University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATIONS - 2011/2012

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. What is a unit of charge?

   (A) Coulomb (C)

   (B) Henry (H)

   (C) Ampere (A)

   (D) Farad (F)

   (E) Weber (Wb)

2. A cylindrical sample of material has a length l=0.6m, a cross sectional A=200 cm^2 and a conductivity $\sigma = 0.3\ \Omega^{-1}m^{-1}$. What is the resistance of the sample?

   (A) 3.03 Ω

   (B) 50 Ω

   (C) 100 Ω

   (D) 3 Ω

   (E) 30 Ω

3. 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) 2 N

   (D) 6 N

   (E) 8 N

4. A resistance of 1kΩ is accidentally connected between an overhead 100kVpower line and ground. Assuming the line remains intact what power is dissipated in the resistance as a result?

   (A) 1 MW

   (B) 10 MW

   (C) 100 MW

   (D) 100 kW

   (E) 10 kW

5. The voltage across a capacitor with capacitance of 250 mF changes at a steady rate of 240 V/minute. What is the current flowing through the capacitor?

(A) 1 A
(B) 0.5 A
(C) 1.5 A
(D) 1 mA
(E) 0.5 mA

6. What is the power dissipated in the 30 kΩ resistor in Figure 1?

(A) 30 kW
(B) 100 W
(C) 7.5 mW
(D) 30 mW
(E) 7.5 W

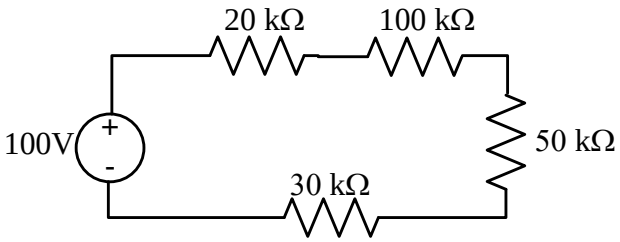


Figure 1

7. Let the Boolean Algebra expression $P = \bar{x}y\bar{z} + \bar{x}yz + xy\bar{z} + xyz$. What is the simplified Boolean Algebra expression for *P*?

(A) $P = \bar{x}y\bar{z}$
(B) $P = y\bar{z}$
(C) $P = x$
(D) $P = y$
(E) $P = x + y$

8. What is the current marked *I* in Figure 2?

(A) 0.57 A
(B) 1 A
(C) 1.09 A
(D) 2 A
(E) 0.1 A

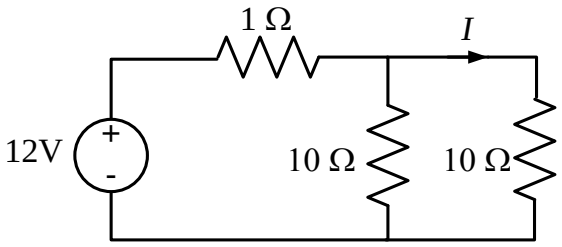


Figure 2

9. What is the voltage between points X and Y in Figure 3?

(A) 15 V
(B) 30 V
(C) 50 V
(D) 60 V
(E) 20 V

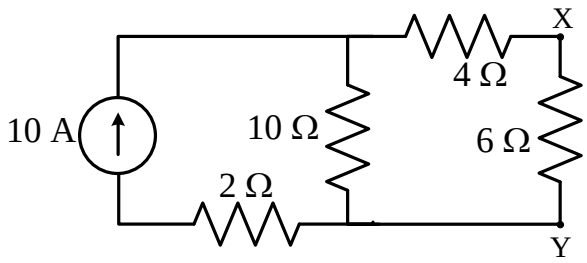


Figure 3

10. Figure 4 shows the frequency spectrum of a signal. What is the bandwidth of this signal?

(A) 10 MHz
(B) 16 MHz
(C) 21 MHz
(D) 26 MHz
(E) 52 MHz

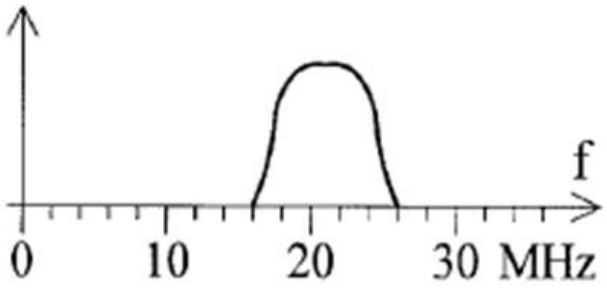


Figure 4

11. Which column in Table 1 shows the correct output for the logic circuit in Figure 5?

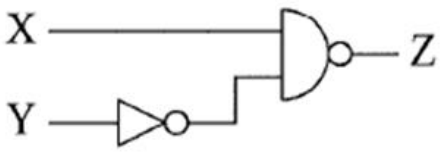


Figure 5

X	Y	Z1	Z2	Z3	Z4
0	0	0	1	1	0
0	1	1	0	1	0
1	0	1	1	0	1
1	1	0	1	1	0

Table 1

(A) Z1
(B) Z2
(C) Z3
(D) Z4

12. The solenoid in Figure 6 has 10 turns of wire, and carries a current of 3A, in the direction shown. Which orientation of the bar magnet would produce a similar magnetic field?

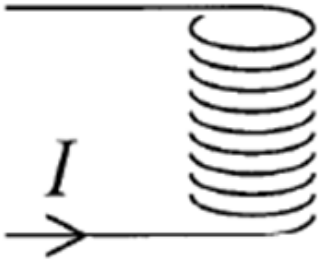
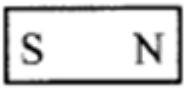


Figure 6

(A) 

(B) 

(C) 

(D) 

13. What is the decimal number 140 in binary format?

(A) 11001100
(B) 10001110
(C) 10111100
(D) 10001000
(E) 10001100

14. Subtract binary number 11011 from binary number 111011?

(A) 111011
(B) 111010
(C) 100000
(D) 100111
(E) 100101

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 of the circuit to the left of the dashed line shown in Figure 7.

(b) Find the Thévenin equivalent voltage of the circuit to the left of the dashed line shown in Figure 7.

(c) Draw the Thévenin equivalent circuit of the circuit to the left of the dashed line shown in Figure 7.

(d) Hence or otherwise find the current flowing through and the power dissipated in the 10 kΩ resistor?

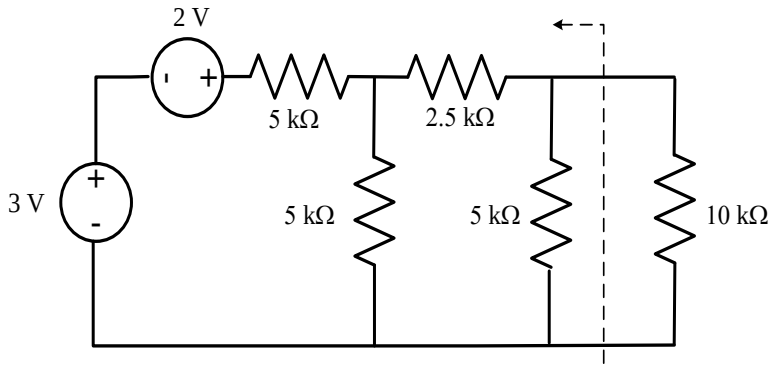


Figure 7

17. A transducer produces an electrical signal which can be described mathematically as $v_1(t)$=0.02sin(200πt) V.

This signal is connected to the input of an amplifier with a voltage gain of 40. The signal at the output of this amplifier is called $v_2(t)$, as shown in Figure 8.

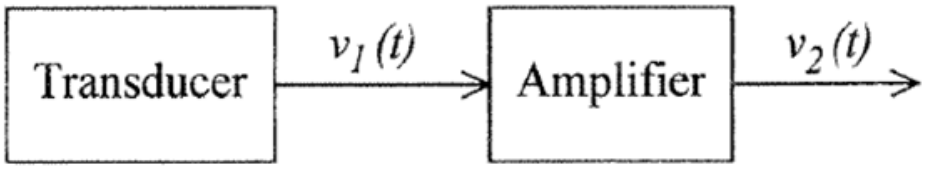


Figure 8

(a) Draw a graph of voltage $v_1(t)$ against time, t. Indicate the scale on the axes.

(b) Write a mathematical expression for $v_2(t)$, and find its amplitude, frequency and period.

(c) Another signal, $v_3(t)$=1.2sin(500πt) V, is added to $v_2(t)$. Sketch the frequency spectrum of the new signal $v_4(t)= v_2(t)+ v_3(t)$. Indicate the scale on the axes.

18. (a) Draw the circuit diagram and give the truth table for the following Boolean expression $P = \bar{a}b + a\bar{b}$.

(b) An alarm system for a bank functions as follows: The alarm (A) is to activate if it is after banking hours (H) and the front door (F) to the bank is open ***or*** if it is after banking hours (H) and the vault door is opened (V).

(i) Generate the truth table to describe this specification.

(ii) Write a Boolean logic expression for the alarm (A).

(iii) Find the minimum sum of products expression for A.

(iv) Draw a logic circuit to realise this function.

19. A loudspeaker uses a magnet which provides a uniform radial magnetic field, with flux density B = 0.2T, in the circular gap between its poles. Figure 9 shows a front view of the magnet.

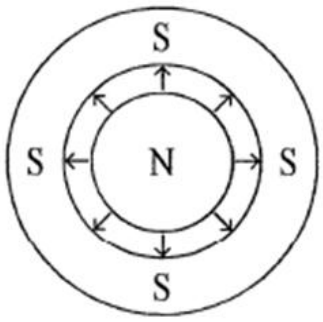


Figure 9

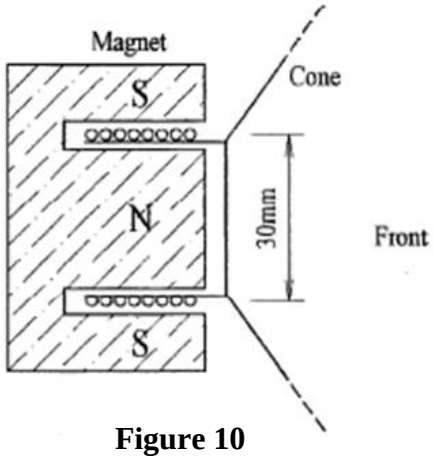


Figure 10

A coil of diameter 30mm is placed in the magnetic field, and is attracted to the cone of the loudspeaker. Figure 10 shows this arrangement in section, from the side. The coil consists of 40 turns of copper wire, of diameter 0.2mm (for clarity, Figure 10 shows only 8 turns, and the wire is not to scale). The conductivity of the copper is 6×10^7 S/m.

(a) What is the resistance of the copper wire? (You will need to calculate the total length of wire in the coil).

(b) If the coil of wire carries a current of 3A, what force acts on it?

(c) If the current flows clockwise, when viewed from the front of the loudspeaker (as marked in Figure 10), in which direction is the force?

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

"**oOo**"