EE1111A Electrical Engineering Principles and Practice

Quiz 1

Semester 1, AY20-21

(Correct answers are highlighted)

1. The risk assessment of an activity in EE1111A's studio session was evaluated as shown in the table. What is the risk of this hazard? Topic: Safety

Task	Hazard	Possible Consequences	Severity	Likelihood	Risk	Risk Control
Characterization of Ohm's Law	Smoke from burning resistor.	Respiratory and eye irritation	2	1		Safety training.

A. 1
B. 2
C. 3
D. 4

2. Which of the following is the least preferred in the hierarchy of safety controls? Topic: Safety

A. Administrative Controls
B. Substitution
C. Engineering Controls
D. Personal Protective Equipment

3. What is (12.13 + 0.1146) x 2.2? Express your answer with correct number of significant figures.

Topic: measurement and significant figures

A. 26
B. 27
C. 26.93
D. 26.94

4. The accuracy of a measurement is … Topic: Measurement

A. determined by how close it is to the true value.
B. the same as the resolution of the instrument
C. independent of the instrument that is being used to make measurements.
D. the same as the precision of the measurements.

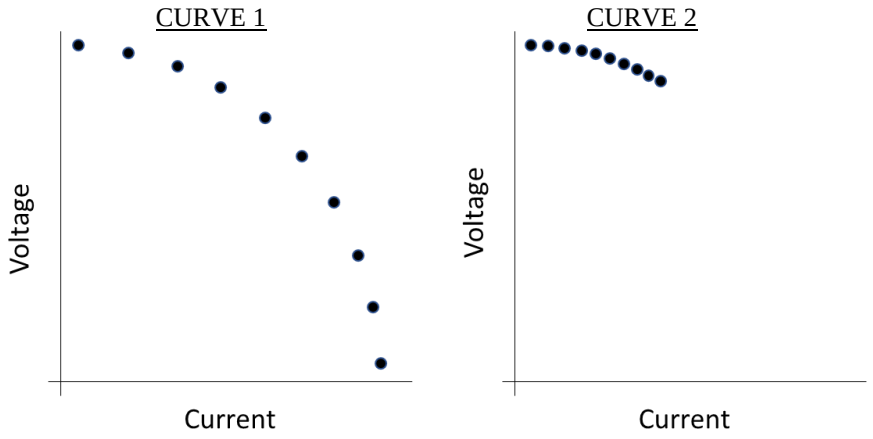
5. Bob measured the current flowing through a resistor five times using a digital ammeter. He scribbled down the following readings: 1.39A, 1.38A, 1.391A, 1.375A. Based on the resistance measurements, what is the resolution of the ammeter?

Topic: Measurement

A. 1 mA
B. 5 mA
C. 10 mA
D. None of the above

6. An engineer wanted to find the IV curve of a solar cell both indoors and outdoors. He had only ten resistors, so he used the same ten resistors indoors and outdoors. In the following curves, the voltage and current axes intersect at 0, but the engineer forgot to numerically label the graphs. Which of the following statements is most likely true?

Topic: PV



A. Curve 1 was taken outdoors
B. Curve 2 was taken outdoors
C. There is insufficient information to determine which was taken outdoors
D. Neither of the curves show the correct relationship between V and I for a solar cell, either indoors or outdoors. The engineer's measurements were thus flawed.

Rationale

The correct answer is "Curve 2 was from experiment done outdoors". This is because the current is higher outdoors. Since V=IR, so with the smallest resistors in the set, the voltage will be higher.

7. In an average month, a house usually used 300 kWh of energy. If the house was located in a place which received 5 hours of peak sun every day, how much total output power from the solar array should we specify when ordering the solar cells?

Topic: PV

A. 1 kW
B. 2 kW
C. 10 kW
D. 100 kW

Rationale

The correct answer is 10kW. With 30 days/month, we need about 10 kWh per day generated over 5 hours, which means a 2 kW system. With a typical 80% inverter/system efficiency, we can size it for 2.5 kW.

This means that options 1kW and 2kW are undersized or insufficient.

100 kW is oversized, so C is the best choice.

8. A solar cell was added in series with a battery so that their voltage added. Which of the following is TRUE?

Topic: PV and battery

A. The current out of the combination will always be higher than the current out of just the battery at a given voltage.
B. The maximum power point of the solar cell will change because of the presence of the battery.
C. This is a dangerous arrangement – a solar cell should always be wired in parallel with a battery, not in series.
D. All of the above

Rationale

Answer: The current out of the combination will always be higher than the current out of just the battery at a given voltage.

If you plot V versus I of just the solar cell and then shift it upwards by V due to the battery, it's easy to see that the current at any voltage is more. The maximum power point of a solar cell depends only on that particular cell and how much sunlight is falling on it, not what's connected to it.

9. Each solar panel was 1 m^2 in surface area and had a solar-to-electrical conversion efficiency of 20%. The voltage at the maximum power point was 60 V. How many panels are needed to supply 2000 W of power at 120 V in full normally incident sunlight?

Topic: PV

A. 1
B. 2
C. 10
D. 20

Rationale

Answer: 10.
About 1000W of solar power is incident on one panel, so one panel gives 200 W. We need 10 of them. We can have 5 parallel groups of 2 panels.

10. A solar cell had an open-circuit voltage of 0.5 V and a short-circuit current of 1.2 mA. 5 of such solar cells were wired in series into a string. Then, 3 such strings were connected in parallel. Estimate the maximum power available from the set.

Topic: PV

A. 0.6 mW
B. 1.8 mW
C. 7.2 mW
D. 9.0 mW

Rationale

Answer: 7.2mW.

The set will have a Voc = 2.5 V and an Isc = 3.6 mA, but the maximum power point will not be as high as Voc * Isc, so D is wrong. C is 80% of that value whereas A, B are < 20%.

11. The mass of a quadcopter including all components and the payload is 1 kg. It is cruising at a constant speed of approximately 6.3 m/s. If the drag force is equal to $0.25(v_h)^2$ where v_h is the speed in the horizontal direction, which of the following statements is correct?

A. The quadcopter is cruising keeping its body parallel to the ground.
B. The quadcopter is tilted at 30°
C. The quadcopter is tilted at 45°
D. The quadcopter is tilted at 50°

Topic: Dynamic equilibrium (the topic is excluded from the EE EPP syllabus)

Rationale

$$F_{prop} \cos\theta = 1 \times 9.8\ N$$

$$F_{prop} \sin\theta = 0.25 \times (6.3)^2\ N$$

$$\tan\theta = \frac{0.25 \times 6.3^2}{9.8} = 1.01$$

$$\theta \approx 45^\circ$$

12. A water tank is located on the roof of a building. The tank holds 10,000 litres of water when it is full. The mid-point of the tank is at a height of 60m from the reservoir at ground level. The tank is filled up at night using energy obtained from a PV system. The building is located at a place that has an average peak sun of 5 hours. The combined efficiency of inverter, water pump, battery and other ancillary components is 0.5. What is the minimum number of solar panels required to support this pump system if each panel is rated at 250 Watt-peak? (Acceleration due to gravity is 9.8 m/s^2)

Topic: Energy and PV

A. 9400
B. 5
C. 3
D. 9408

Rationale

Increase in potential energy of water:

$$mgh = 10000\ kg \times 9.8 m/s^2 \times 60m = 5880000\ J$$

$$mgh = \frac{5880000}{60 \times 60} \approx 1633 W\,h$$

$$N \times 250\ W\,p \times 5\ hours \times 0.5 = 1633$$

$$N = 2.6 \rightarrow 3$$

13. The operating voltage of a 650 W dc load is 14 V. You are looking for battery packs for this load and found four different models of battery pack. Which of these will give the longest operating time from one recharging to another while ensuring safe operation? (You can use more than one battery pack of the same model)

Topic: battery

A. 14V, 4000 mAh, 20C
B. 14V, 6000 mAh, 5C
C. 7V, 5000 mAh, 10C
D. 7V, 4000 mAh, 8C

Note: As there was no limit put on the number of cells that can be used, effectively all batteries can meet the specification.

14. A DC source consists of 4 cells in 2S2P arrangement. The specifications of the cells show 1.5 V open-circuit voltage (V_{OC}) and 0.5 Ω internal resistance. However, the battery pack was found to require too frequent recharging. As part of your investigation, you first measured the V_{OC} and I_{SC} which were 3 V and 5 A, respectively. Then you started replacing one battery at a time and found that replacing just one of the cells with a fresh cell of the same type fixed the problem. Which of the following most accurately characterize the faulty battery?

Topic: battery

A. V_{OC}=1.0 V, R_{int}=0.5 Ω
B. V_{OC}=1.5 V, R_{int}=1.0 Ω
C. V_{OC}=1.5 V, R_{int}=0.1 Ω
D. V_{OC}=1.5 V, R_{int}=0.1 Ω

Rationale

For the battery pack with faulty battery in:

$$V_{Th} = 3\ V, \quad I_{SC} = 5\ A, \quad \rightarrow \quad R_{Th} = 3/5 = 0.6\ \Omega$$

Open circuit voltage is 3V. So, all four batteries were 1.5V. (As a battery becomes old, its terminal voltage doesn't change, but internal resistance increases)

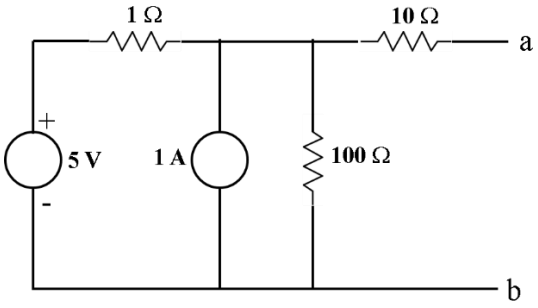
Thevenin resistance of 2S2P battery pack is

$$(0.5 + 0.5)||(0.5 + R_{faulty}) = \frac{0.5+R_{faulty}}{1.5+R_{faulty}}$$

Equating this to 0.6 ohms, we get

$$R_{faulty} = 1\ \Omega$$

15. What are the Thevenin voltage and the Thevenin resistance between the open terminals 'a' and 'b' of the circuit shown in the figure below.

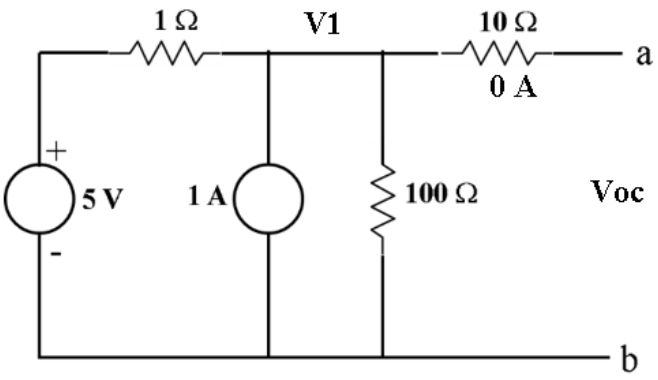


Topic: Circuits (Thevenin)

A. $V_{Th} \cong 6.0$ V and $R_{Th} \cong 11\ \Omega$
B. $V_{Th} \cong 100.0$ V and $R_{Th} \cong 11\ \Omega$
C. $V_{Th} \cong 6.0$ V and $R_{Th} \cong 110\ \Omega$
D. $V_{Th} \cong 5.0$ V and $R_{Th} \cong 11\ \Omega$

Rationale

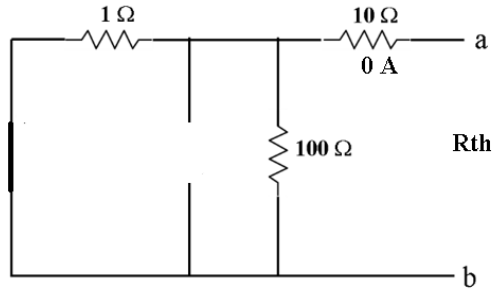
Find Thevenin voltage:



Node voltage equation at V1, : $15-V1+1-100V1=0$

Solving this gives $V1\approx 6$ V. $VTh=Voc=V1\approx 6$ V

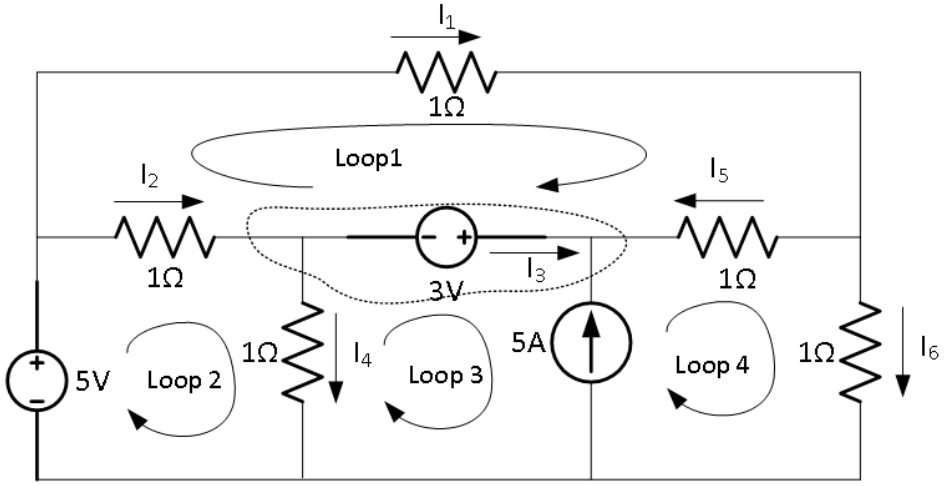
Find Thevenin Resistance:



$RTh=10\ \Omega+(1\ \Omega)||(100\ \Omega)\approx 11\ \Omega$

16. For the circuit shown below, which of the four equations given is correct KCL equation?

Topic: Circuit



A. $I_1 + I_2 - 5 = 0$

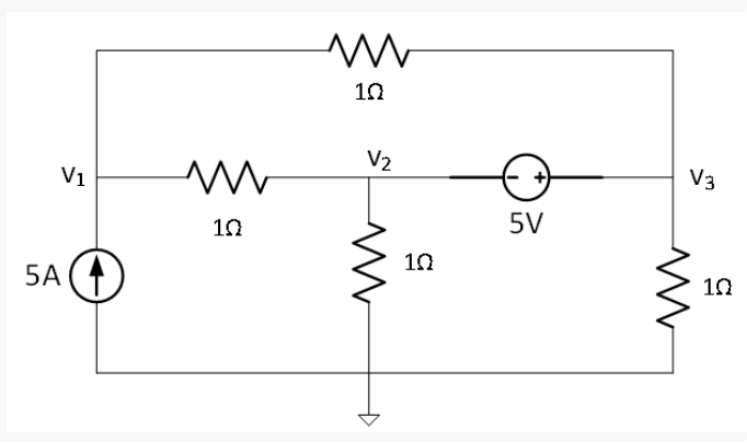
B. $I_2 + I_5 + 5 - I_4 = 0$

C. $I_5 + I_6 - I_1 = 0$

D. $I_2 + I_5 - I_4 = 0$

17. Which of the following KCL equations in terms of the node voltages is CORRECT?

Topic: Circuit



A. $\frac{V_1-V_2}{1} + 5 + \frac{V_1-V_3}{1} = 0$

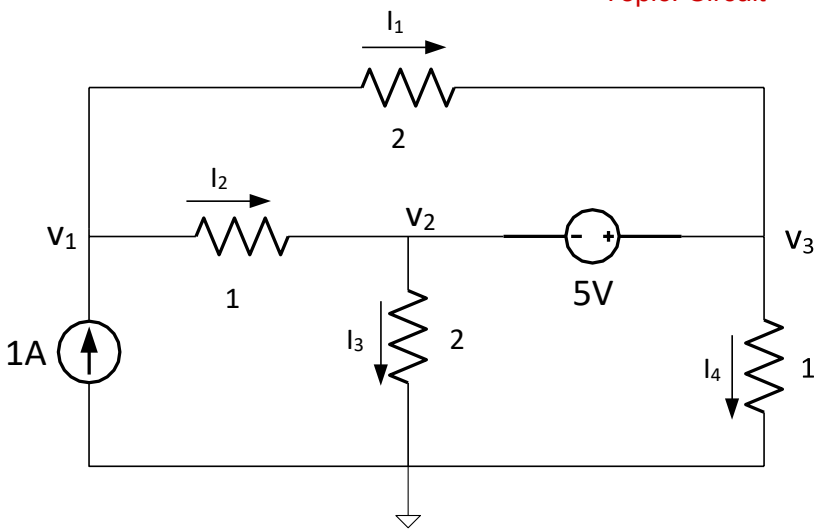
B. $\frac{V_2-V_1}{1} - 5 + \frac{V_2}{1} = 0$

C. $\frac{V_2-V_1}{1} + \frac{V_2}{1} + \frac{V_3}{1} + \frac{V_3-V_1}{1} = 0$

D. $\frac{V_3-V_1}{1} + 5 + \frac{V_3}{1} = 0$

18. Which option gives the closest values of node voltages V_1, V_2, and V_3 in the circuit below?

Topic: Circuit



A. $V_1 = 3V, V_2 = 2V, V_3 = 1V$
B. $V_1 = 3V, V_2 = -1V, V_3 = 4V$
C. $V_1 = 1V, V_2 = -5V, V_3 = 5V$
D. $V_1 = 2V, V_2 = 1V, V_3 = 5V$

Rationale

All options for this question are wrong.

You could solve it using node voltage analysis or CicuitLab.

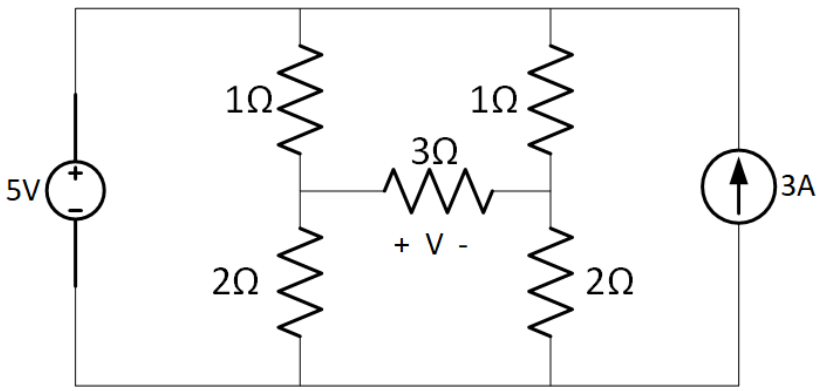
The correct answers should be: V_1=-1/3V, V_2=-8/3V, V_3=7/3V.

All students will get 1 mark for this question.

19. In the circuit below, which option gives the CORRECT values of voltage V , the contribution of voltage source (V_1) and the contribution of the current source (V_2)?

According to Superposition principle, $V = V_1 + V_2$.

Topic: Circuits (superposition)



A. V=3 V, V1=2 V, V2=1 V

B. V=10/3 V, V1=0 V, V2=10/3 V

C. V=0 V, V1=0 V, V2=0 V

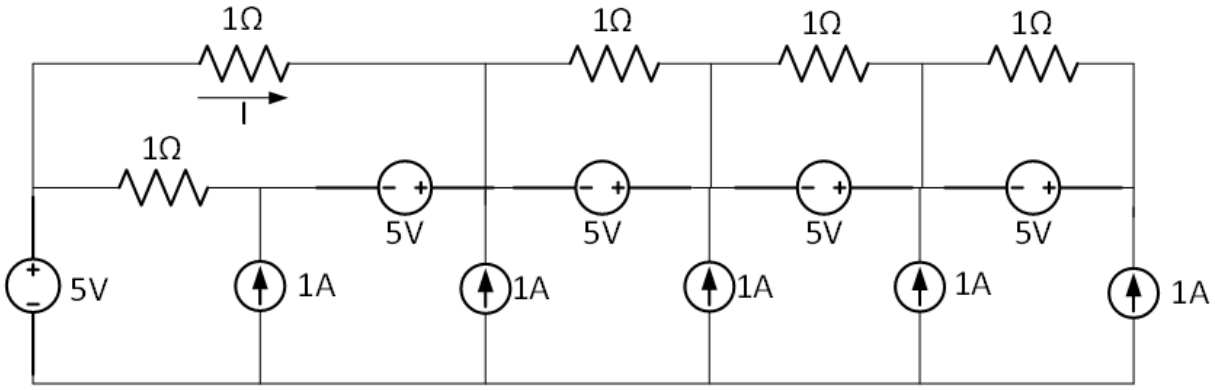
D. V=3 V, V1=1 V, V2=2 V

Rationale

We can find the contribution of 5V voltage source by **opening the current source branch** branch. The resistors form a bridge with equal ratio between the top resistor and bottom resistor for the two vertical legs. Thus, according to voltage divider rule, the potential at both ends of the horizontal branch will be equal and voltage V_1 will be zero.

We can find the contribution of the current source by **shorting the voltage source branch.** The 1A will flow through the shorted path and no current will flow through any of the resistors. Thus voltage V_2 will be also be zero.

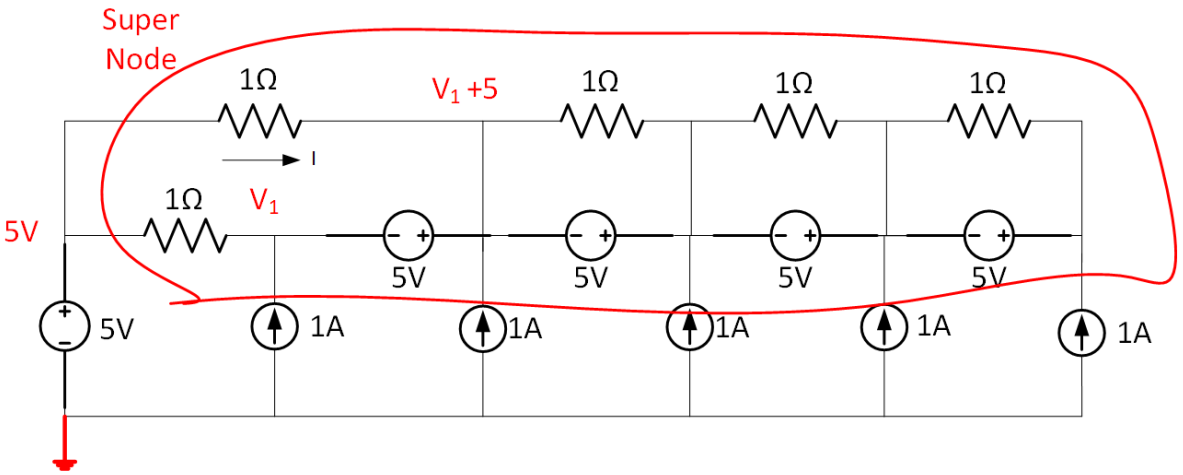
20. Which option gives the CORRECT value of the current **I** in the circuit.



Topic: Circuits

A. 5 A
B. 2.5 A
C. -5 A
D. -2.5 A

Rationale



We can solve the circuit using Node voltage analysis method.

To find I, we only need to know about V1

Applying KCL for the super node, (5−V1) + (5−V1−5) + 1+1+1+1+1=0

Thus, V1=5

I=15−V1−5=−5A

- END OF QUIZ -