The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: **DMX3304 Applied Electronics**
Academic Year	: 2020/21
Date	: 09th February 2022
Time	: 1400hr – 1700hr
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Eight (8)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear handwriting.
7. Do not use **Red** color pen.

Question 01

a) Briefly explain the definition of Circuit analysis. State the two main methods of analyzing an electrical circuit.

[5 Marks]

b) State and explain the Kirchhoff's Current Law (KCL).

[3 Marks]

c) Consider the circuit given below in Figure Q01, use KCL, KVL, and Ohm's Law to:

i. Find i_1, i_2, and V_o.

[6 Marks]

ii. Check the power balance in this circuit.

[6 Marks]

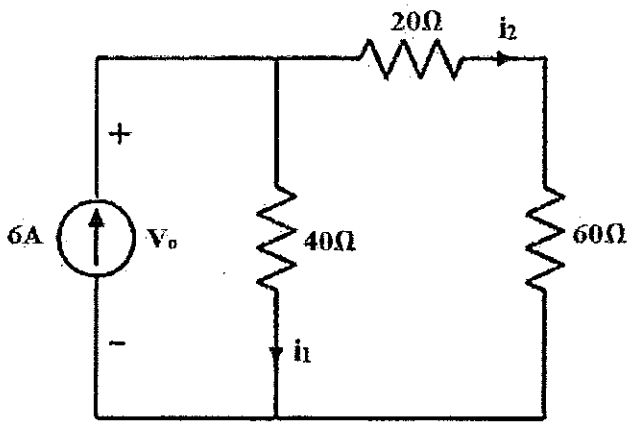

Figure Q01

Question 02

a) State three advantages of the Wheatstone bridge method.

[3 Marks]

b) State three disadvantages of a Field Effect Transistor **(FET)** over that of a Bipolar Junction Transistor **(BJT).**

[3 Marks]

Question 03

a) State the three modes of the operation of Bipolar Junction Transistors (BJT). Briefly explain how to force a BJT to operate in each of the three modes.

[5 Marks]

b) Consider the Bipolar Junction Transistor (BJT) given in the circuit in Figure Q03(b) where $\beta = 50$. If $V_{CEsat} = 0.3V$ and $V_{BE} = 0.7V$,

i. Find the V_{CE} and the Operating mode of the BJT transistor (i.e., whether forward active, saturation, or cutoff), when $V_B = 5V$.

[6 Marks]

ii. Find V_E, V_C, and I_B when $V_B = 2.5V$.

[3 Marks]

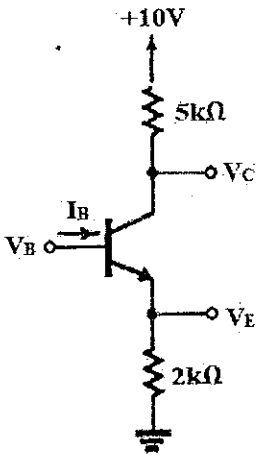

Figure Q03(b)

c) Consider the **NPN** Bipolar junction transistor (BJT) circuit shown in Figure Q03(c). A base current of $50\mu A$ is applied to the transistor and a voltage of 5V is doped across the R_C. Determine the β_{DC} (DC current gain) of the transistor.

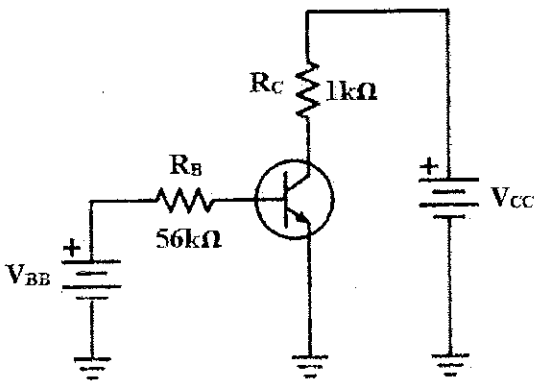

Figure Q03(c)

[6 Marks]

c) Consider the circuit given below in Figure Q02(c). Calculate the input resistance of the circuit between the points A and B (R_{AB}).

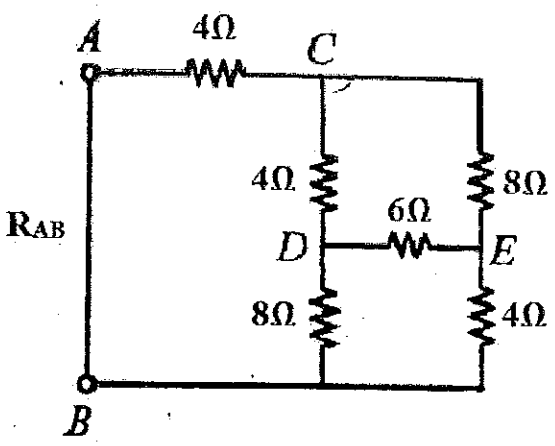

Figure Q02(c)

[7 Marks]

d) Consider the Field-Effect Transistor (FET) amplifier with DC voltage (V_{DD}) given below in Figure Q02(d). Determine the values of V_{DS} and V_{GS}.

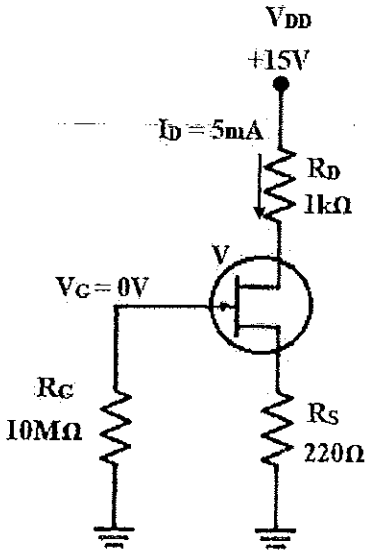

Figure Q02(d)

[7 Marks]

Question 04

a) State four characteristics of a Non-Ideal Op-amp.

[4 Marks]

b) State three applications of using Operational Amplifiers.

[3 Marks]

c) Consider the Ideal Op-amp shown in Figure Q04(c). Calculate the value of the current i_L.

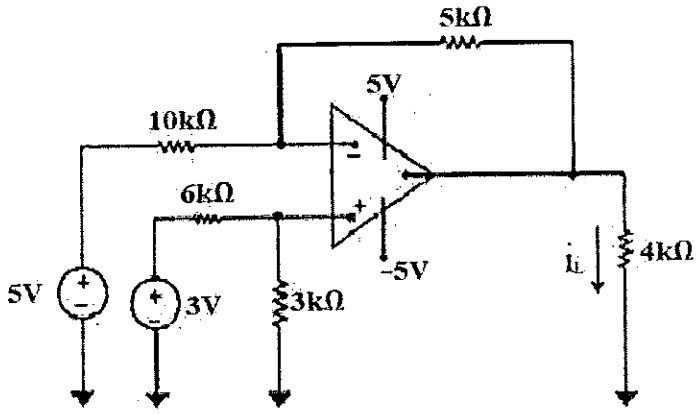

Figure Q04(c)

[6 Marks]

d) Consider the following Ideal Op-amp circuit given below in Figure Q04(d).

i. Determine the Output voltage $\mathbf{V_o}$ if $\mathbf{R_x = 60k\Omega}$.

[3 Marks]

ii. Calculate the the largest value possible for $\mathbf{R_x}$ before the amplifier saturates.

[4 Marks]

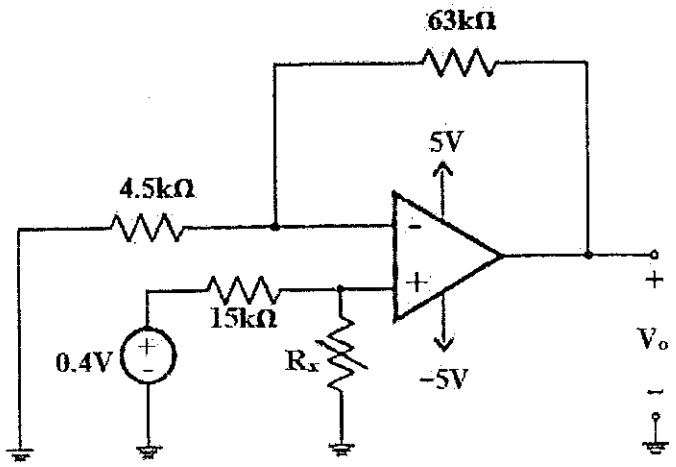

Figure Q04(d)

Question 05

a) State four advantages of using Zener diodes.

[4 Marks]

b) Briefly explain the definition of an Ideal diode. Sketch the I-V characteristics curve of an ideal diode.

[4 Marks]

c) Consider the diode circuit shown in Figure Q05(c). Find the diode current $\mathbf{I_D}$ by using each of the following methods.

i. Ideal diode model

[3 Marks]

ii. Offset diode model with $\mathbf{V_\gamma = 0.7\ V}$

[3 Marks]

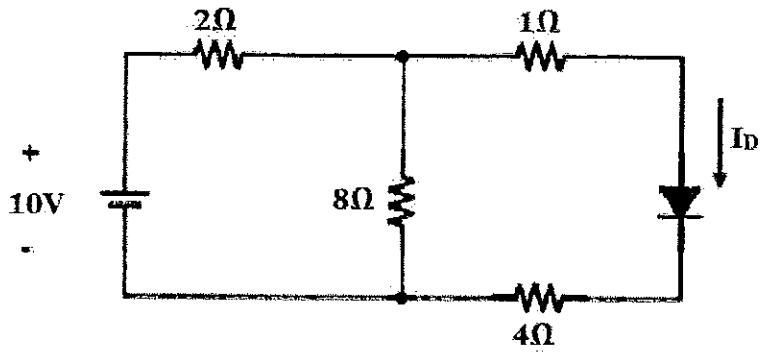

Figure Q05(c)

d) Consider the Zener diode voltage regulator shown in Figure Q05(d). The Zener diode is characterized by $\mathbf{V_Z = 3.3V}$ and $\mathbf{R_Z = 10\Omega}$. For this circuit $\mathbf{V_S = 5V}$, $\mathbf{R_S = 250\Omega}$ and the load resistance $\mathbf{R_L = 1k\Omega}$.

i. Calculate the voltage $\mathbf{V_L}$ across the load R_L.

[2 Marks]

ii. Calculate the power dissipated in the load.

[2 Marks]

iii. Calculate the power dissipated in the Zener diode.

[2 Marks]

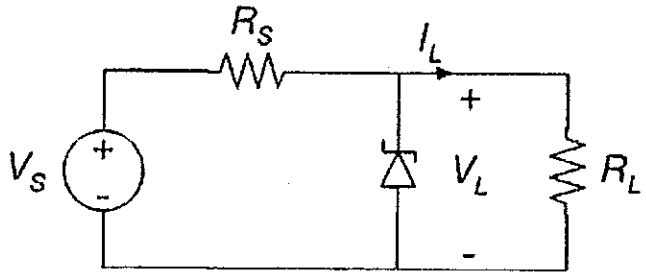

Figure Q05(d)

Question 06

a) State what is meant by the Binary number system.

[2 Marks]

b) List the advantages of the Octal number system over the binary system.

[2 Marks]

c) Convert the Hexadecimal number **$5A.B_{16}$** to an Octal number.

[3 Marks]

d) Convert the Binary number **11010111_2** to Decimal, Octal, and Hexadecimal number systems.

[4 Marks]

e) Perform Binary addition and subtraction on the following unsigned binary numbers.

i. $1111_2 + 1001_2$

[2 Marks]

ii. $11001_2 - 1111_2$

[2 Marks]

f) Represent the Decimal number **-14_{10}** as an 8-bit Binary number using **2's Complement** representation.

[5 Marks]

Question 07

a) Briefly explain the definition of Universal gates in Boolean algebra. List the two types of Universal gates.

[3 Marks]

b) Draw the Logic circuit for the **EXOR gate** for two inputs A and B, state the Boolean function and construct the truth table.

[3 Marks]

c) Reduce the following Boolean expression to **ONE** literal.

$$\bar{A}\,B(\bar{D} + \bar{C}D) + B(A + \bar{A}CD)$$

[4 Marks]

d) Draw the Logic diagram corresponding to the following Boolean expression without simplifying.

$$(A + B)(C + D)(\bar{A} + B + D)$$

[4 Marks]

e) Construct the Truth table for the following function and express the function as a **Sum of Min terms** (SOP).

$$f = (XY + Z)(Y + XZ)$$

[6 Marks]

Question 08

a) State two advantages of using Karnaugh Maps **(K-Maps)** as a Boolean algebraic simplification technique.

[2 Marks]

b) Implement the following expression with a 3-Level **NAND circuit**. (Hint: Simplify the expression and use only NAND gates to implement the circuit).

$$F = A\bar{B} + ABD + AB\bar{D} + \bar{A}\bar{C}\bar{D} + \bar{A}B\bar{C}$$

[4 Marks]

c) Simplify the following expression using a 3-Variable **K-Map.**

$$f = (\bar{X}\bar{Y} + YZ + \bar{X}Y\bar{Z})$$

[4 Marks]

d) Determine the **Min terms** of the following Boolean expression by plotting the function in a **K-Map.**

$$F = \bar{C}D + AB\bar{C} + AB\bar{D} + \bar{A}\bar{B}D$$

[5 Marks]

f) Simplify the following Boolean function using a **3 Variable K-Map** and express the function as a **Product of Sums (POS).**

$$F = \bar{X}\bar{Z} + \bar{Y}\bar{Z} + Y\bar{Z} + XY$$

[5 Marks]

END