NATIONAL UNIVERSITY OF SINGAPORE

EE1111A – ELECTRICAL ENGINEERING PRINCIPLES & PRACTICE I

MID-SEMESTER QUIZ
(with correct answer indicated)

(Semester 1 : AY2019/2020)
05 October 2019

Time allowed: 90 minutes

INSTRUCTIONS TO STUDENTS:

1. This quiz contains 20 questions and comprises 10 printed pages excluding the cover page.
2. Students are required to answer ALL questions.
3. **Please shade your matriculation number correctly on the scantron sheet.**
4. **Write your matriculation number and your contact number on the scantron sheet.**
5. Use a 2B pencil to shade completely all entries and the correct answers on the scantron sheet.
6. More than one answer (over-writing) per question will carry zero marks.
7. Do not submit the question paper, submit only the scantron sheet.
8. This is an **OPEN BOOK ASSESSMENT**.
9. All materials related to the topic are permitted.
10. No mobile devices are allowed.

1. Which of the following values of electric current is fatal? Topic: Safety

   (a) 60 milliamperes
   (b) 70 milliamperes
   (c) 80 milliamperes
   (d) All of the above

2. How can the Risk Assessment of a work activity be executed? Topic: Safety

   (a) Identifying all potential hazards in the work activity
   (b) Identifying the severity of the hazard
   (c) Identifying if the likelihood of the hazard causing harm is remote or otherwise
   (d) All of the above

3. What is $7.0 \times (13.81 + 0.211)$ equal to? Express your answer with correct number of significant figures. Topic: Measurement and significant figures

   (a) 98.15
   (b) 98
   (c) 98.14
   (d) 98.1

   For Questions 4 and 5, use the scenario given here. Bob measured the resistance of a resistor four times using a digital multimeter. He noted down the readings as: 21.53 $k\Omega$, 21.61 $k\Omega$, 21.44 $k\Omega$ and 21.55 $k\Omega$.

4. What is the average resistance of this resistor? Express your answer with the correct number of significant figures.

   Topic: Measurements and significant figures

   (a) 21.5 $k\Omega$
   (b) 22.0 $k\Omega$
   (c) 21.53 $k\Omega$
   (d) 21.533 $k\Omega$

5. Based on the resistance measurements, what is the resolution of the multimeter?

Topic: Measurement and significant figures

(a) 1 Ω
(b) 10 Ω
(c) 100 Ω
(d) 1 $k\Omega$

6. The block diagram of a robotic vacuum cleaner is shown in Figure 1. Which of the statements below is true?

Topic: block diagram

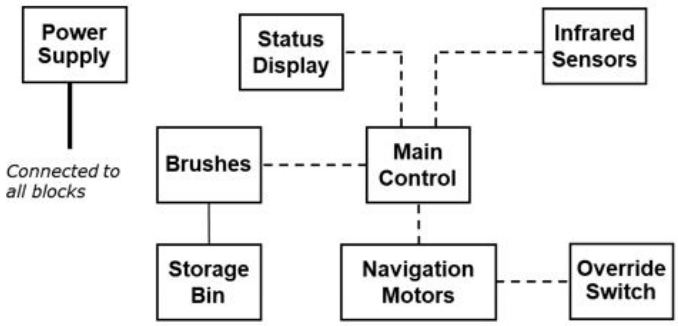

Figure 1: Block diagram of a robotic vacuum cleaner

(a) The main controller of the robotic vaccum cleaner receives user inputs in the form of a switch.
(b) The robotic vaccum cleaner automatically detects when the storage bin is full.
(c) The main controller of the robotic vaccum cleaner receives information from the infrared sensors and controls the motors and brushes.
(d) None of the above.

7. The resultant thrust produced by four rotors of a quadcopter is 7.8 N while hovering. Then the quadcopter is tilted such that the resultant thrust acts at an angle $\theta = 35°$ with the vertical axis, as shown in Figure 2. The drag force is equal to $0.024(v_{hor})^2$, where v_{hor} is the forward velocity of the quadcopter.

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

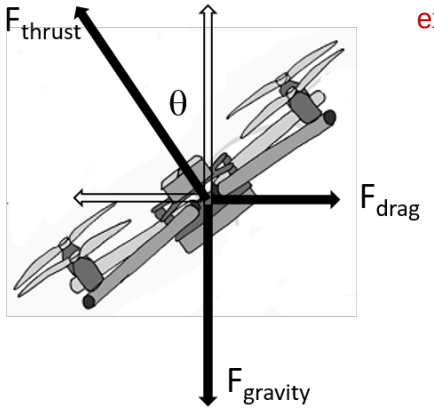

Figure 2: The quadcopter is tilted to make it move forward

(a) The quadcopter will start moving at the speed of approximately 15 m/s immediately after it is tilted

(b) The quadcopter first accelerates in the direction opposite to F_{drag} and eventually reaches the velocity of approximately 15 m/s

(c) The quadcopter first accelerates in the direction opposite to F_{drag} and eventually reaches the velocity of approximately 20 m/s

(d) The quadcopter will start moving at the speed of approximately 20 m/s immediately after it is tilted

8. Which are the correct values of I_1 and I_2 in the circuit of Figure 3?

Topic: circuits

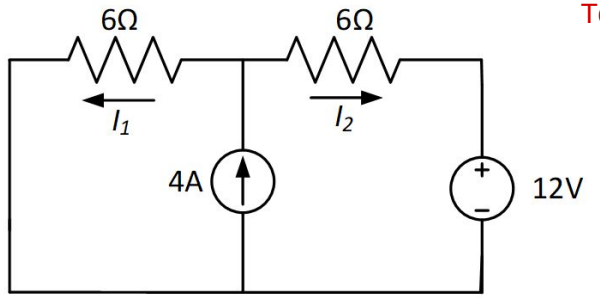

Figure 3: Circuit schematic for Question 8

(a) 3 A, 4 A
(b) 0 A, 4 A
(c) 3 A, 1 A
(d) 4 A, 0 A

9. What are the values of I and V in the circuit of Figure 4?

Topic: circuits

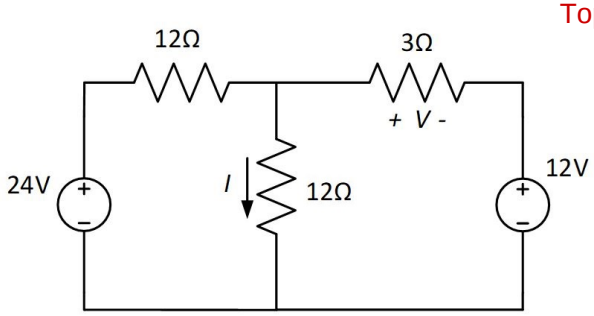

Figure 4: Circuit schematic for Question 9

(a) 1.5 A and 12 V
(b) 2 A and 6 V
(c) 1 A and 0 V
(d) 6 A and 0 V

10. What are the values of V_1 and V_2 in the circuit of Figure 5? Topic: circuits

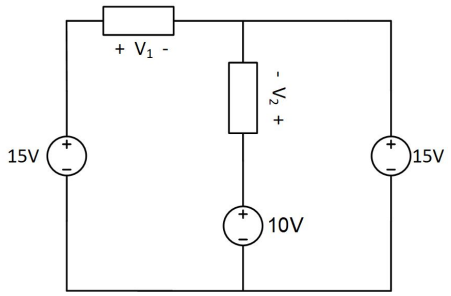

Figure 5: Circuit schematic for Question 10

(a) 0 V and 5 V
(b) 0 V and -5 V
(c) 5 V and 5 V
(d) 5 V and 15 V

11. What are the correct values of I_1, I_2, I_3 and I_4 in the circuit of Figure 6?

Topic: circuits

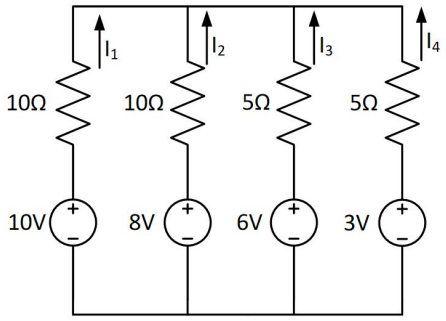

Figure 6: Circuit schematic for Question 11

(a) 0.4 A, 0.2 A, -0.6 A and 0 A
(b) 1.0 A, 0.8 A, 1.2 A and 0.6 A
(c) 0.4 A, 0.2 A, 0 A and -0.6 A
(d) -1 A, -0.8 A, -1.2 A and -0.6 A

12. What are the values of V_x and V_y in the circuit of Figure 7? Topic: Circuits

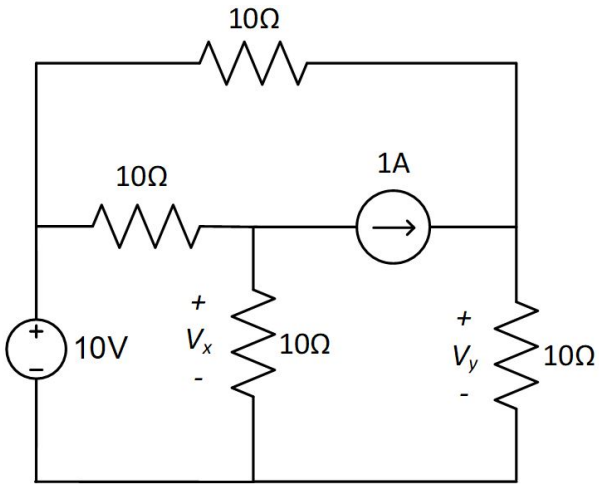

Figure 7: Circuit schematic for Question 12

(a) 5 V and 5 V
(b) 0 V and 10 V
(c) 0 V and -5 V
(d) 5 V and -5 V

13. In an electrical equipment, the current through and the voltage across a resistor are 50 A and 2 V, respectively. This system is kept ON for 30 minutes. Find the velocity with which a mass of 1000 kg must move in order to produce kinetic energy equal to the energy dissipated in the resistor of the electrical system?

Topic: Energy

(a) 15 m/s
(b) 19 m/s
(c) 23 m/s
(d) 27 m/s

14. You are given a battery pack made with several 3.7 V Li-ion batteries. The casing of the battery pack is opaque and you cannot see how many batteries are there inside. In order to determine the number of batteries, you carried out an experiment by measuring the terminal voltages and currents with two different resistors connected to the battery pack. With one of the resistors, the voltage and current readings are 10.90 V and 2.18 A. With the second resistor, these values are 10.66 V and 4.27 A, respectively. How many batteries are there in the pack and how are they connected? Internal resistance of individual Li-ion battery is approximately 0.1 Ω.

Topic: Battery

(a) Three batteries connected in series

(b) Three batteries connected in parallel

(c) Six batteries connected in two parrallel strings

(d) Six batteries connected in three parrallel strings

15. The battery shown in Figure 8 has these words written on its label: **5C, 3.7V, 2450 mAh**. What can possibly happen when you keep this battery connected to a load of resistance 0.25 Ω?

Topic: Battery

Figure 8: Battery specifications are written on the label

(a) The battery will supply 14.80 A current to the resistor for approximately 10 mins

(b) The battery will supply 12.25 A current to the resistor for approximately 12 mins

(c) The battery will supply 14.80 A current but terminal voltage will drop below 3.7 V

(d) The battery will be destroyed

For Questions 16 and 17, refer to the circuit shown in Figure 9.

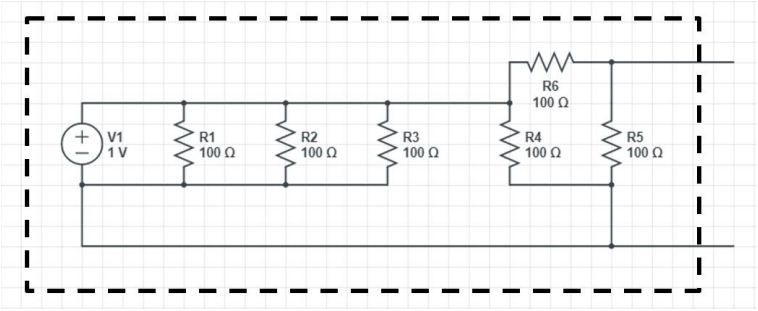

Figure 9: Refer to this circuit for answering Q16 and Q17

16. Figure 9 shows a circuit with two wires which can be used as terminals. The dotted lines surrounding the circuit represent a physical enclosure which is inaccessible to the user of the circuit. What is the Thevenin equivalent voltage and equivalent resistance of the circuit within the enclosure, as measured at the two wire terminals emerging from the box?

Topic: Thevenin equivalent

(a) $V_{Th} = 0.5\ V$ and $R_{Th} = 50\ \Omega$

(b) $V_{Th} = 0.5\ V$ and $R_{Th} = 150\ \Omega$

(c) $V_{Th} = 1.0\ V$ and $R_{Th} = 120\ \Omega$

(d) None of the above

17. Determine the power supplied by the 1V source labeled V1 in Figure 9, with nothing attached to the terminals, and choose the best answer from those below.

Topic: Circuits (Thevenin)

(a) The power supplied by the 1 V source V1 is 45 mW, and this is equal to the power supplied by the voltage source V_{Th} in the Thevenin-equivalent circuit.

(b) The power supplied by the 1 V source V1, as well as the power supplied by the voltage source V_{Th} in the Thevenin-equivalent circuit, are 0 W.

(c) The power supplied by the 1 V source V1 is 45 mW, and this is greater than the power supplied by the voltage source V_{Th} in the Thevenin-equivalent circuit.

(d) The power supplied by the 1 V source V1 is greater than the power supplied by the voltage source V_{Th} in the Thevenin-equivalent circuit.

18. A solar panel is going to be used to charge a 1.5 V battery. Which of the following scenarios would most likely result in a battery which is safely charged, if no additional circuitry is used? Topic: PV

    (a) The solar panel should be chosen so that its open circuit voltage is as close to 1.5 V as possible, so that it is well-matched to the battery's voltage.

    (b) The voltage at the maximum power point of the solar panel should be as close to 1.5 V as possible, so that it is well-matched to the battery's voltage.

    (c) The current at the maximum power point of the solar panel should exceed the maximum safe charge current of the battery.

    (d) The short-circuit current of the solar panel should be as close as possible to the maximum safe charge current of the battery.

19. A solar cell was characterized by a handheld multimeter and a handful of resistors indoors and outdoors. Which statement is most accurate? Topic: PV

    (a) The open circuit voltage measurement is probably more accurate than the short circuit current measurement both indoors and outdoors.

    (b) The short circuit current measurement is probably more accurate than the open circuit voltage measurement both indoors and outdoors.

    (c) The current at the maximum power point measured outdoors is probably less accurate than the current at the maximum power point measured indoors.

    (d) The voltage at the maximum power point measured outdoors is probably less accurate than the voltage at the maximum power point measured indoors.

Figure 10: The car supplying electricity to charge portable electronics

Model No.	KMX
Maximum Power P_{max}	1.2 W
Voltage V_{mp}	4 V
Current I_{mp}	300 mA
Tolerance	$\pm 5\%$
Dimensions	110 $mm \times 94$ mm

Table 1: Solar PV Specifications

Topic: PV

20. An off-the-grid cabin in the woods in California uses electricity only to charge small portable electronics (maximum power use of 12 W at the load), since the owner prefers to burn wood in the fireplace for heating and cooking. The electricity is currently provided by a long wire stretching into the cabin directly from the cigarette lighter in the owner's 1986 Pontiac Parisienne, pictured in Figure 10. Inside the cabin is a small inverter providing the necessary 120 V socket. The owner prefers to use a solar PV system instead. Which of the following setups would you choose, making use of several KMX solar cells (refer to Table 1)? It was mentioned during the exam that the voltage of a car battery is 12 V.

    (a) Ten (10) KMX solar cells on the cabin roof should be wired in series creating one panel. This panel should be wired to the inverter.

    (b) Three (3) KMX solar cells on the cabin roof should be wired in series creating one panel. Four (4) such panels should be wired to the inverter.

    (c) Three (3) KMX solar cells on the cabin roof should be wired in series creating one panel. Eight (8) such panels should be wired to the inverter.

    (d) Thirty (30) KMX solar cells should be wired in series creating one panel. This panel should be wired to the inverter.

- END OF QUIZ -