NATIONAL UNIVERSITY OF SINGAPORE

EE1111A – ELECTRICAL ENGINEERING PRINCIPLES & PRACTICE I

END-SEMESTER QUIZ

(Semester 1, AY2022/2023)

05 November 2022

Time Allowed: 1.5 Hour

INSTRUCTIONS TO STUDENTS:

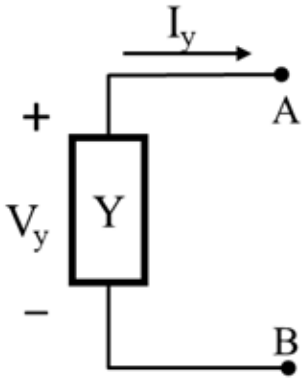
1. This quiz contains 20 questions and comprises 11 printed pages including the cover page.
2. Students are required to answer **ALL** questions.
3. **Please shade your matriculation number correctly on the scantron sheet.**
4. **Write your matriculation number and your contact number on the scantron 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 laptop or mobile devices are allowed.

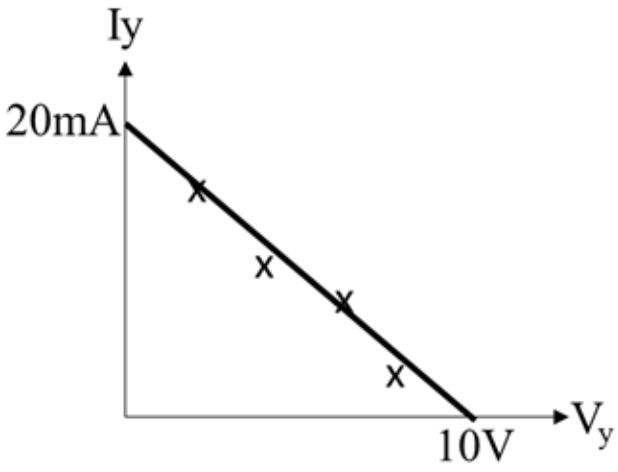
1. Which of the following is an example of an Administrative Control of a Hazard?

   A. Fume Cupboard
   B. Toe-covered Shoes
   C. Standard Operating Procedures
   D. Laboratory Coats

For Questions 2 and 3, use the scenario given below.

The behaviour of unknown circuit Y is characterized using different resistor loads connected between A and B, and the measurements are shown in the plot below. It is known that circuit Y consists only of ideal resistors and sources.





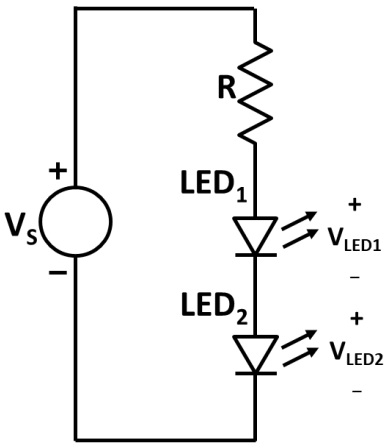
2. A practical voltmeter with a total internal resistance of 500kΩ is connected across terminals A-B. What is the reading likely displayed on the voltmeter?

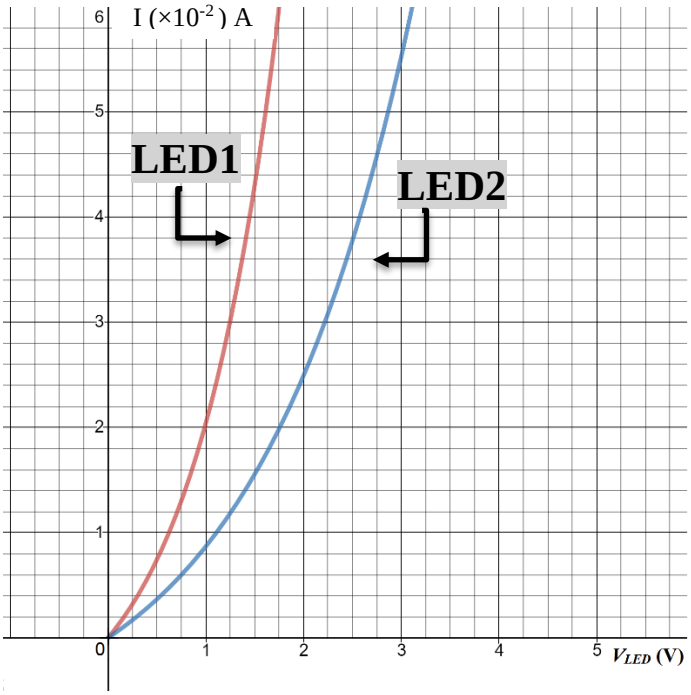
   A. 10 V
   B. 9.00 V
   C. 9.99 V
   D. 9.90 V

3. Which of the following statement is **FALSE**?

   A. When Y is connected to a load of 500Ω, the total power consumption of the entire circuit (Y and 500Ω load) is 0.1W.
   B. When Y is connected to a capacitive load of 1uF, the time taken to fully charge the capacitor is approximately 2.5ms.
   C. When Y is connected to a load of 500Ω, the power consumption of the load is 0.05W.
   D. When Y is connected to an inductive load of 1H, the time taken to fully charge the inductor is approximately 10ms.

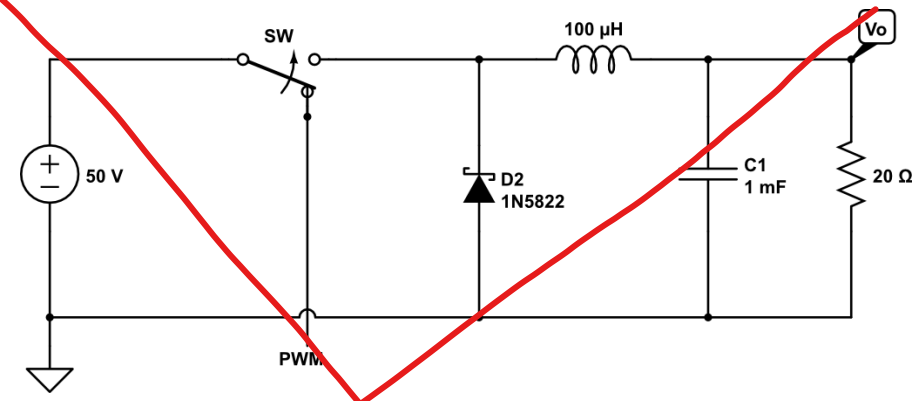
4. The I-V characteristics of two different LEDs, LED_1 and LED_2, and the circuit in which they are connected, are shown below. Both LEDs require V_{LED} to be at least 1V to turn on visibly. For Vs = 5V, what is the largest value that can be used for R?





A. 90 Ω
B. 110 Ω
C. 150 Ω
D. 375 Ω

5. The schematic of a DC-DC Buck Converter is as shown below.

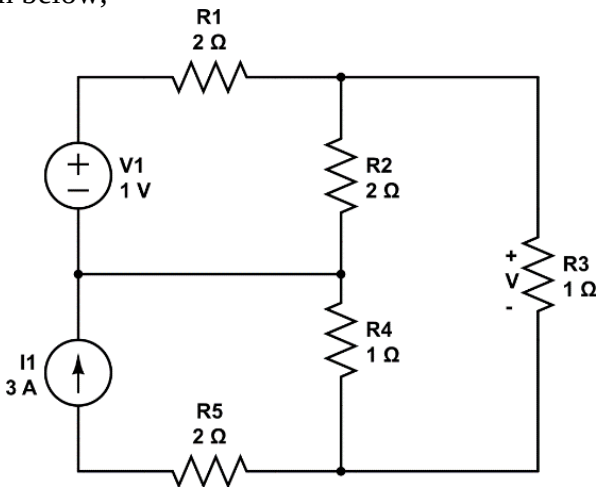


The switch is controlled by a PWM signal of duty cycle 30% and frequency of 62.5 kHz. If the PWM signal is HIGH, then the source is connected to the circuit. If it is LOW, then the source is disconnected. The steady-state DC output voltage observed at V_O is approximately constant around a value of

BUCK CONVERTER WILL NOT BE TESTED

A. 15 V
B. 30 V
C. 35 V
D. 70 V

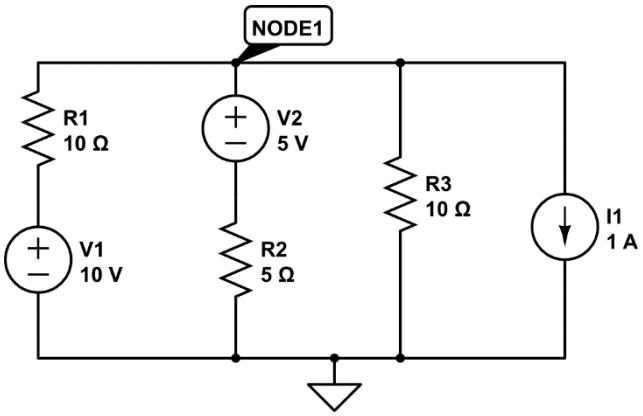
6. In the circuit given below,



which option does give the individual contribution of each source towards the voltage V across the resistor R_3? V_{1V} and V_{3A} are contribution of the 1V voltage source and 3A current source, respectively.

A. $V_{1V} = \frac{1}{6}V, V_{3A} = 2V$
B. $V_{1V} = \frac{1}{3}V, V_{3A} = 2V$
C. $V_{1V} = \frac{1}{6}V, V_{3A} = 1V$
D. $V_{1V} = \frac{1}{3}V, V_{3A} = 1V$

7. In the circuit given below, which option does give the correct value of the voltage at NODE1 with respect to the ground node?

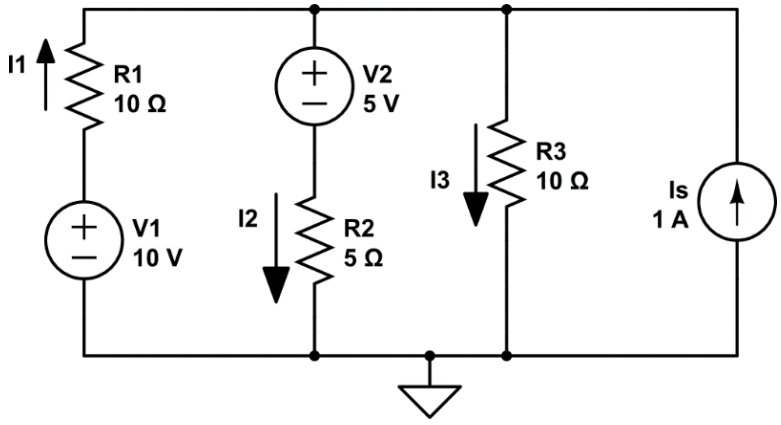


A. 10 V
B. 5V
C. 10/3 V
D. 5/3 V

Correct answer is 2.5 V. This question is invalid.

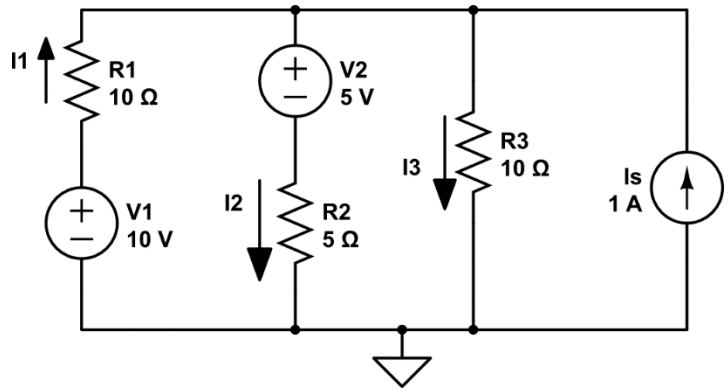
This question was removed.

8. In the circuit below, which option does give a correct KCL equation?



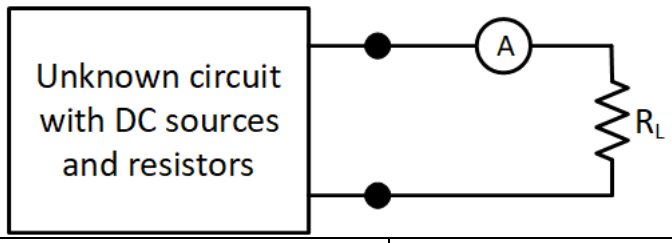
A. I1-I2-I3-1=0
B. I1-I2-I3=0
C. I1-I2=I3
D. I1-I2-I3+1=0

9. In the circuit below, which option does give a correct KVL equation?



A. $10 - I1R1 - 5 - I2R2 = 0$
B. $-10 + I1R1 - 5 + I2R2 = 0$
C. $I2R2 + 5 + I3R3 = 0$
D. $10 - I1R1 + I3R3 = 0$

10. A box contains a circuit made up of a few DC sources and resistors. Only two terminals of the circuit are accessible from outside. VI characterization of the circuit was done by connecting different resistors R_L across the two terminals and measuring the current drawn by the resistors, as shown below.

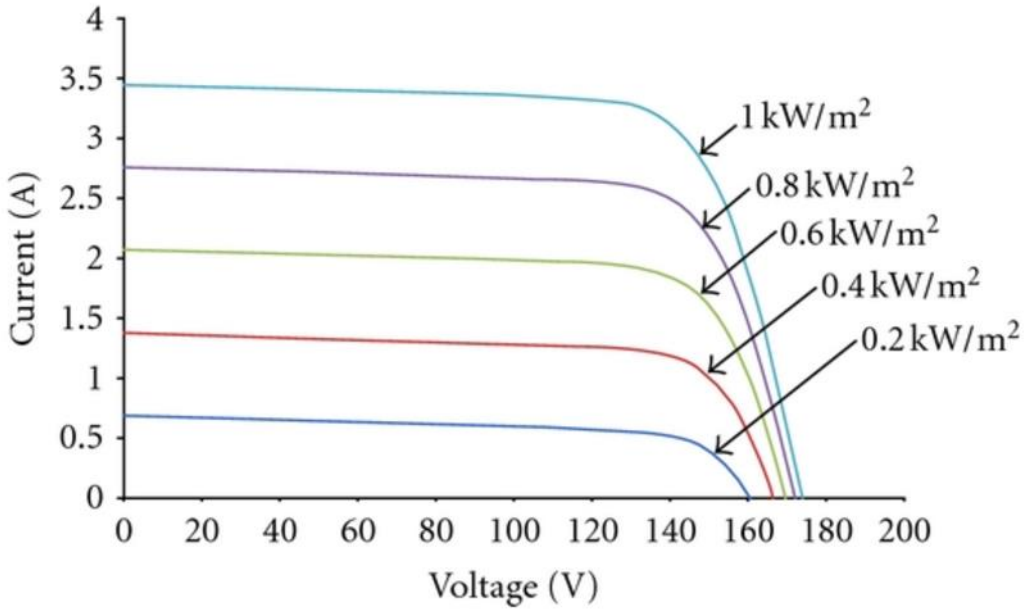


Value of resistor R_L connected	Value of current drawn
100 Ω	0.15 A
50 Ω	0.2 A

What will be the current drawn from the circuit if a 200 Ω resistor is connected across the terminals?

A. 0.05 A
B. 0.1 A
C. 0.3 A
D. 0.25 A

11. The IV-characteristics of a photovoltaic (PV) module under five different solar irradiance conditions are shown in the figure below.



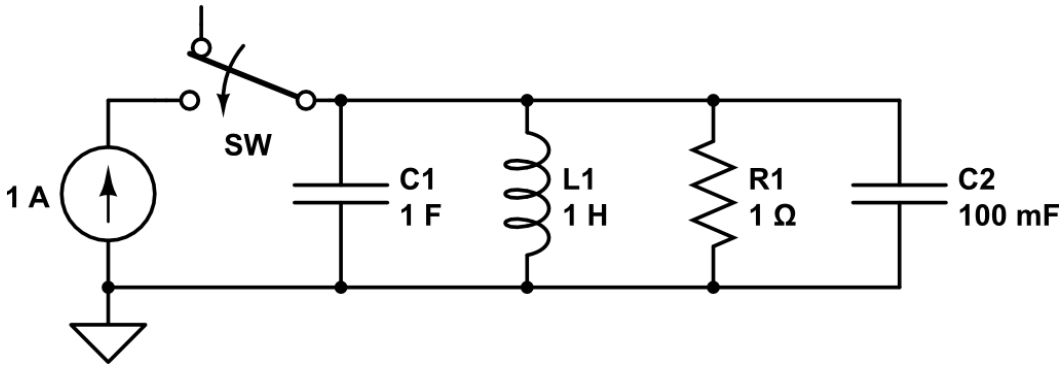
In a separate experiment with a 60 Ω load resistor, the voltage measured across the load is 120 V. If an ammeter is connected across this load, what would be the most likely value of the ammeter reading?

A. 3.50 A
B. 2.05 A
C. 1.50 A
D. Cannot be determined from the given information

12. The label of a LiPo battery shows 7.4 V, 180 mAh, 20C. Four of these batteries are connected in 2S2P configuration to provide electrical power to a load. What is the maximum current that can be continuously supplied to the load without causing any damage to the batteries?

A. 3.6 A
B. 360 mA
C. 7.2 A
D. 20 A

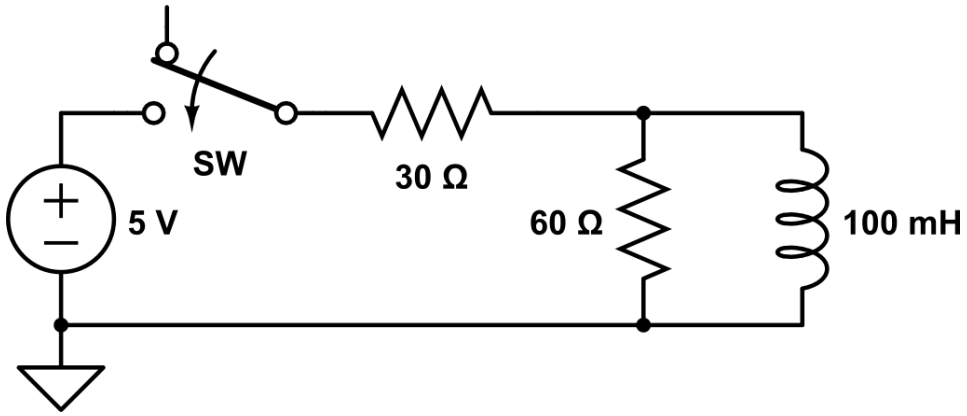
13. In the circuit below, a current source is connected through a switch to a parallel connection of a capacitor C1, an inductor L1, a resistor R1, and a capacitor C2.



The switch is closed at $t = 0$, i.e., at $t = 0$ the current source is connected to the four parallel components. Before closing the switch, the capacitors are uncharged, and no current is flowing through the resistor and the inductor. Right after closing the switch, most of the current flows through the branch containing:

A. C1
B. L1
C. R1
D. The combination of L1, R1, C2 (due to the resonance of L1 and C2, damped by R1)

14. In the circuit below, a voltage source is connected through a switch and a resistor to a parallel combination of an inductor and a resistor. At $t = 0$ the switch SW is closed.



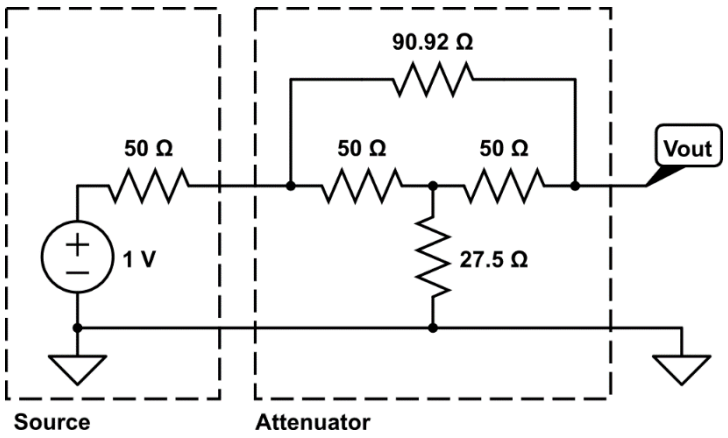
After 10 ms the current through the inductor is closest to:

A. 216 mA
B. 144 mA
C. 167 mA
D. 250 mA

15. A capacitor of 4 F is charged to 5 V. After charging it, the capacitor is connected to an inductor of 3 H, which results in an oscillatory exchange of energy between the capacitor and the inductor. How often is the energy in the capacitor maximum?

A. One time per 21.8 seconds.
B. Two times per 21.8 seconds.
C. One time per 21.8/(2π) seconds.
D. Two times per (2π)*21.8 seconds.

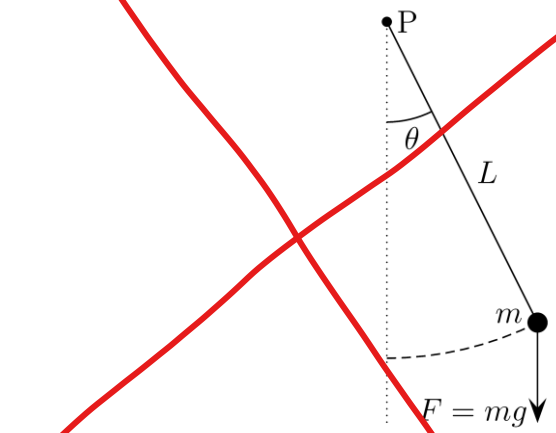
16. A source is represented by its Thévenin equivalent circuit with a voltage of 1 V and a resistance of 50 Ω. This source is connected to a so-called bridged tee attenuator, which consists of two resistors of 50 Ω, a resistor of 90.92 Ω, and a resistor of 27.5 Ω. The function of the attenuator is to attenuate the source.



The combination of the source and the attenuator can be represented by a Thévenin equivalent circuit. The Thévenin voltage "Vout" is closest to:

A. 212 mV
B. 230 mV
C. 291 mV
D. 355 mV

17. A pendulum consists of a line with low mass of length L with a mass of m kg on one side of the line and the other side of the line fixated at a point P, as shown in the below figure. The gravitational force on the mass m is $m*g$, where g is the gravitational constant (g = 9.81 m/s^2).



NOT TO BE TESTED

For small swings, the second order differential equation describing the motion of the pendulum (the angle θ with respect to time t) is given by:

$$\frac{d^2\theta}{dt^2} + \frac{g}{L}\theta = 0$$

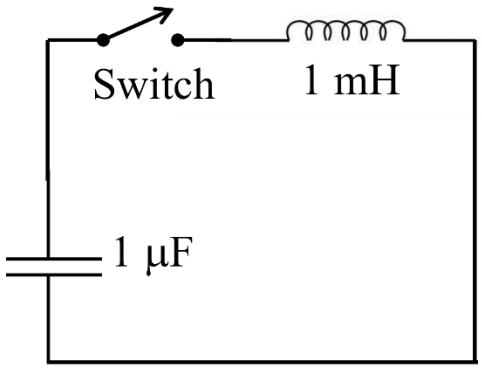
The solution to this differential equation is given by:

$$\theta(t) = \theta_0 \sin(2\pi f_n t)$$

where f_n is the natural frequency of the swinging pendulum. If the mass m is 0.2 kg, which is the closest length L to obtain a pendulum swing period of $T_n = 1/f_n = 2$ seconds?

A. 49.7 cm
B. 99.4 cm
C. 156.1 cm
D. 312.3 cm

18. A charged capacitor, with initial voltage 10 V, is connected to an inductor via a switch as shown below. The capacitance and the inductance are 1 μF and 1 mH, respectively. The switch is closed at t=0 causing oscillatory exchange of energy between the two components. Assuming that there is not resistive loss in the circuit, what will be the peak value of the oscillating current?



A. 316 mA
B. 433 mA
C. 100 mA
D. Cannot be determined from the given information

For questions 19 and 20, use the following scenario.
An IC (integrated circuit) chip is mounted on a heat sink for better heat dissipation. Under steady-state condition, reached after 5 minutes, the temperature of the heat sink is 50°C when the atmospheric temperature is 30°C. Instead of mounting one chip, two such chips are mounted on the same heatsink. Power dissipation in each IC remains the same.

19. Which of the following options does give the steady-state temperature of the heat sink with two chips mounted on it?

A. 50°C
B. 100°C
C. 70°C
D. Cannot be determined from the given information

20. What is the time taken for the heat sink to reach the steady-state temperature with two chips mounted on it?

A. 5 minutes
B. 10 minutes
C. 15 minutes
D. Cannot be determined from the given information

Thermal capacity is not tested.

- END OF QUIZ -