Course Name:	Elements of Electrical and Electronics Engineering	Semester:	I
Exam:	EEEE IA1	Division:	C5
Name:	Rajat Kumar	Branch:	AI & DS
Roll No:	16014224054	Roll No:	54

Q2. Calculate the current through 4 Ω resistor using Norton's theorem. In the circuit shown in figure 2, the value of R1 will be the **last two digits of roll no. time's Ω**

For eg: For Roll no: 1000020, then R1 = 20Ω. If your last digits are from 01 to 10, kindly add 10 to your last two digits, so roll no with last two digits with 01 will become 11, then R1 = 11Ω **(EVEN ROLL NO ATTEMPT Q2)**

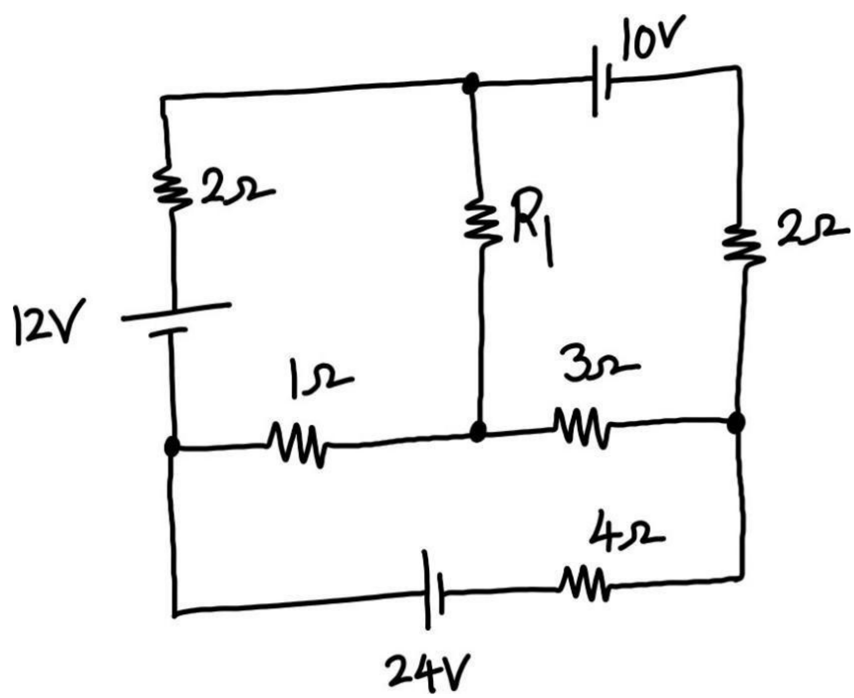
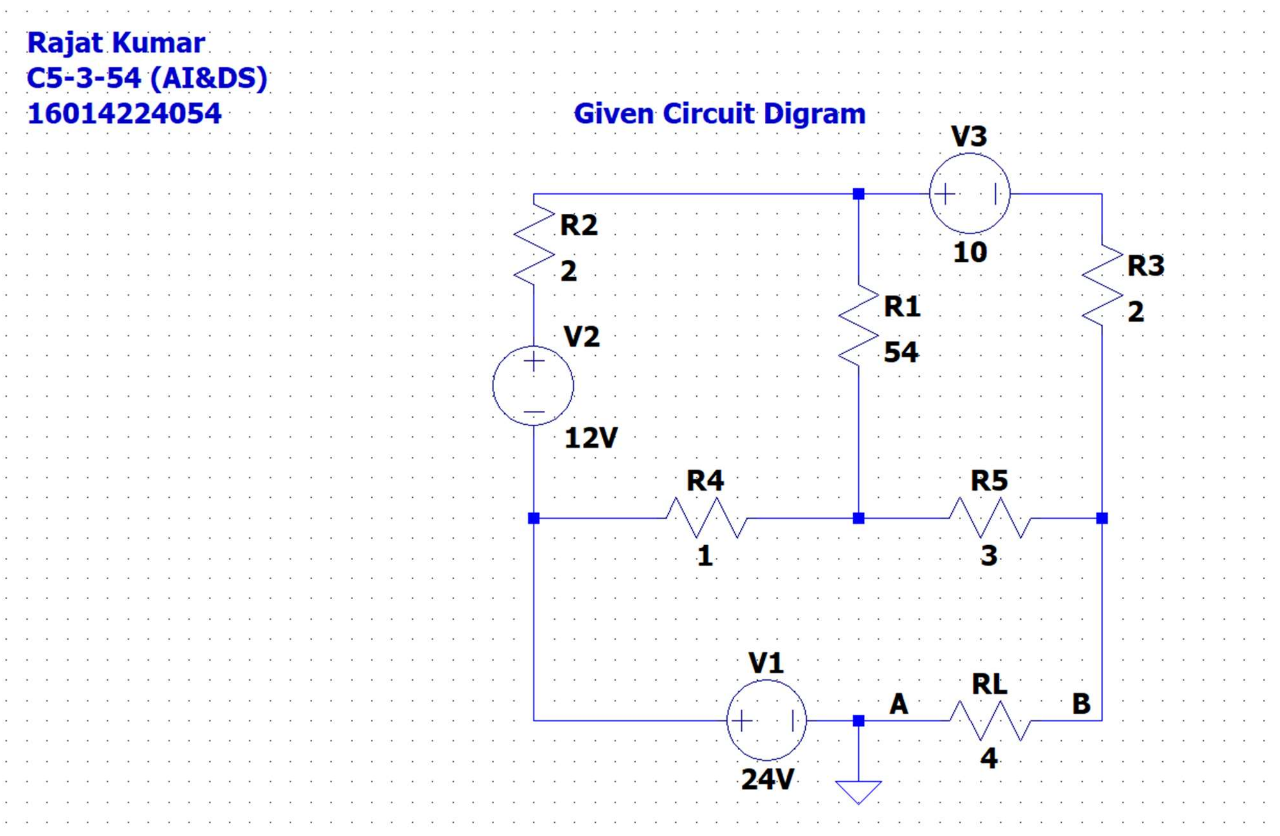


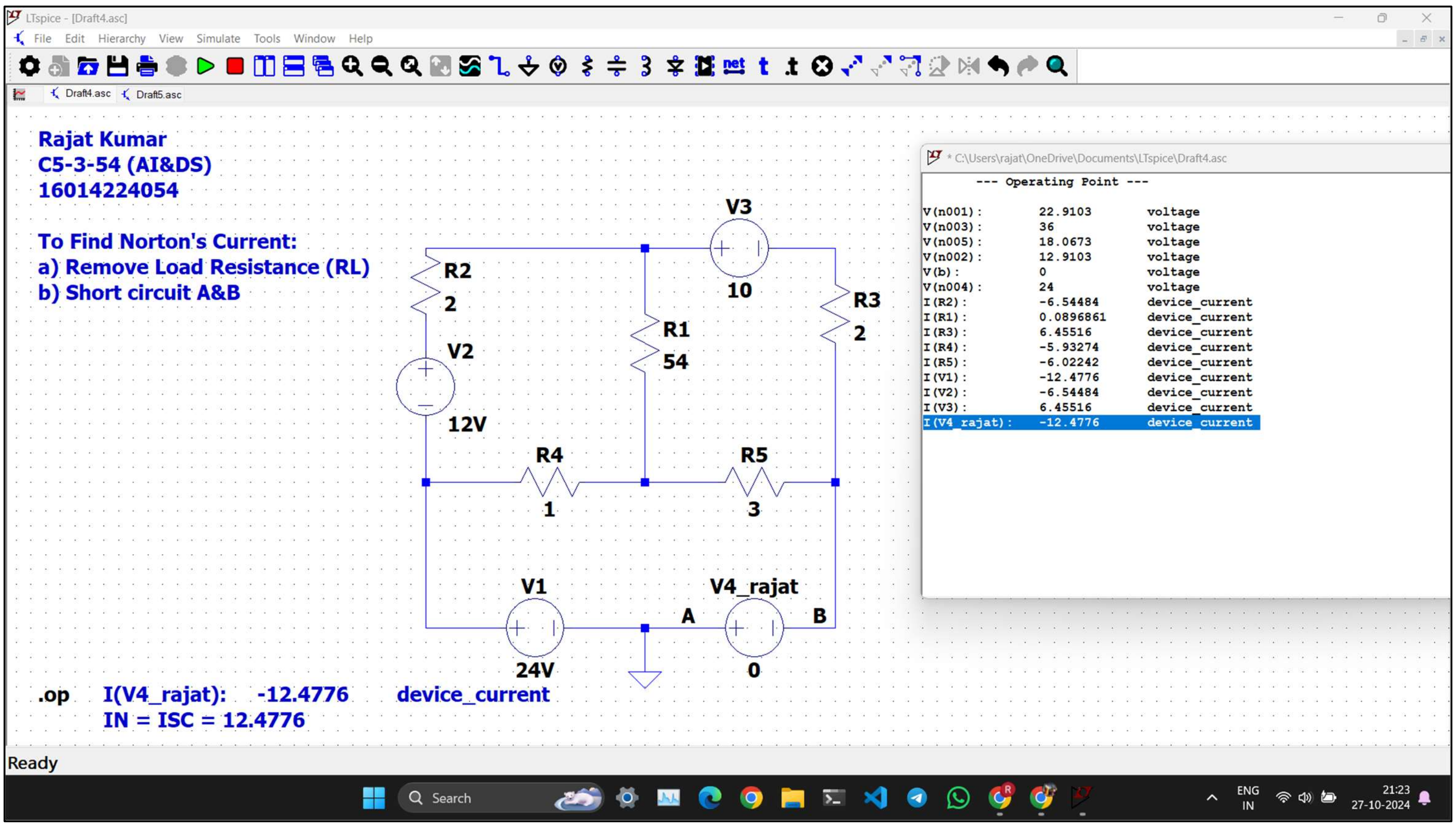
Figure 2

a) Simulate the circuit show in figure 2, using ***LTSpice*** software and measure I_N, R_N and I_L.

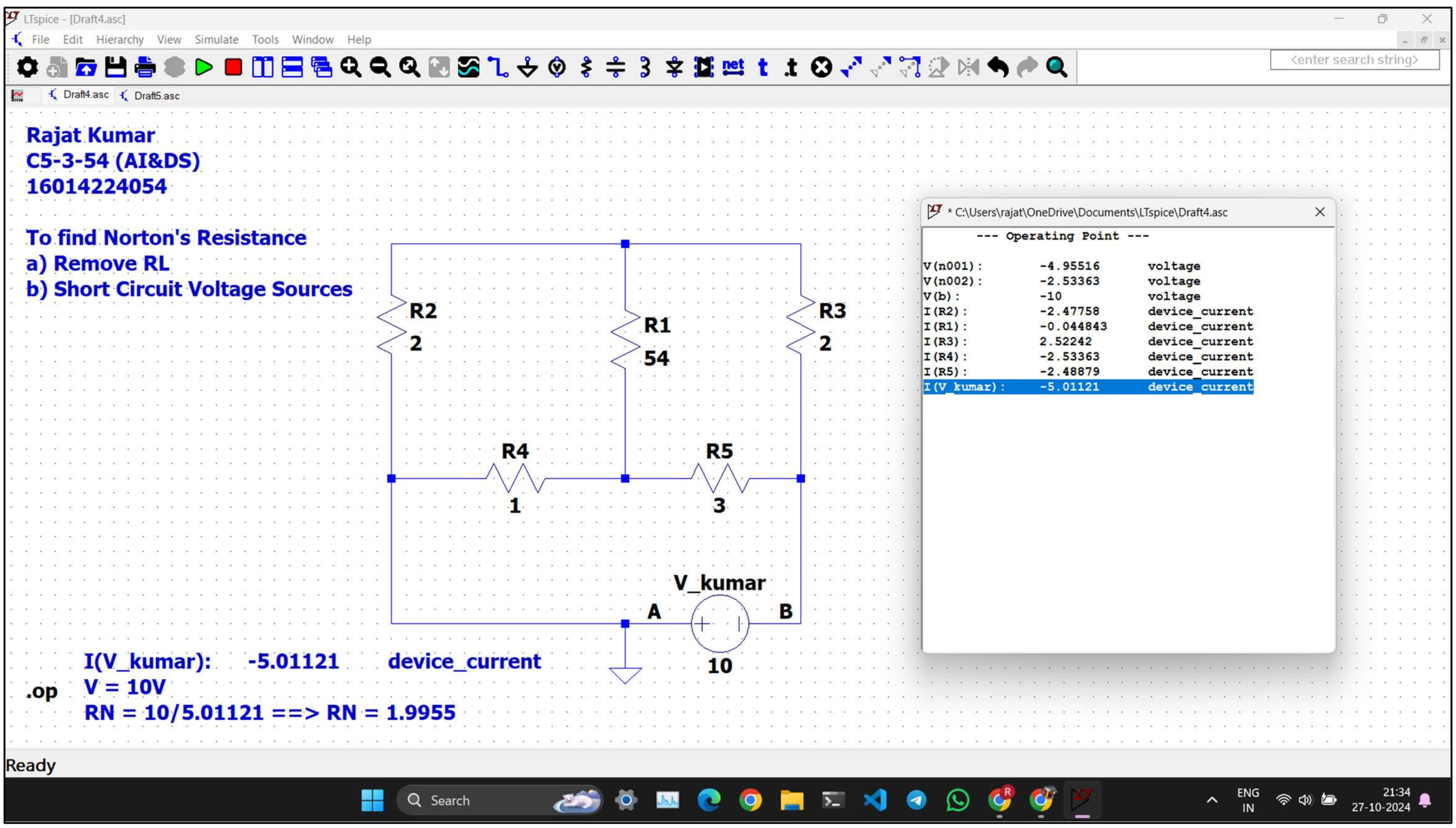
Circuit Diagram:



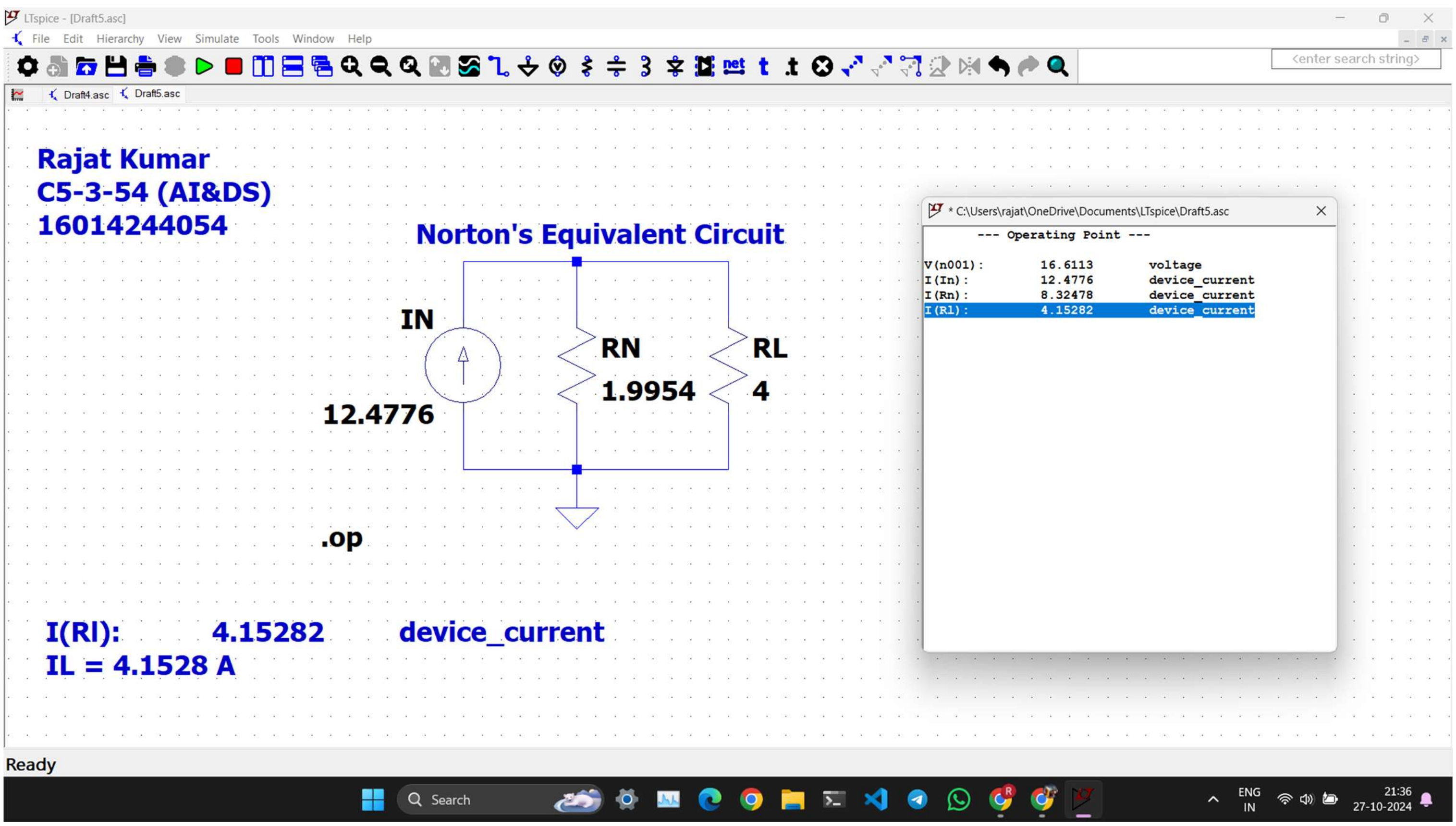
To find Norton's Current (I_N):



To find Norton's Resistance (R_N):



To Find Required Load Current (I_L) across Load Resistance (4 Ω):



b) Also Solve the numerical theoretical and measure I_N, R_N and current through 4 Ω load resistor (IL)

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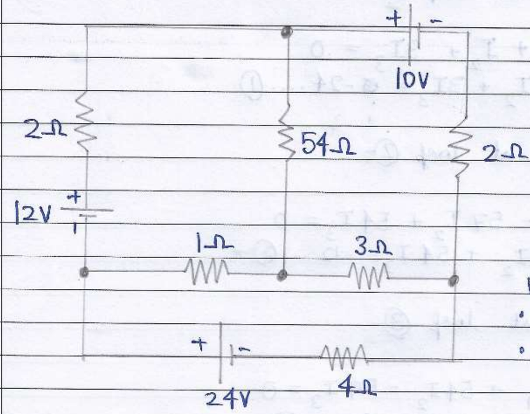
Q2.



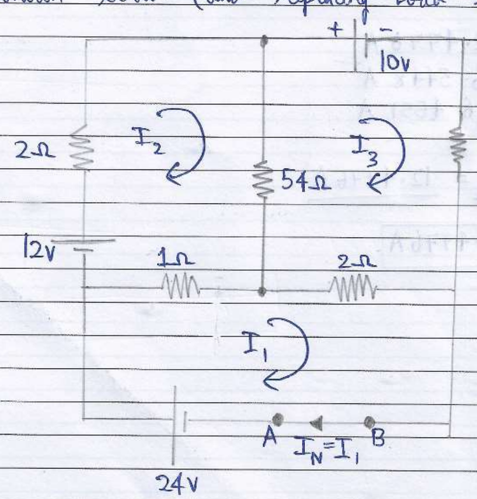
To calculate the current through 4Ω resistor using Norton's Theorem.

To calculate: I_N, R_N, I_L using Norton's Theorem;
- Norton's Equivalent circuit
- Norton's Identity:

$$\Rightarrow \left[I_L = \frac{I_N R_N}{R_N + R_L} \right]$$

Sol: Step ①: To Calculate Norton's Current (I_N):
a) Remove R_L (Load resistance)
b) Short circuit A & B.

Let, I_1, I_2, I_3 be currents flowing in the loops as shown below: (and replacing Load resistor R_L (4Ω) with short circuit branch)



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Applying KVL at loop 1 -

$\Rightarrow 24 - 4I_1 + I_2 + 3I_3 = 0$

$\Rightarrow -4I_1 + I_2 + 3I_3 = -24 \quad \ldots (1)$

Applying KVL at loop 2 -

$\Rightarrow 12 + I_1 - 57I_2 + 54I_3 = 0$

$\Rightarrow I_1 - 57I_2 + 54I_3 = -12 \quad \ldots (2)$

Applying KVL at loop 3 -

$\Rightarrow -10 + 3I_1 + 54I_2 - 59I_3 = 0$

$\Rightarrow 3I_1 + 54I_2 - 59I_3 = 10 \quad \ldots (3)$

$\therefore$ Solving Equations 1, 2, 3 using calculator:

$$\begin{bmatrix} -4 & 1 & 3 \\ 1 & -57 & 54 \\ 3 & 54 & -59 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -24 \\ -12 \\ 10 \end{bmatrix}$$

$\therefore I_1 = 12.4776\ A$

$I_2 = 6.5448\ A$

$I_3 = 6.4551\ A$

$\therefore I_N = I_1 = \underline{12.4776\ A}$

$$\boxed{I_N = 12.4776\ A}$$

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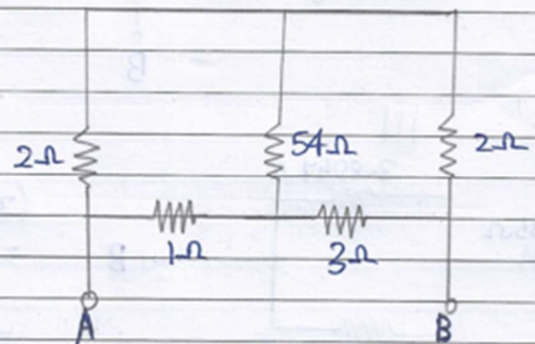
Step ②: To Calculate Norton's Resistance (R_N):
a) Remove R_L
b) Replacing all active sources (here Voltages) with their internal resistances. (i.e., Short crt)



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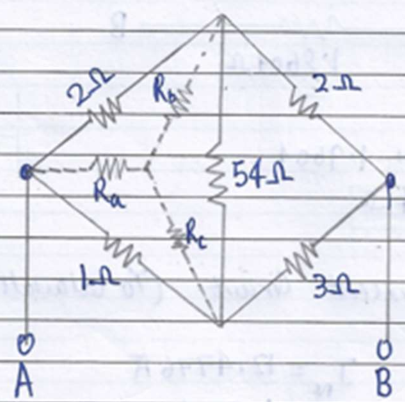

Using Δ(Delta) ⟶ λ (Star) Conversion:

$$\therefore R_a = \frac{2 \times 1}{2+1+54} = \frac{2}{57} = 0.035\,\Omega$$

$$\therefore R_b = \frac{2 \times 54}{2+1+54} = \frac{108}{57} = 1.8947\,\Omega$$

$$\therefore R_c = \frac{54 \times 1}{2+1+54} = \frac{54}{57} = 0.9473\,\Omega$$

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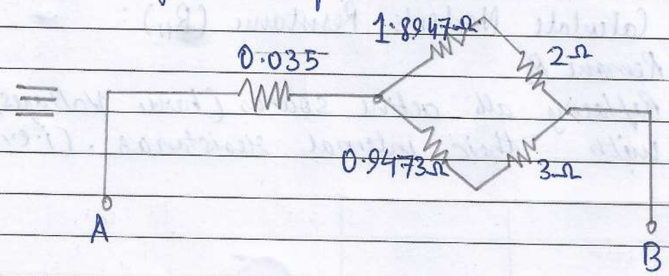
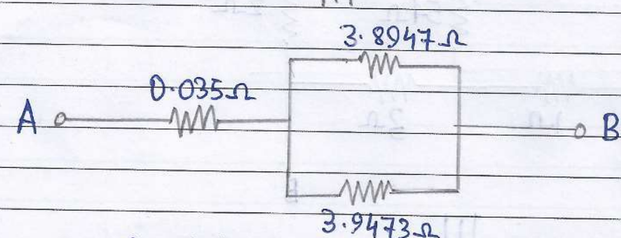
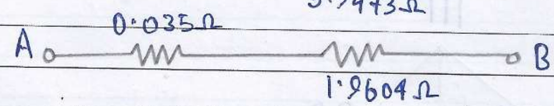
Thus, we get this equivalent circuit-





Simplifying-

$$(3.8947 \parallel 3.9473) = \frac{3.8947 \times 3.9473}{3.8947 + 3.9473} = \underline{1.9604}$$

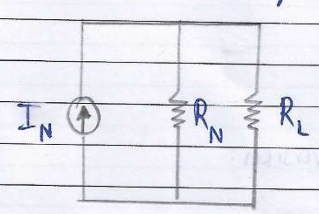


$\therefore R_N = R_{AB}$

$\therefore R_N = 0.035 + 1.9604$

$\boxed{R_N = 1.9954\ \Omega}$

Step (3) : Norton's Equivalent Circuit: (To Calculate Load Current I_L)



$I_N = 12.4776\ A$
$R_N = 1.9954\ \Omega$
$R_L = 4\ \Omega$ (Given)

Using, Norton's Identity -

$$\Rightarrow I_L = \frac{I_N \times R_N}{R_N + R_L} = \frac{12.4776 \times 1.9954}{1.9954 + 4} = \frac{24.8978}{5.9954}$$

$\therefore \boxed{I_L = 4.1528\ A}$

Tabulate the results as shown in the table below.

Parameter	Theoretical value	Simulated value
Norton's Current (I_N)	12.4776 A	12.4776 A
Norton's Resistance (R_N)	1.9954 Ω	1.9955 Ω
Load Current (I_L)	4.1528 A	4.1528 A

Q5. Explain the principle & working of Megger with a neat labelled diagram.
If last two digits of roll no are from 41 to 60, attempt Q5

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Q5. Explain the principle and working principle of Megger with a neat labelled diagram.

Sol: The megger is an instrument used for measuring the insulation resistance of electrical equipment such as cables, transformers, and motor windings. The test is crucial for ensuring safety and efficient operation by identifying potential faults in insulation. If resistance ~~re~~ of insulation is high, pointer coil deflects towards infinity, if low, pointer indicates zero resistance.
Accuracy of megger is high as compared to other instruments. Combination of both generator & ohmmeter is basically a megger.

Principle:
The principle of a megger is based on Ohm's Law and principle of electromagnetic induction. When a voltage is applied across an electrical circuit, a current flows through the insulation. By measuring the resulting current, the megger calculates the insulating resistance. A megger typically applies a high DC voltage (500V → 5kV) to the insulation, and the resistance is calculated based on current generated.

Circuit Diagram-

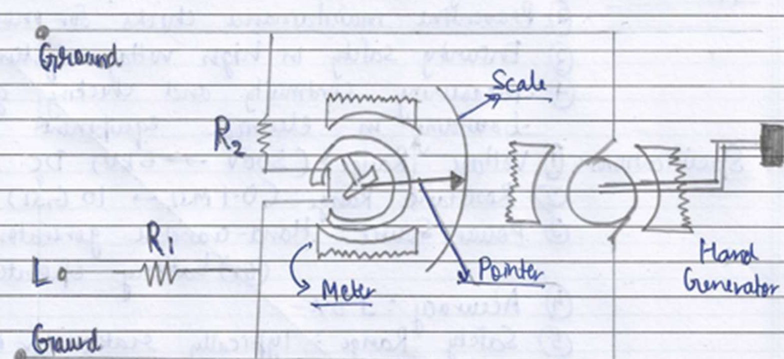

Fig. Basic Megger Circuit

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WORKING:

① Initial Setup: The test terminals are connected to the device which ~~is~~ have insulation to be tested. The terminals marked "Line" and "Earth" are connected to the ends of the insulation being measured, while "Guard" may be used to remove leakage effects from the measurement.

② Voltage Generation: When the handle is cranked, the generator in the megger produces a high DC voltage. For modern meggers, batteries may replace the mechanical generator.

③ Resistance Measurement: the generated voltage is applied across the insulation under test. The insulation typically allows a small amount of current to pass. The current measured ~~is~~ by the PMMC meter inside megger

④ Meter Deflection: The current passing through the circuit causes deflection in the needle of the meter, indicating the insulation resistance. A higher deflection means lower resistance, indicating poor insulation, while little or no deflection indicates high insulation resistance which is desired.

Applications:
① Testing insulation resistance in electrical cables.
② Preventive maintainance checks for motors.
③ Ensuring safety in high voltage systems.
④ Measuring continuity and checking ground bonding in electrical equipment.

Specifications:
① Voltage Range: (500V → 5kV) DC
② Resistance Range: (0.1 MΩ → 10 GΩ)
③ Power Source: Hand-cranked generator (or) battery operated.
④ Accuracy: ± 5%
⑤ Safety Range: Typically rated for individual or field use with IP protection.