University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATIONS - 2012/2013

School of Electrical, Electronic and Communications Engineering

EEEN10010 Electronic & Electrical Engineering I

Professor McLaughlin

Professor Brazil

Dr. Duignan*

Time Allowed: 2 hours

Instructions for Candidates

Attempt all 15 questions in Section A and 3 out of 4 questions in Section B. Each question in Section A is worth 4 marks. Each question in Section B is worth 20 marks. The exam is worth a total of 120 marks.

Please complete Section A on a Multiple Choice Answer Sheet using a HB pencil.

Instructions for Invigilators

Please supply one Answer Book and one Multiple Choice Answer Sheet to each candidate

Non-programmable calculators are permitted.

No rough-work paper is to be provided for candidates.

Section A

Answer all of the following multiple-choice questions. Each question is worth 4 marks.

1. A cylindrical sample of material has a length l = 0.9m, a cross sectional A = 150 cm^2 and a conductivity $\sigma = 0.6\ \Omega^{-1}m^{-1}$. What is the resistance of the sample?

   (A) 0.01 Ω

   (B) 50 Ω

   (C) 36 Ω

   (D) 100 Ω

   (E) 3.6 mΩ

2. What is the magnitude of the force exerted by a charge q_1= 40 μC due to a charge q_2= 150 μC a distance 3m away? Assume the charge lies in free space (i.e. $\varepsilon_0 = 8.85\times10^{-12}\ C^2N^{-1}m^2$).

   (A) 12 N

   (B) 18 N

   (C) 6 N

   (D) 2 N

   (E) 9 N

3. What is the voltage V in the circuit shown in Figure 1?

   (A) 9 V

   (B) 9.6 V

   (C) 2.82 V

   (D) 3 V

   (E) 8.47 V

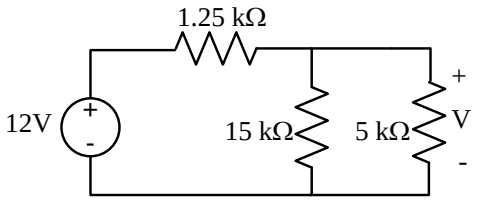


Figure 1

4. What is the current flowing in the 3 kΩ resistor in the circuit shown in Figure 2?

   (A) 3 A

   (B) 4 A

   (C) 4.8 A

   (D) 1 A

   (E) 5.33 A

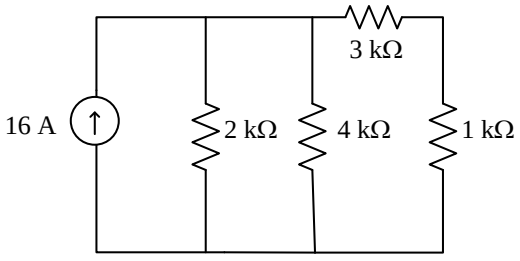


Figure 2

5. What is measured in Volts per Ohm?

   (A) Charge
   (B) Current
   (C) Permittivity
   (D) Conductivity
   (E) Force

6. Find the average power input to a device that consumes 54 k J in 2 hours?

   (A) 27 W
   (B) 27 kW
   (C) 7.5 W
   (D) 15 W
   (E) 0.75 W

7. Which V-I characteristic in Figure 3 below describes the behaviour of an ideal current source?

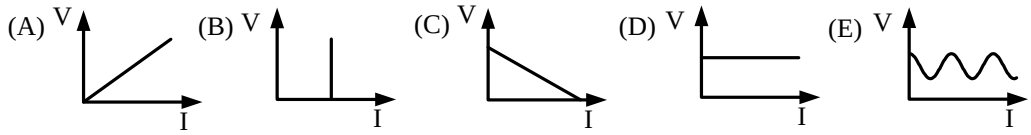


Figure 3

8. Which of the following sampling frequencies would be appropriate to accurately sample a signal with the frequency spectrum shown in the Figure 4?

   (A) 1.5 kHz
   (B) 100 Hz
   (C) 800 Hz
   (D) 2 kHz
   (E) 700 Hz

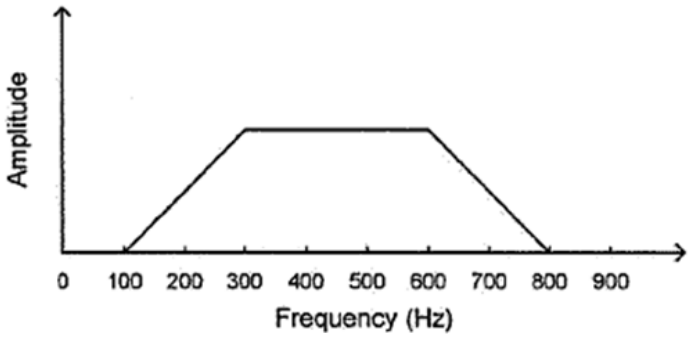


Figure 4

9. A solenoid with a free space core has 10 turns and carries a current of 10A. What happens to the magnitude of the magnetic flux density in the core, if the air is replaced with a metal with permeability 500 times that of free space and current is reduced to 0.2 A?

(A) Increases by a factor of 10

(B) Decreases by a factor of 10

(C) Decreases by a factor of 5

(D) Nothing

(E) Decreases by a factor of 2

10. What is decimal 118 in binary format?

(A) 1110101

(B) 1110110

(C) 1011011

(D) 1100101

(E) 1101110

11. Subtract binary number 10011 from binary number 111001?

(A) 111011

(B) 111010

(C) 100110

(D) 100111

(E) 100101

12. In the Logic circuit shown A=1, B=1 and C=0. What are X and Y?

(A) X=0 and Y=0

(B) X=1 and Y=0

(C) X=0 and Y=1

(D) X=1 and Y=1

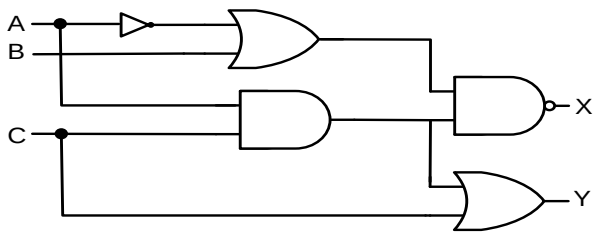


Figure 5

13. Find the minimum sum of products expression of the function represented by the Karnaugh map shown.

(A) $f = \overline{W}.Y + X.Z$

(B) $f = \overline{W}.YX + X.Z + W.\overline{Z}$

(C) $f = \overline{W}.Y + X.Z + W.X.Z$

(D) $f = \overline{W}.Y + X.Z + W.\overline{X}.\overline{Z}$

(E) $f = X.Z + W.\overline{Z}$

WX \ YZ	00	01	11	10
00	0	0	1	1
01	0	1	1	1
11	0	1	1	0
10	1	0	0	1

14. An electron is moving down the page between the poles of a magnet, as shown in Figure 6. In which direction will the electron be deflected by the magnetic field?

(A) Right

(B) Left

(C) Into the page

(D) Out of the page

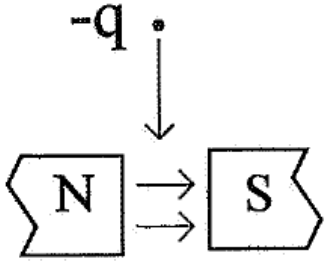


Figure 6

15. Global Energy System Policy is driven by a number of interconnected issues. What are these issues?

(A) Cost, Voltage and Current

(B) Cost, Climate Change and Security of Supply

(C) Wind, Biofuels and Nuclear Energy

(D) Generation, Distribution and Security of Supply

(E) Interconnection, Global Population and Climate Change

Section B

Answer *three* of the following four questions. Each question is worth 20 marks.

16.

(a) Find the Thévenin equivalent resistance between terminals a and b in the circuit shown in Figure 7.

(b) Find the Thévenin equivalent voltage between terminals a and b in the circuit shown in Figure 7.

(c) Draw the Thévenin equivalent circuit between terminals a and b in the circuit shown in Figure 7.

(d) Hence or otherwise, determine the resistance of the unknown load resistor R_L such that the load draws (7/3) A of current.

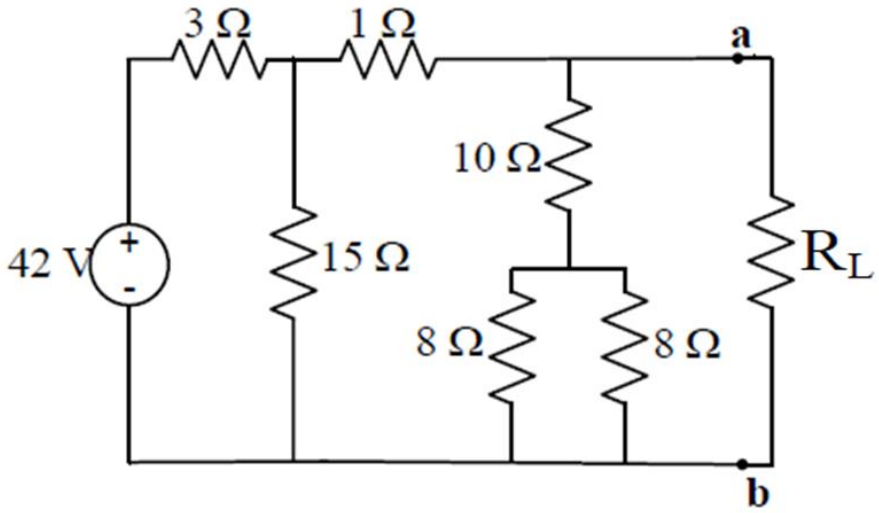


Figure 7

17. (a) Draw the Karnaugh Map for the logic function X defined in Table 1.

(b) Find the minimum expression for the logic function X.

(c) Draw a logic circuit to realise this function using AND, OR and NOT gates.

(d) Using De Morgan's Laws, show how this function could also be implemented using just NOT and NAND gates. Draw a diagram of your circuit.

A	B	C	D	X
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

Table 1

18. (a) The mystery device pictured in Figure 8 has the V-I characteristic pictured in Figure 9. What is the device likely to be? Be as specific as possible.

Figure 8

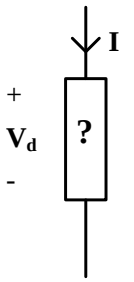
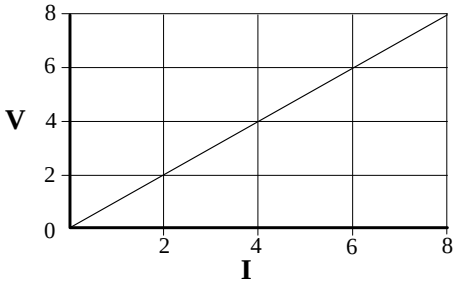


Figure 9



(b) It is discovered that the V-I characteristic of the device depends on room temperature for the room in which the device is placed. The dependence is that the slope of the line in the V-I characteristic changes linearly with the temperature. For example, when the room temperature is 25 degrees, the slope is 1V per 1A as shown in Figure 9. When the room temperature is 30 degrees, the slope increases to 1.1V per 1A. When a current of 5A flows through the device, what is the voltage across the device

i. when the temperature is 22 degrees?

ii. when the temperature is 26 degrees?

(c) The device is put into a circuit with an ideal 5A current source and an ideal voltage source of V_t volts as shown in Figure 10. The voltage across the device and the voltage source, V(t) is put through an amplifier and then passed to a display which displays the input voltage as listed in Table 2. What should the gain of the amplifier and the voltage V_t of the voltage source be so that the correct room temperature is displayed?

Input Voltage	Displayed Symbols
0.0 V	0.0
0.2 V	0.2
:	:
10.0 V	10.0
:	:
40.0 V	40.0

Table 2

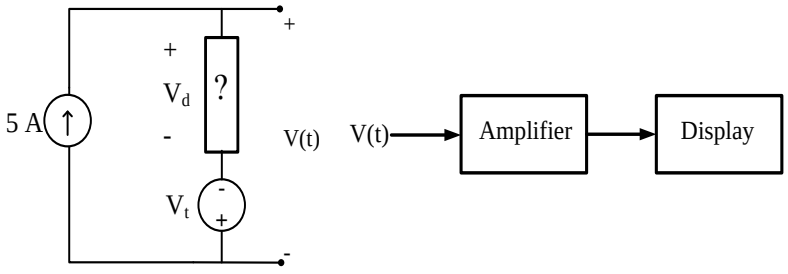


Figure 10

19. (a) A long vertical wire of length carries a downward current of 25A. What is the magnitude and direction of the magnetic flux density at a point 50mm south of the wire ($\mu_0 = 4\pi \times 10^{-7}$ Tm/A) ?

(b) Figure 11 shows a rectangular coil, which consists of 5 turns. The coil is placed in a region of uniform magnetic flux density, B, perpendicular to the plane of the coil as shown. The flux density changes as a function of time according to Figure 12.

i. Draw a graph of the total flux, $\phi(t)$, through the coil as a function of time from 0 ms to 6 ms.

ii. Draw a graph of the voltage, v(t), between the ends of the coil over the same time interval.

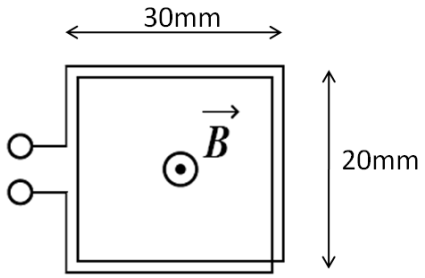


Figure 11

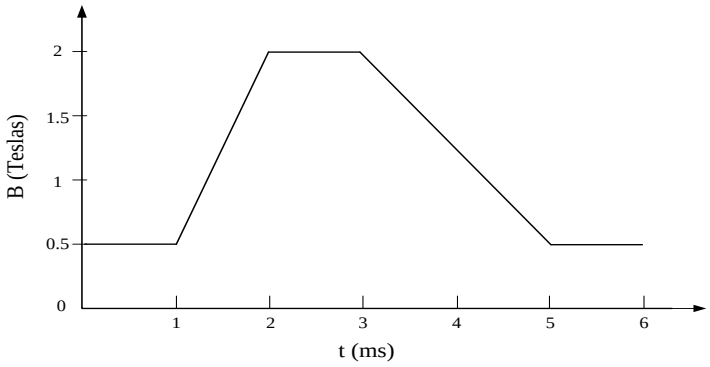


Figure 12

Formulae

The symbols below have their usual meanings.

$\vec{F} = Q\vec{E}$	$R = \frac{L}{\sigma A}$	$\overline{\overline{A}} = A$	$A + B = B + A$	$A + A \cdot B = A$
$W = QV$	$V = RI$	$A \cdot A = A$	$A \cdot B = B \cdot A$	$A \cdot (A + B) = A$
$I = \frac{dq}{dt}$	$\frac{V_2}{V_1} = \frac{N_2}{N_1}$	$A \cdot \overline{A} = 0$	$A + (B + C) = (A + B) + C$	$A + \overline{A} \cdot B = A + B$
$P = VI$	$\vec{F} = Q(\vec{u} \times \vec{B})$	$A \cdot 0 = 0$	$A \cdot (B \cdot C) = (A \cdot B) \cdot C$	$A \cdot (\overline{A} + B) = A \cdot B$
$\vec{J} = \sigma\vec{E}$	$F = BlI$	$A \cdot 1 = A$	$A \cdot (B + C) = A \cdot B + A \cdot C$	$\overline{A \cdot B} = \overline{A} + \overline{B}$
$\lvert\vec{E}\rvert = \frac{V}{L}$	$v = N\frac{d\phi}{dt}$	$A + A = A$	$A + (B \cdot C) = (A + B) \cdot (A + C)$	$\overline{A + B} = \overline{A} \cdot \overline{B}$
$\lvert\vec{J}\rvert = \frac{I}{A}$	$\lvert\vec{B}\rvert = \frac{\phi}{A}$	$A + \overline{A} = 1$	$A + 0 = A$	$A + 1 = 1$
$G = \frac{\sigma A}{L}$	$\lvert\vec{B}\rvert = \frac{\mu I}{2\pi d}$	$I = GV$	$\lvert\vec{B}\rvert = \frac{\mu N I}{l}$	Charge on electron= -1.6×10^{-19}C

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