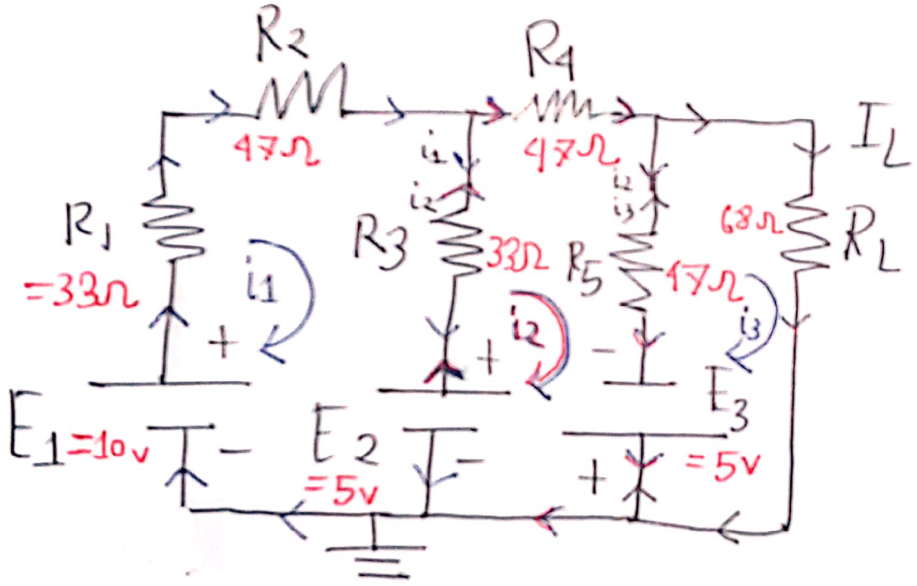
Lab - 5 (Superposition Theorem)

$E_1 = 10V$, $E_2 = 5V$, $E_3 = 5V$

$R_1 = 33\Omega$, $R_2 = 47\Omega$, $R_3 = 33\Omega$, $R_4 = 47\Omega$

$R_5 = 47\Omega$, $R_L = 68\Omega$



$I_L = i_3$

Applying KVL at mesh 1;

$$10 - 33i_1 - 47i_1 - (i_1 - i_2)33 - 5 = 0$$

$$\Rightarrow 10 - 5 - 33i_1 - 47i_1 - 33i_1 + 33i_2 = 0$$

$$\Rightarrow 5 - 66i_1 - 47i_1 + 33i_2 = 0$$

$$\Rightarrow 5 - 113i_1 + 33i_2 = 0 \quad \Rightarrow 5 = 113i_1 - 33i_2 \quad (1)$$

Applying KVL at mesh 2;

$$5-(i_2-i_1)33-47i_2-47(i_2-i_3)+5=0$$

$$\Rightarrow 10-33i_2+33i_1-47i_2-47i_2+47i_3=0$$

$$\Rightarrow 10+33i_1+47i_3-127i_2=0$$

$$\Rightarrow 10=-33i_1+127i_2-47i_3 \quad \text{——(II)}$$

Applying KVL at mesh 3;

$$-5-(i_3-i_2)47-68I_L=0$$

$$\Rightarrow -5-47i_3+47i_2-68I_L=0$$

$$\Rightarrow -5-47i_3+47i_2-68i_3=0$$

$$\Rightarrow -5-115i_3+47i_2=0$$

$$\Rightarrow -5=-47i_2+115i_3 \quad \text{——(III)}$$

Solving equation (I), (II) and (III) we will get,

$i_1 = 0.0722\ A$

$= 0.0722 \times 1000\ A$

$= 72.265\ mA$

$i_2 = 0.095937\ A = 0.09593 \times 1000\ A$

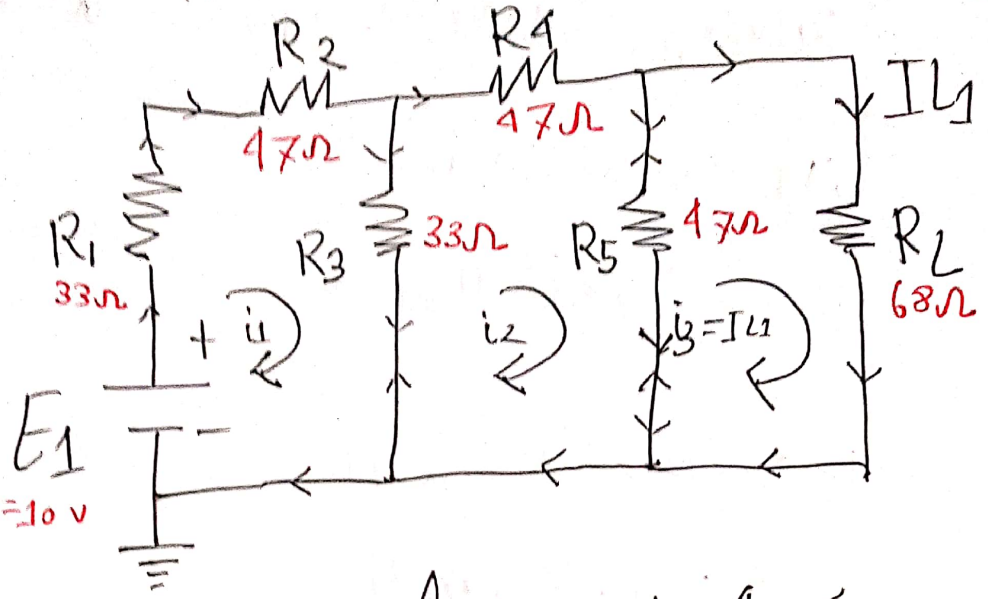
$= 95.93\ mA$

$i_3 = -0.0042688\ A = 0.0042688 \times 1000\ A$

$= -4.268\ mA$

Here $I_L = i_3$ So,

$I_L = -4.268\ mA$.



Applying KVL at mesh 1;

$$10 - 33i_1 - 47i_1 - (i_1 - i_2)33 = 0$$

$$\Rightarrow 10 = 113i_1 - 33i_2 \quad \text{——— (I)}$$

Applying KVL at mesh 2;

$$-(i_2 - i_1)33 - 47i_2 - 47(i_2 - i_3) = 0$$

$$\Rightarrow 0 = -33i_1 + 127i_2 - 47i_3 \quad \text{——— (II)}$$

Applying KVL at mesh 3

$$-(i_3 - i_2)47 - 68I_{L1} = 0$$

Here, $I_{L1} = i_3$

$$\Rightarrow 0 = -47i_2 + 115i_3 \quad \text{——— (III)}$$

solving equation (i) (ii) and (iii)

$i_1 = 0.09718\ A$

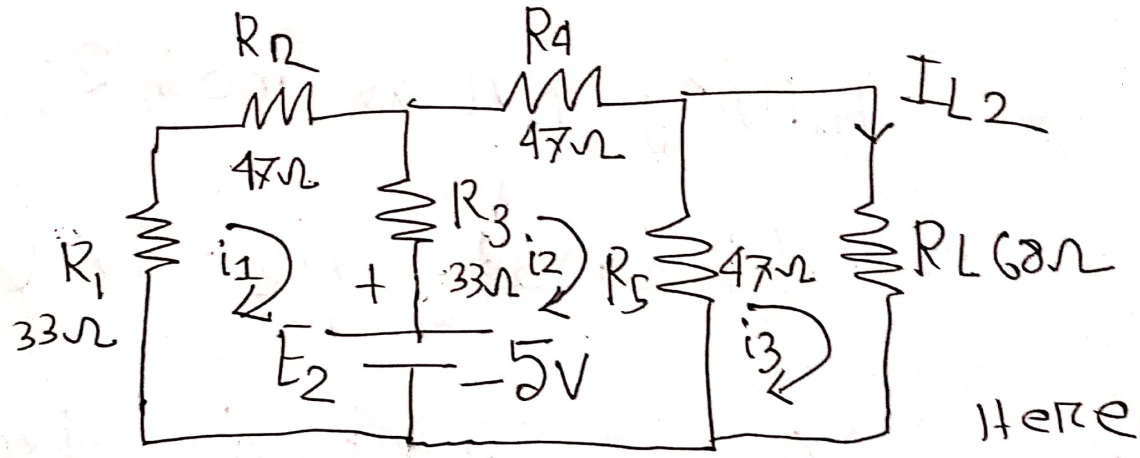
$= 97.18\ mA$

$i_2 = 0.02975\ A$

$= 29.75\ mA$

$i_3 = I_{L_1} = 0.01215\ A$

$= 12.16\ mA$



Here,
$I_{L_2} = i_3$

Applying KVL at mesh 1,

$-33i_1 - 47i_1 - (i_1 - i_2)33 - 5 = 0$

$\Rightarrow -33i_1 - 47i_1 - 33i_1 + 33i_2 - 5 = 0$

$\Rightarrow -113i_1 + 33i_2 = 5 \quad \text{---------- (1)}$

Applying KVL at mesh 2;

$$5 - 33(i_2 - i_1) - 47i_2 - 47(i_2 - i_3) = 0$$

$$\Rightarrow 5 - 33i_2 + 33i_1 - 47i_2 - 47i_2 + 47i_3 = 0$$

$$\Rightarrow 33i_1 - 127i_2 + 47i_3 = -5 \quad \text{---(II)}$$

Applying KVL at mesh 3;

$$\Rightarrow -47(i_3 - i_2) - 68i_3 = 0$$

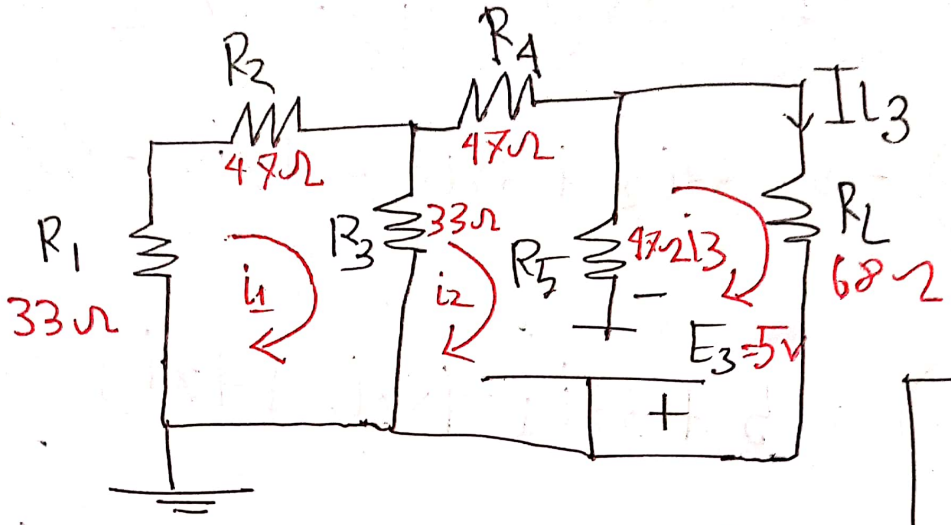
$$\text{or, } 0 = -47i_2 + 115i_3 \quad \text{---(III)}$$

Solving equation (I), (II) and (III) we get

$$i_1 = -0.033715\,A = 33.71\,mA$$

$$i_2 = 0.036039\,A = 36.063\,mA$$

$$i_3 = I_{L_2} = 0.014739\,A = 14.74\,mA$$



Here,
$I_{L3} = i_3$

Applying KVL at Mesh 1,

$$-113i_1 + 33i_2 = 0 \quad \text{——— (I)}$$

Applying KVL at Mesh 2;

$$-(i_2 - i_1)33 - 47i_2 - (i_2 - i_3)47 + 5 = 0$$

$$\Rightarrow 5 = -33i_1 + 127i_2 - 47i_3 \quad \text{——— (II)}$$

Applying KVL at mesh 3,

$$-5 = -47i_2 + 115i_3 \quad \text{——— (III)}$$

Solving equation (I), (II) and (III) we get,

$i_1 = 0.0087964\ A = 8.797\ mA$

$i_2 = 0.030121\ A = 30.13\ mA$

$I_{L_3} = i_3 = -0.031167\ 8\ A = -31.17\ mA$

Now,

Superposition Theorem we all know,

$$I_L = I_{L_1} + I_{L_2} + I_{L_3}$$

or, $-4.268 = 12.16 + 14.74 + (-31.17)$

or, $-4.268 = -4.268$