University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

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**SEMESTER II EXAMINATIONS - 2010/2011**

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**School of Electrical, Electronic and Mechanical Engineering**

**EEEN10010 Electronic & Electrical Engineering I**

Professor McLaughlin

Professor Fitzpatrick

Professor Brazil

Ms. 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. Electrons pass through a wire cross-section at a rate of $20\times10^{12}$ electrons every 2 seconds. What is the current flowing in the wire?

   (A) -0.16 μA

   (B) -1.6 μA

   (C) -32 μA

   (D) -160 μA

   (E) -320 mA

2. A cylindrical conductor has a cross sectional area of $8mm^2$ and is 800m long. The resistance measured between the ends of the conductor is 1.6 Ω . Using the table of resistivities, Table 1, what is the metal most likely to be?

   (A) Silver

   (B) Copper

   (C) Gold

   (D) Tungsten

| Material at 20°C | Resistivity (Ωm) |
|---|---|
| Silver | $1.6\times10^{-8}$ |
| Copper | $1.72\times10^{-8}$ |
| Gold | $3.14\times10^{-8}$ |
| Tungsten | $6.28\times10^{-8}$ |

**Table 1**

3. Which V-I characteristic in Figure 1 below describes the behaviour of an ideal voltage source?

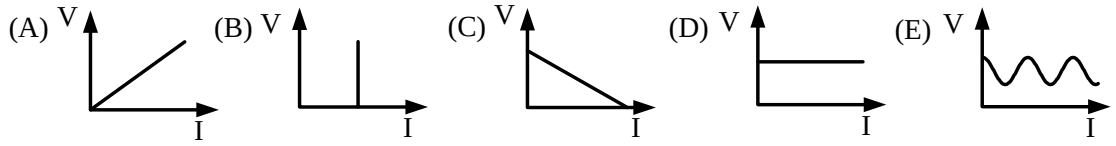


Figure 1

4. Find the average power input to a device that consumes 7200 J in 10 minutes.

   (A) 200 W

   (B) 20 W

   (C) 120 W

   (D) 1.2 W

   (E) 12 W

5. What is the voltage V in the circuit shown in Figure 2?

(A) 1.5 V
(B) 2 V
(C) 2.5 V
(D) 3 V
(E) 4.5 V

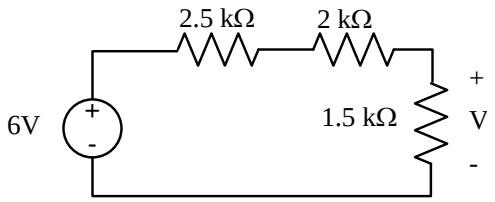


**Figure 2**

6. What is the current flowing in the 2.5 kΩ resistor in the circuit shown in Figure 3?

(A) 12 µA
(B) 16 µA
(C) 12 mA
(D) 16 mA
(E) 20 mA

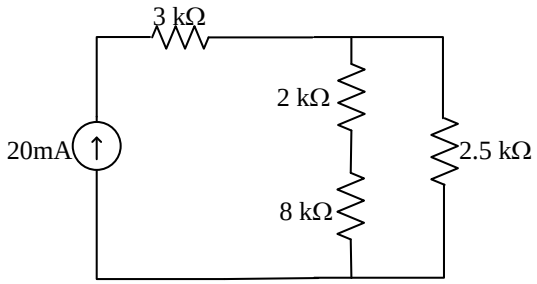


**Figure 3**

7. In the circuit in Figure 4 what is the power dissipated in the 20kΩ resistor?

(A) 0.6 W
(B) 6 W
(C) 18 W
(D) 1.8 W
(E) 0.18 W

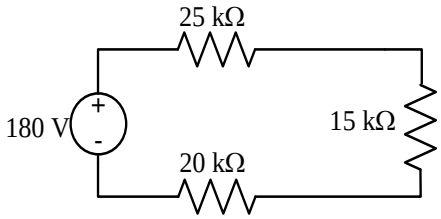


**Figure 4**

8. What is decimal number 110 in binary format?

(A) 1110101
(B) 1010111
(C) 1011101
(D) 1100101
(E) 1101110

9. What is the sum of binary numbers 100100 and 110101?

   (A) 1110110

   (B) 1010101

   (C) 1011001

   (D) 1000101

   (E) 1101010

10. Which of the logic circuits shown in Figure 5 can be used to implement the exclusive-OR (XOR) operation?

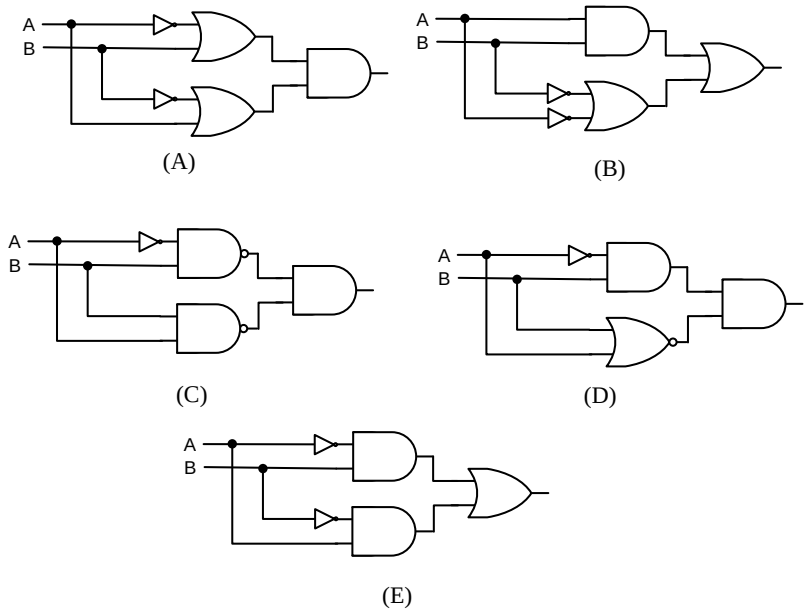


**Figure 5**

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

   (A) Into the page

   (B) Out of the page

   (C) To the left

   (D) Upwards

   (E) Downwards

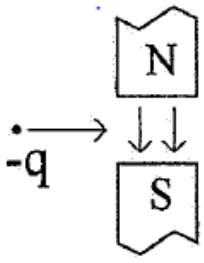


Figure 6

12. Which signal best describes the frequency spectrum shown in Figure 7?

(A) $v(t)= 2\sin(200\pi t) + 3\sin(400\pi t) + 5\sin(100\pi t)$

(B) $v(t)= 5\sin(200\pi t) + 3\sin(400\pi t) + 5\sin(800\pi t)$

(C) $v(t)= 5\sin(100\pi t) + 3\sin(200\pi t) + 2\sin(400\pi t)$

(D) $v(t)= 3\sin(200\pi t) + 5\sin(400\pi t) + 2\sin(1000\pi t)$

(E) $v(t)= 5\sin(200\pi t) + 3\sin(400\pi t) + 2\sin(800\pi t)$

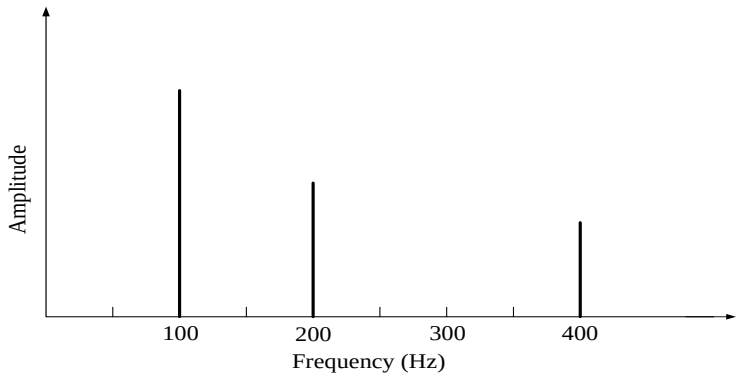


**Figure 7**

13. In order to select the component with the largest amplitude and eliminate the other components, the signal in Figure 7 should be passes through which of the following?

(A) A Low Pass Filter (B) A Band Pass Filter (C) A Band Stop Filter
(D) A High Pass Filter (E) An Amplifier

14. Figure 8 illustrates the Right Hand Grip Rule, where the right hand is gripped around a conductor as shown. Which of the following statements is true?

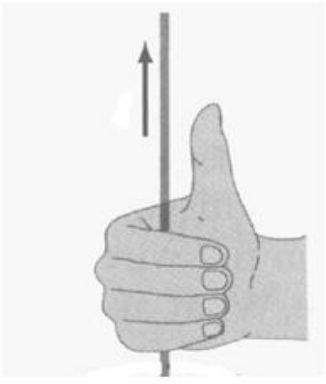

**Figure 8**

(A) The thumb points in the direction the current and the fingers show the direction of the magnetic field.

(B) The thumb shows the direction the magnetic field and the fingers point in the direction of the current.

(C) Both the thumb and the fingers show the direction of the magnetic field.

(D) The thumb points in the direction of the magnetic field and the fingers point in the direction of the force.

15. What is Boolean Algebra?

(A) The force experienced by a charge in a magnetic field.

(B) How any logic function can be implemented using only OR and NOT gates, or AND and NOT gates.

(C) The observation that the density of transistors on integrated circuits doubles every two years.

(D) The mathematics associated with the binary number system and the general field of logic.

(E) The relationship between current and voltage for an ideal resistor.

## Section B

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

16. (a) Find the Thévenin equivalent resistance of the circuit shown in Figure 9.

(b) Find the Thévenin equivalent voltage of the circuit shown in Figure 9.

(c) Draw the Thévenin equivalent circuit of the circuit shown in Figure 9.

(c) An unknown load R is connected between terminals A and B in Figure 9. Calculate the value of this load R given that the load draws 0.5mA of current.

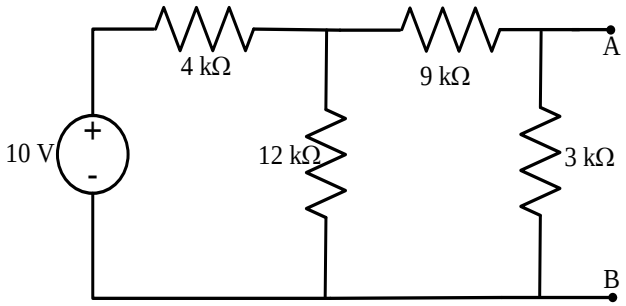


**Figure 9**

17. (a) Draw the Karnaugh Map for the logic function X defined in Table 2.

(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 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 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 | 0 |
| 1 | 1 | 1 | 1 | 1 |

**Table 2**

18. (a) A wire of length $\ell$ carrying current $I$ sits in a uniform magnetic field with magnetic flux density $B$, as shown in Figure 10. Using Lorenz's force law, $F = QuB\sin(\theta)$, show that the force felt by the wire is $F = I\ell B$.

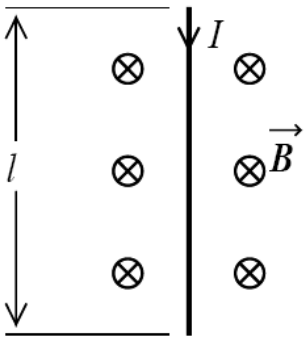


**Figure 10**

(b) Figure 11(a) 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 11(b).

i. Draw a graph of the total flux, ϕ(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.

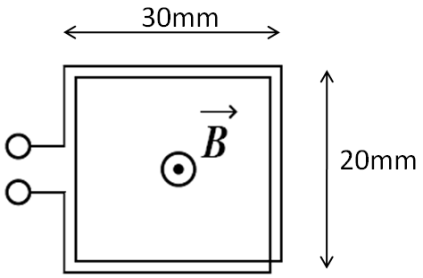


**Figure 11(a)**

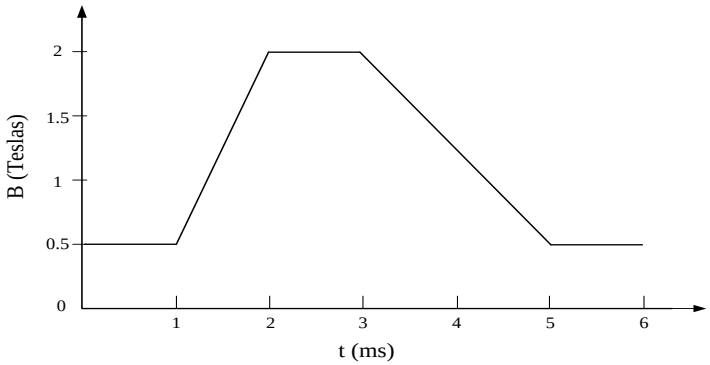


**Figure 11(b)**

19. (a) The inputs and outputs of a Half Adder are shown in Figure 12. Write Boolean expressions for S and C in terms of A and B that describe the Half Adder.

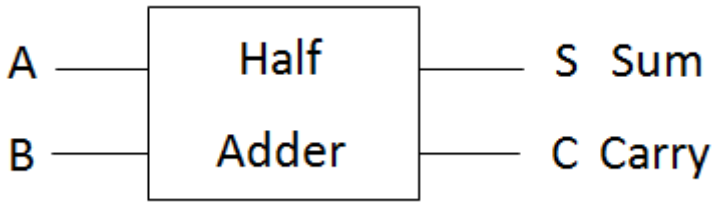


**Figure 12**

(b) A signal is described by v(t) = 5 + 3 sin(50πt)

i. If v(t) is sampled every 4 ms starting at t=0, what are the first 4 sample values?

ii. If v(t) is sampled every 20 ms starting at t=0, what are the first 4 sample values? Comment on your answer.

**Formulae**

The symbols below have their usual meanings.

| | | | | |
|---|---|---|---|---|
| $\vec{F}=Q\vec{E}$ | $R=\frac{L}{\sigma A}$ | $\overline{\overline{A}}=A$ | $A+B=B+A$ | $A+A\cdot B=A$ |
| $W=QV$ | $V=RI$ | $A\cdot A=A$ | $A\cdot B=B\cdot A$ | $A\cdot(A+B)=A$ |
| $I=\frac{dq}{dt}$ | $\frac{V_2}{V_1}=\frac{N_2}{N_1}$ | $A\cdot\overline{A}=0$ | $A+(B+C)=(A+B)+C$ | $A+\overline{A}\cdot B=A+B$ |
| $P=VI$ | $\vec{F}=Q(\vec{u}\times\vec{B})$ | $A\cdot 0=0$ | $A\cdot(B\cdot C)=(A\cdot B)\cdot C$ | $A\cdot(\overline{A}+B)=A\cdot B$ |
| $\vec{J}=\sigma\vec{E}$ | $F=BlI$ | $A\cdot 1=A$ | $A\cdot(B+C)=A\cdot B+A\cdot C$ | $\overline{A\cdot B}=\overline{A}+\overline{B}$ |
| $\lvert\vec{E}\rvert=\frac{V}{L}$ | $v=N\frac{d\phi}{dt}$ | $A+A=A$ | $A+(B\cdot C)=(A+B)\cdot(A+C)$ | $\overline{A+B}=\overline{A}\cdot\overline{B}$ |
| $\lvert\vec{J}\rvert=\frac{I}{A}$ | $\lvert\vec{B}\rvert=\frac{\phi}{A}$ | $A+\overline{A}=1$ | $A+0=A$ | $A+1=1$ |
| $G=\frac{\sigma A}{L}$ | $\lvert\vec{B}\rvert=\frac{\mu I}{2\pi d}$ | $I=GV$ | $\lvert\vec{B}\rvert=\frac{\mu NI}{l}$ | Charge on electron= $-1.6\times10^{-19}$C |

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