Section 1 Multiple choice questions:

Q1a. Which of the following statement(s) is/are correct?

The output voltage of an electronic system can be higher than the input voltage.
The output current of an electronic system can be higher than the input current.
The output power of an electronic system can be higher than the input power.
The output resistance of an electronic system can be higher than the input resistance.

Q1b. Which of the following statement(s) is/are correct?

The frequency of the output of an electronic system can be higher than the frequency of the input.
The ideal output resistance of an electronic system is zero.
The ideal input resistance of an electronic system is zero.
The output voltage of an electronic system can be kept unchanged even if the input voltage is changed.

Q2a. What is the fundamental frequency of the waveform
$v(t)=10\sin(2000\pi t)+2\cos(4000\pi t)$?

a. 1kHz
b. 2kHz
c. 4kHz
d. Not periodic

Q2b. What is the fundamental frequency of the waveform
$v(t)=10\sin(2000\pi t)+2\cos(3000\pi t)$?

a. 1kHz
b. 1.5kHz
c. 333.3Hz
d. Not periodic

Q3a. What are the amplitude and frequency of the waveform
$v(t)=3\sin(2000\pi t)+4\cos(2000\pi t)$ V

a. 5V, 1kHz
b. 7V, 1kHz
c. 5V, 2kHz
d. 7V, 2kHz

Q3b. What are the amplitude and frequency of the waveform
$v(t)=6\sin(5000\pi t)+8\sin(5000\pi t)$ V

a. 14V, 2.5kHz
b. 10V, 5kHz
c. 10V, 2.5kHz
d. 14V, 5kHz

Q4a. A lithium battery has no-load voltage of 4.3V and output resistance of 10mΩ. If it is connected to a 10Ω load, what is the terminal voltage?

a. 4.2957V

b. 4.3000V
c. 4.2125V
d. 4.2523V

Q4b. A lithium battery has no-load voltage of 4.3V and output resistance of 10mΩ. If it is connected to a 10Ω load, what is the output current?

a. 429.50mA
b. 430.00mA
c. 421.25mA
d. 425.23mA

Q5a. If three sinusoidal voltage sources are connected in series, must the total output current be sinusoidal?

Undetermined
No.
Yes.

Q5b. If three sinusoidal current sources are connected in parallel, must the total output voltage be sinusoidal?

Undetermined
No.
Yes.

Q6a. How many frequency components will be produced if two sinusoids are multiplied?

2
1
3
1, 2, or 3

Q6b. If two sinusoids with frequencies $f_1$ and $f_2$, respectively, are multiplied, what frequency components appear at the product

$f_1 + f_2$ and $f_1 - f_2$
$f_1 \text{x} f_2$ and $f_1 + f_2$
$f_1$ and $f_2$
$2f_1$ and $2f_2$

Q7a. If a battery has the output characteristic of $v_b = 14 - 0.02 i_b$, where $v_b$ is the battery voltage and $i_b$ is the battery current, respectively. Determine the battery voltage if the output current is 10A.

13.8V
14V
10V

12V

Q7b. If a battery has the output characteristic of $v_b = 14 - 0.02 i_b$, where $v_b$ is the battery voltage and $i_b$ is the battery current, respectively. Determine the battery current if a 10Ω resistor is connected to the battery.

1.397A
1.400A
1.208A
1.245A

Q8a. What is the average voltage of the signal $v(t) = -5 + 2\cos(1000\pi t)$ V?

-5V
3V
5V
-3V

Q8b. What is the peak value of the signal $v(t) = -5 + 2\cos(1000\pi t)$ V?

-3V
5V
2.5V
3V

Q9a. If a square-wave voltage generator with peak-to-peak voltage of 100V and fundamental frequency of 2kHz is connected to a 100 Ω resistor, determine the peak value of the 7kHz current component through the resistor.

0A
128mA
106.1mA
127.7mA

Q9b. If a square-wave voltage generator with peak-to-peak voltage of 100V and fundamental frequency of 2kHz is connected to a 100 Ω resistor, determine the peak value of the 9kHz current component through the resistor.

0A
100mA
127.7mA
63.7mA

Q10a. If a system is connected to a 200Ω load, its output voltage is changed from 20V into 15V, what is the output resistance of the system?

66.67Ω
150Ω
266.67Ω
100Ω

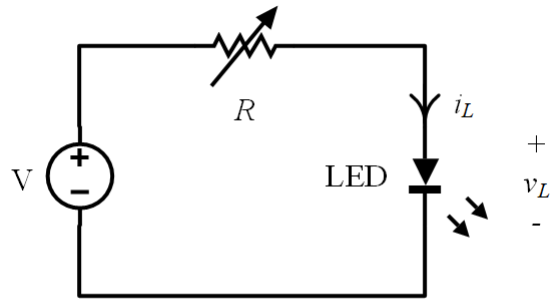
Q10b. The output voltage of an amplifier is changed from 12V into 4V, if the amplifier is connected to a 400Ω load. Determine the output resistance of the amplifier.

800Ω
400Ω
1.2kΩ
100Ω

Section 2 Long questions

Question 2(a)

Fig. 1 shows a circuit that can control the brightness of an LED. The current-voltage characteristic of the different LEDs is given.



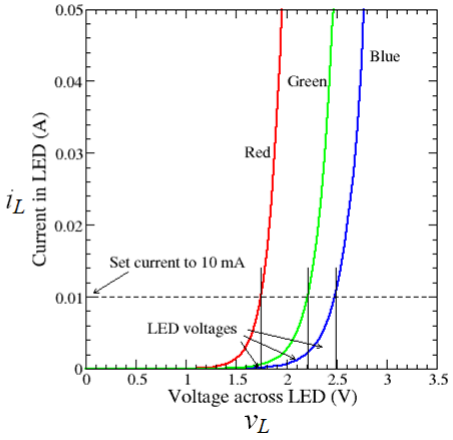




Fig. 1

(a) Express $i_L$ in terms of $V$, $R$, and $v_L$. (1 mark)

Ans.: $i_L = (V - v_L)/R$

(b) Based on (a), discuss how the LED voltage and LED current are determined graphically. (1 mark)

Draw the straight line using the function derived in part (a). The intersection point of the straight line and the LED characteristic is the operating point that gives the LED voltage and LED current. [Other reasonable answers are acceptable.]

(c) What is the minimum value of $V$ to turn on a red LED? (1 mark)

1.1V

(d) Discuss the main technical issue if a red LED, a green LED, and a blue LED are connected in parallel and their brightness are controlled with the circuit. (1 mark)

As they have different current-voltage characteristics, LED with lower forward voltage will be stressed. For example, when the blue LED is operated at 10mA, the red LED will have a very large current. [Other reasonable answers are acceptable.]

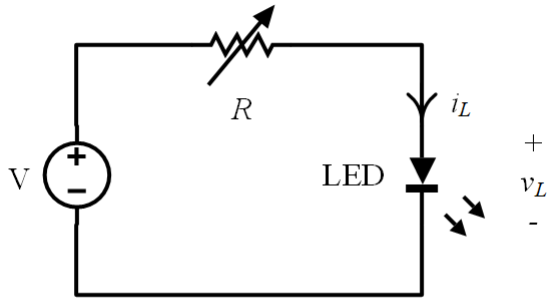
(e) Suggest a method to resolve the issue discussed in part (d). (1 mark)

1) Three separate circuits connected to the same are used to control individual LEDs so that the currents of the three circuits can be controlled or
2) The LEDs can be connected in series to share the same current.

[Other reasonable answers are acceptable.]

Question 2(b)

Fig. 1 shows a circuit that can control the brightness of an LED. The current-voltage characteristic of the different LEDs is given.



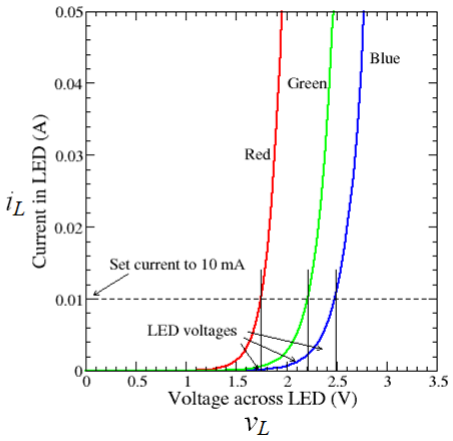




Fig. 1

(a) Express $i_L$ in terms of $V$, $R$, and $v_L$. (1 mark)

Ans.: $i_L = (V - v_L)/R$

(b) Based on (a), discuss how the LED voltage and LED current are determined graphically. (1 mark)

Draw the straight line using the function derived in part (a). The intersection point of the straight line and the LED characteristic is the operating point that gives the LED voltage and LED current. [Other reasonable answers are acceptable.]

(c) Suggest how the brightness of the blue LED can be controlled. (1 mark)

Change the value of $R$.

(d) If $R$ = 0 and the voltage source is driven by a Microbit board with PWM output, suggest how the brightness is controlled by the Microbit board. (1 mark)

By changing the pulsewidth of the PWM signal, the average value of $V$, and thus the brightness, can be controlled. [Other reasonable answers are acceptable.]

(e) Suggest a method that can compose different colors and brightness with the Microbit board (1 mark)

Three separate circuits are connected to the Microbit. Then, the brightness of each LED can be controlled. Then different colors can be composed. [Other reasonable answers are acceptable.]