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Course: EEEE - IA

Batch: C4

Q4) Explain the principle and Working of Energy Meter with a neat labelled diagram.

Principle:

⇒ A single phase Energy is used for measuring the power consumed in kilowatt-hours (kwh) of a domestic or a industrial electrical installation.

On a single phase AC supply, the electromechanical induction by counting the revolutions of a non-magnetic, but electrically conductive metal disc which is made to rotate at a speed proportional to the power passing through the meter.

Construction:

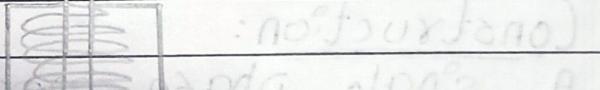
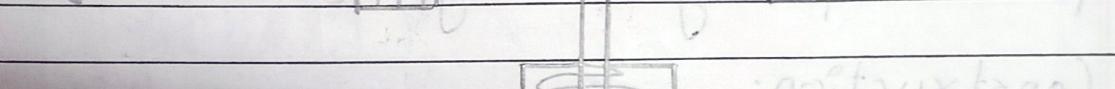
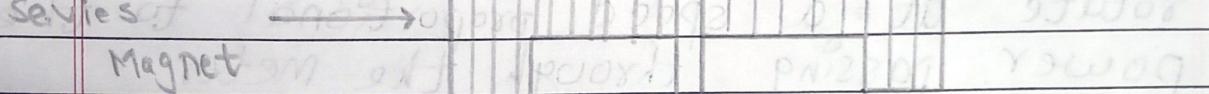
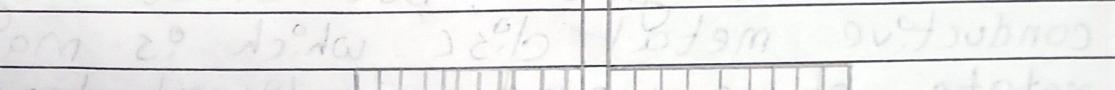
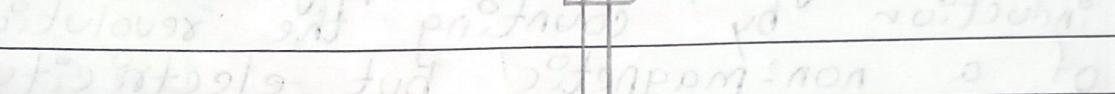
⇒ A single phase energy meter is a sort of induction type watt-hour meter. It consists of two electromagnets. When the meter is connected to the supply line and the load, then both the coils produce their magnetic field. The field produced by the circuit coils directly proportional to the magnitude of the current flowing through it. The field produced by the pressure coil depends on the voltage across it. Both the fluxes produces two eddy current and hence two driving torques resultant produces on the disc.

The damping torque is produced by the permanent magnet. Shading rings are mounted on the shunt magnet for the correction in power factor of the meter. The rotational speed of the disc is counted by a counting mechanism which may be of any-one of the types (cyclodial, clock dial, number dial).

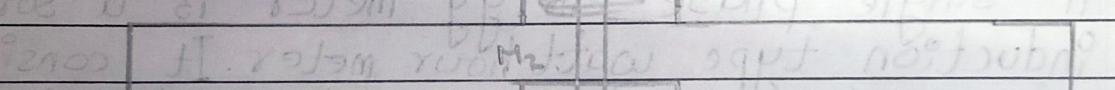
Diagram:



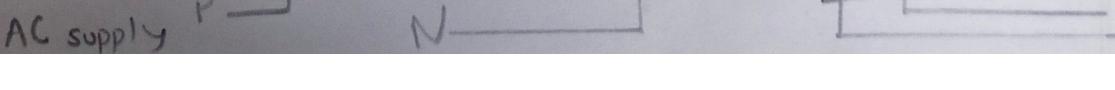
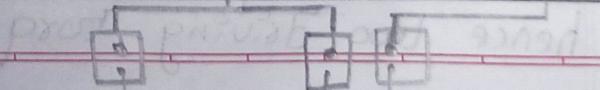
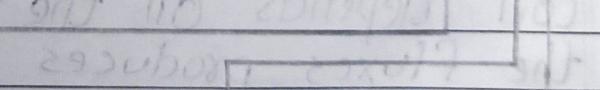
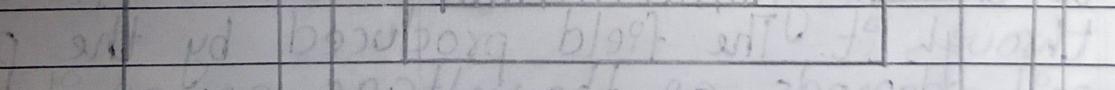
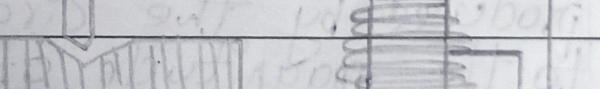
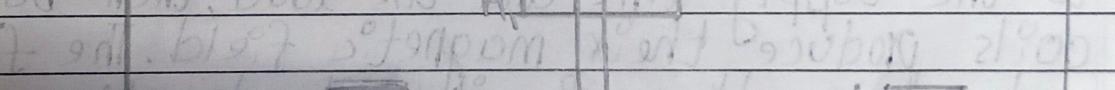
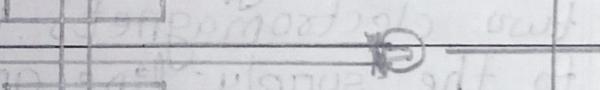
Counter Mechanical



: no hatching

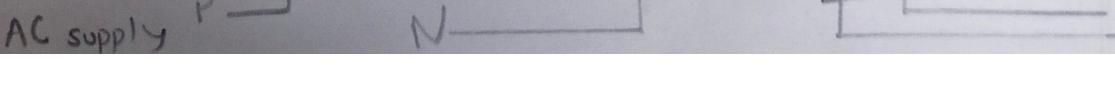
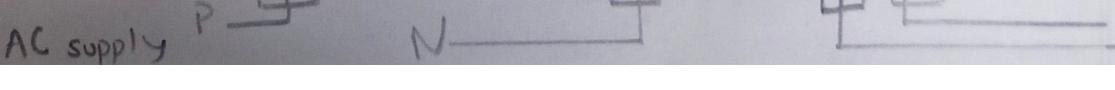


Horse
shoe Magnet



- Load N

Shunt
Magnet

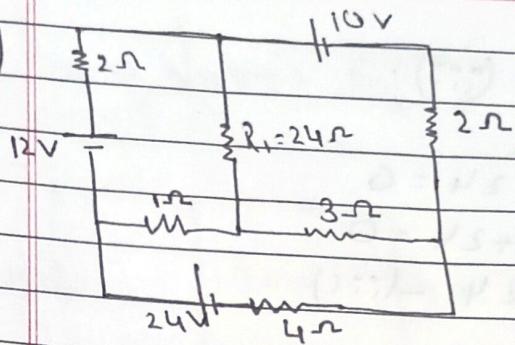


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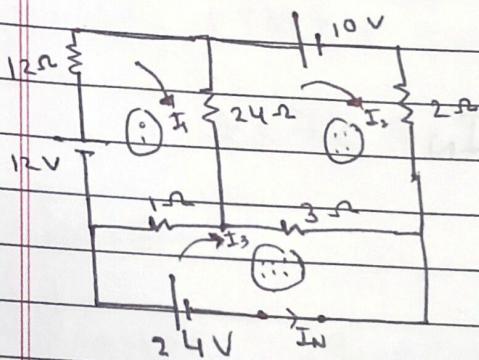
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Q1)



i) Remove load $R_L = 4\Omega$



ii) Find short circuit current (I_{IN})

Applying KVL in mesh (i)

$$12 - 2I_1 - 24(I_1 - I_2) - 1(I_1 - I_3) = 0$$

$$12 - 2I_1 - 24I_1 + 24I_2 - I_1 + I_3 = 0$$

$$-27I_1 + 24I_2 + I_3 = -12 \quad (\because)$$

Applying KVL in mesh (ii)

$$-3(I_2 - I_3) - 24(I_2 - I_1) - 10 - 2I_2 = 0$$

$$-3I_2 + 3I_3 - 24I_2 + 24I_1 - 10 - 2I_2 = 0$$

$$24I_1 - 29I_2 + 3I_3 = 10 \quad (\because)$$

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Applying KVL in mesh (i₁, i₂, i₃):

$$-1(I_3 - I_1) - 3(I_3 - I_2) + 24 = 0$$

$$-I_3 + I_1 - 3I_3 + 3I_2 + 24 = 0$$

$$I_1 + 3I_2 - 4I_3 = -24 \quad (\text{i.e.})$$

By solving eq's (i), (ii) & (iii)

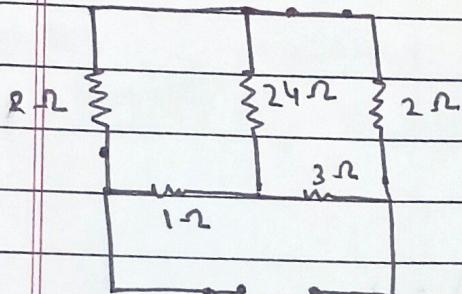
$$I_1 = 6.597 \text{ A}$$

$$I_2 = 6.402 \text{ A}$$

$$I_3 = 12.451 \text{ A} = I_N$$

$$\therefore I_N = 12.451 \text{ A}$$

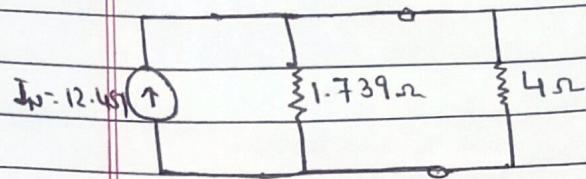
(i.e.) Find R_N.



$$R_N = (3 \parallel 24) \parallel 5$$

$$= 1.739$$

(iv) Draw Norton's Eq^L circuit.

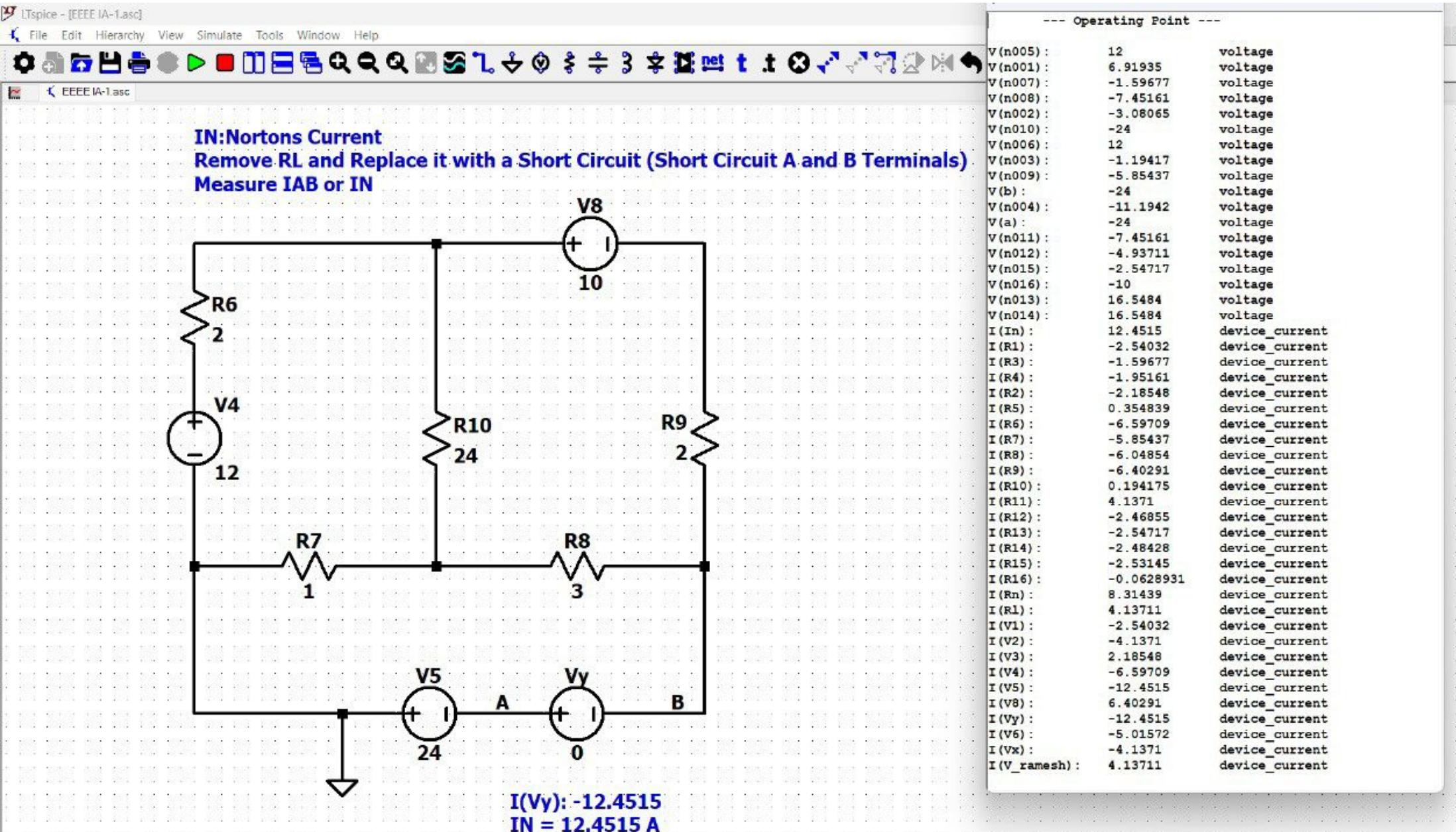


$$I_{4\Omega} = \frac{1.739 \times 12.451}{1.739 + 4}$$

$$= 3.772 \text{ A}$$

TABLE:-

Parameter	Theoretical Value	Simulated value
Norton's current I_N	12.451 A	12.451
Norton's Resistance R_N	1.739 Ω	1.990 Ω
Load Current I_L	3.772 A	4.137 A



Ready



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LTspice - [EEEE IA-1.asc]

File Edit Hierarchy View Simulate Tools Window Help

RN: Norton's Resistance
Deactive All Source
Remove RL
Measure RAB or RL

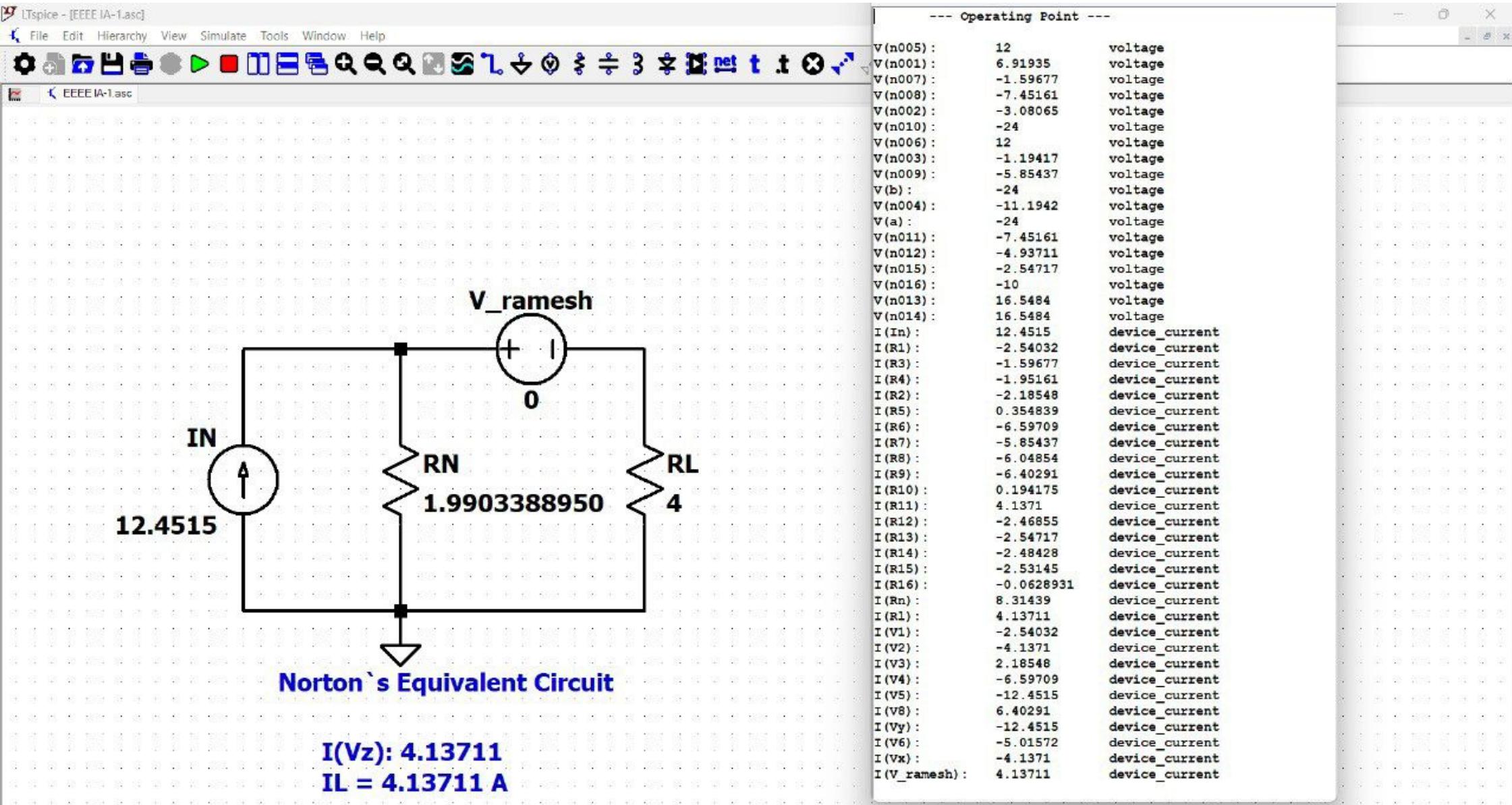
$V = IR$
 $R = V/I$

$I(V6): -5.02427$
 $RN = V6/I(V6) = 10/5.02427 = 1.9903388950 \text{ ohms}$

--- Operating Point ---		
$V(n005):$	12	voltage
$V(n001):$	6.91935	voltage
$V(n007):$	-1.59677	voltage
$V(n008):$	-7.45161	voltage
$V(n002):$	-3.08065	voltage
$V(n010):$	-24	voltage
$V(n006):$	12	voltage
$V(n003):$	-1.19417	voltage
$V(n009):$	-5.85437	voltage
$V(b):$	-24	voltage
$V(n004):$	-11.1942	voltage
$V(a):$	-24	voltage
$V(n011):$	-7.45161	voltage
$V(n012):$	-4.90291	voltage
$V(n015):$	-2.57282	voltage
$V(n016):$	-10	voltage
$V(n013):$	16.5484	voltage
$V(n014):$	16.5484	voltage
$I(In):$	12.4515	device_current
$I(R1):$	-2.54032	device_current
$I(R3):$	-1.59677	device_current
$I(R4):$	-1.95161	device_current
$I(R2):$	-2.18548	device_current
$I(R5):$	0.354839	device_current
$I(R6):$	-6.59709	device_current
$I(R7):$	-5.85437	device_current
$I(R8):$	-6.04854	device_current
$I(R9):$	-6.40291	device_current
$I(R10):$	0.194175	device_current
$I(R11):$	4.1371	device_current
$I(R12):$	-2.45146	device_current
$I(R13):$	-2.57282	device_current
$I(R14):$	-2.47573	device_current
$I(R15):$	-2.54854	device_current
$I(R16):$	-0.0970874	device_current
$I(Rn):$	8.31439	device_current
$I(R1):$	4.13711	device_current
$I(V1):$	-2.54032	device_current
$I(V2):$	-4.1371	device_current
$I(V3):$	2.18548	device_current
$I(V4):$	-6.59709	device_current
$I(V5):$	-12.4515	device_current
$I(V8):$	6.40291	device_current
$I(Vy):$	-12.4515	device_current
$I(V6):$	-5.02427	device_current
$I(Vx):$	-4.1371	device_current
$I(V_ramesh):$	4.13711	device_current

Ready

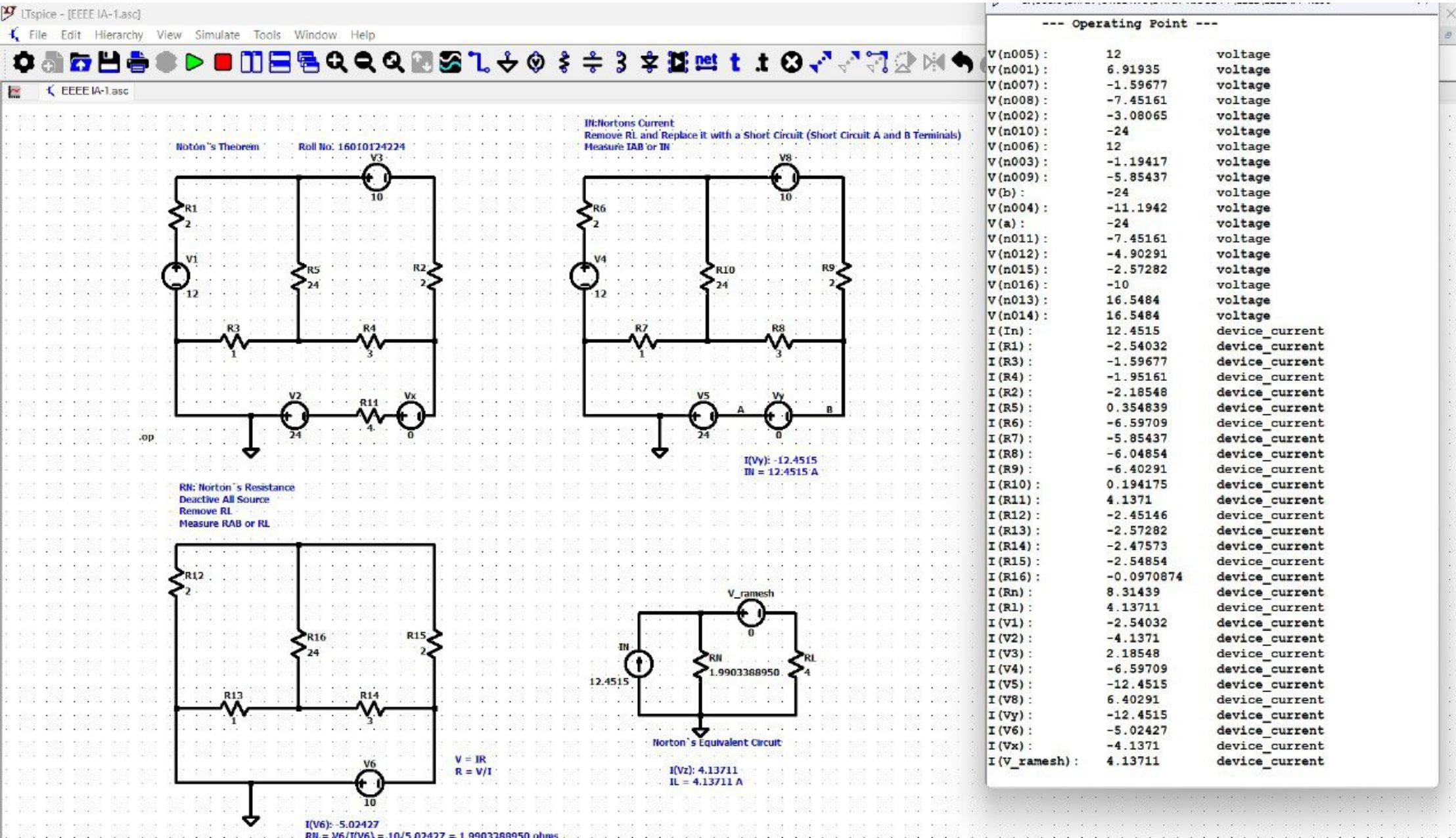




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