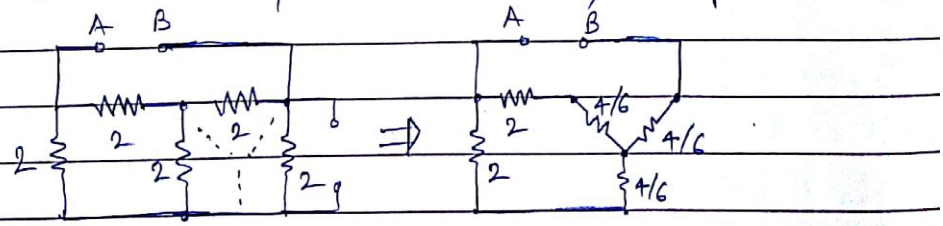
$$\therefore 2I_1+2I_2-6I_3=10 \quad -③$$

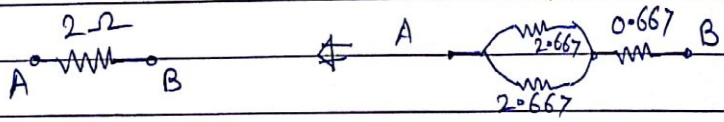
after solving above eq. ①, ② & ③ we get

$$I_1=2.50\,A,\ I_2=4.0A,\ I_3=0.5A$$

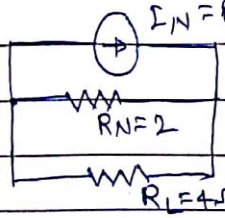
$$I_{sc}=I_2=4A\ (\rightarrow)=I_N$$

To find R_N replace all sources by it's eqv. resistances.





$$\therefore R_N=2\Omega$$

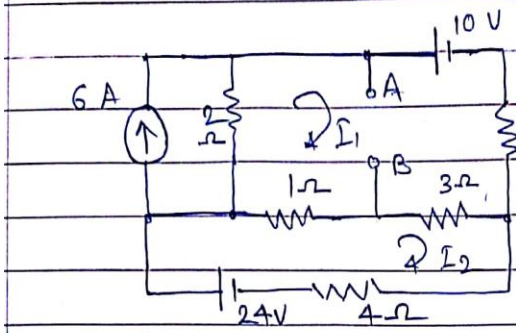


$$I_L=\frac{R_N}{R_N+R_L}I_N=1.33\,A\ (\downarrow)$$

OR

Calculate current flowing through 10 Ω resistance in the following network by using Thevenin's theorem.

Find open circuit voltage by removing load resistance from ckt.



Find Loop currents using mesh analysis.

When Loop ① is considered, we get.

$$-2(I_1-6)-10-2I_1-4(I_1-I_2)=0$$

$$\therefore -8I_1+4I_2=-2 \quad -①$$

When Loop ② is considered, we get

$$-4(I_2-I_1)-4I_2+24=0$$

$$\therefore 4I_1-8I_2=-24 \quad -②$$

After solving eq. ① & ② we get,

$I_1 = 2.333\,A$, $I_2 = 4.1667\,A$

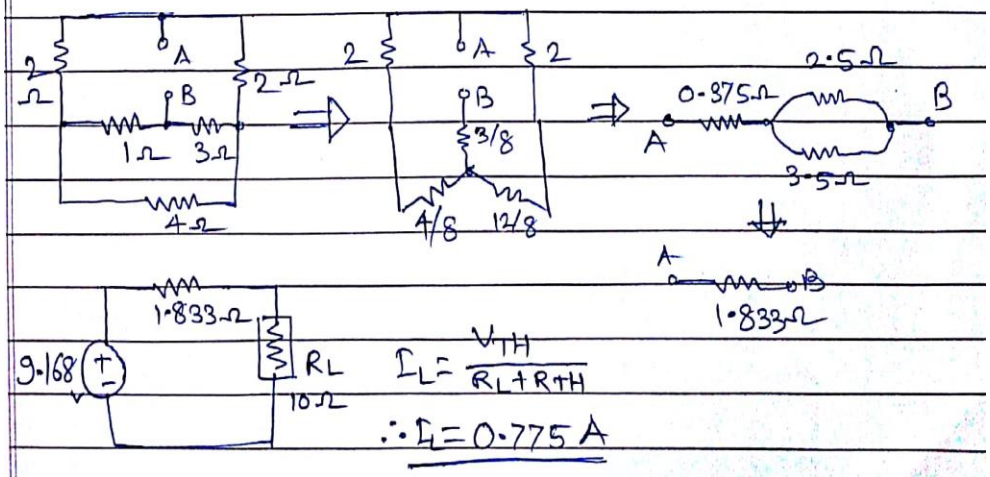
considering left side of Loop ①

$$\therefore V_{AB}-2(6-I_1)-1(I_2-I_1)=0$$

$$\therefore V_{AB}-2(6-2.333)-1(4.1667-2.333)=0$$

$$\therefore V_{AB}=9.168\,V=V_{TH}$$

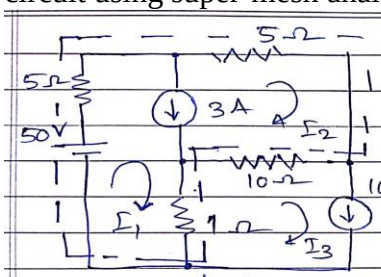
to find R_{TH} replace all sources by its eqv. resistances.



$$I_L=\frac{V_{TH}}{R_L+R_{TH}}$$

$$\therefore I_L=0.775\,A$$

Q.3	Calculate power consumed by 10 Ω resistance in the following electrical circuit using super-mesh analysis.	10
Q 4 A	With the help of superposition theorem calculate current flowing through 15 Ω resistance in the following electrical circuit.	5
Q 4 B	What will be current flowing through 10 Ω resistance in the following electrical circuit? Use source transformation technique.	5



In the given n/w we know that Loop ③ has constant current source ∴ $I_3 = 10$ A

Loop ① & ② form a super Loop &

$I_1 - I_2 = 3$ A — ① given.

considering superloop formed by Loop ① & Loop ② we get :

$50 - 5I_1 - 5I_2 - 10(I_2 - I_3) - 1(I_1 - I_3) = 0$

$\therefore 50 - 5I_1 - 5I_2 - 10(I_2 - 10) - 1(I_1 - 10) = 0$

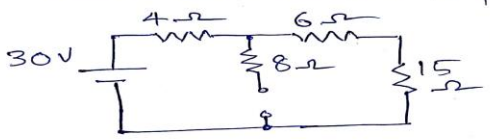
$\therefore -6I_1 - 15I_2 = -160$ — ②

$\therefore I_1 = 9.762$ A, $I_2 = 6.762$ A

$I_{10\Omega} = I_2 - I_3 = 6.762 - 10 = -3.238$ A (↓)

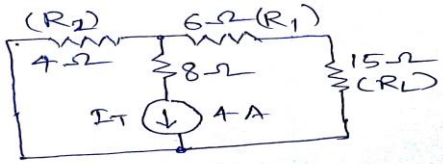
$\therefore P_{10\Omega} = I_{10\Omega}^2 \times R = 3.238^2 \times 10 = 104.85$ W

When 30 V source is present in the ckt.



$I_1' = \frac{30}{4+6+15} = 1.2$ A (↓)

When 4A source is present in the ckt.



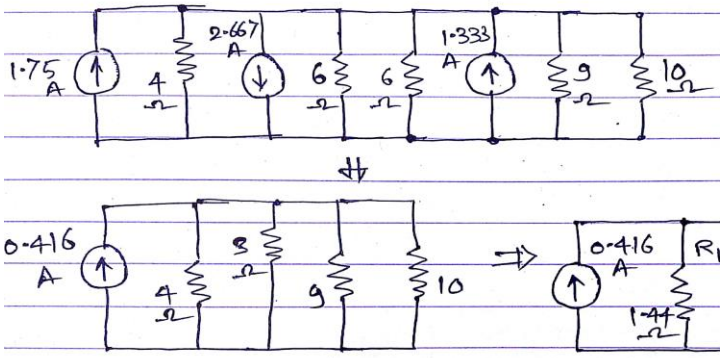
$I_1'' = I_T \times \frac{R_2}{R_2 + R_1 + R_L}$

$= 4 \times \frac{4}{4+6+15}$

$= 0.64$ A (↑)

$I_1 = I_1'' + I_1'$

$= 1.2$ A (↓) + 0.64 A (↑) $= 0.56$ A (↓)



$I_{10\Omega} = I_T \times \frac{R_1}{R_1 + R_L} = 0.416 \times \frac{1.44}{10 + 1.44} = 0.052$ A