

Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : DMX3304 Applied Electronics
Academic Year : 2022/2023
Date : 16th of February 2024
Time : 09.30-12.30
Duration : **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions
2. This question paper consists of **Five (5) compulsory** questions in five (5) pages.
3. All questions carry equal marks.
4. Answer to each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. The symbols used in this paper have their usual meanings.
7. Clearly state any assumptions that you may make.
8. Answers should be in clear handwriting. Do not use a red pen.
9. You are not allowed to use a programmable calculator.

Question 01

- (a) Consider the circuit diagram shown in Figure Q1 (a). Find the current flowing through the 8Ω resistor using mesh analysis (8 marks).

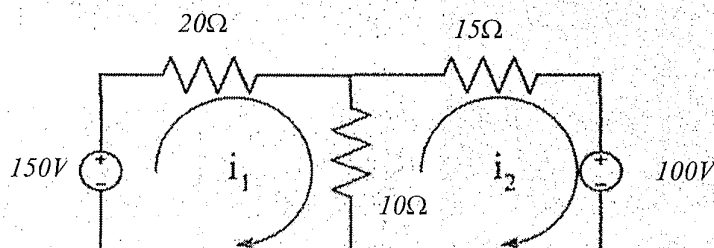


Figure Q1 (a)

- (b) Name two (2) applications of the Wheatstone bridge (2 marks).
- (c) The Wheatstone bridge shown in Figure Q1 (c) has a fixed resistor R_1 of $1\text{k}\Omega$. R_2 and R_3 resistors can be adjusted. Suppose that the bridge is balanced with $R_3 = 732\Omega$ and $R_2 = 10\text{k}\Omega$. What is the value of R_x ? (4 marks).

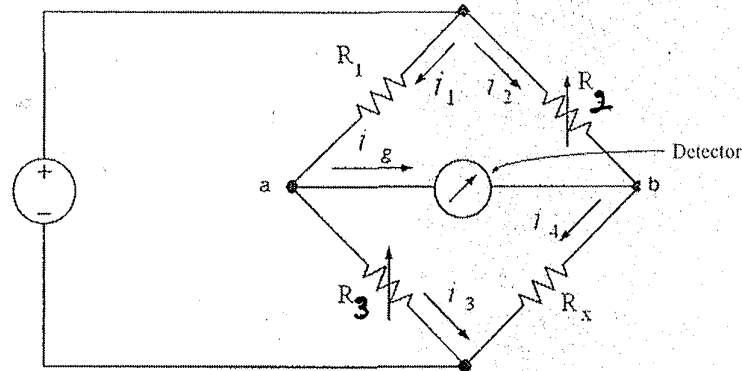


Figure Q1 (c)

- (d) Consider the following Wye network shown in Figure Q1 (d). If the load impedances $Z_1 = Z_2 = Z_3 = Z_y$, then, draw the equivalent Delta network and state its corresponding equation for impedance using usual notations (6 marks).

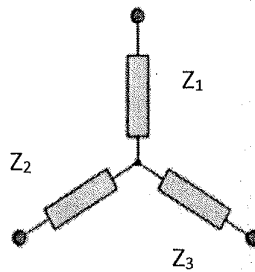


Figure Q1 (d)

Question 02

- (a) List 3 applications of the Bipolar Junction Transistors (BJT) (3 marks).
- (b) Draw the N – Channel JFET schematic diagram and its corresponding circuit symbol labeling each terminal (4 marks).
- (c) Draw the output characteristics for a BJT (Bipolar Junction Transistor) in CE (Common Emitter) Configuration. Label each region clearly (6 marks).

- (d) Find I_B , I_C and v_o in the transistor circuit of Figure Q2 (d). Assume that the transistor operates in active mode and that $\beta = 50$. Consider V_{BE} as 0.7V (7 marks).

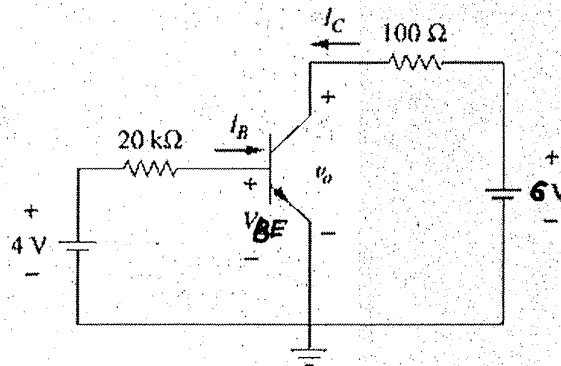


Figure Q2 (d)

Question 03

- (a) List 4 characteristics of an ideal op-amp (4 marks).
- (b) Determine an expression for the closed loop voltage gain A_v , for the circuit shown in Figure Q3 (b). Assume that the op-amp is an ideal op-amp (8 marks).

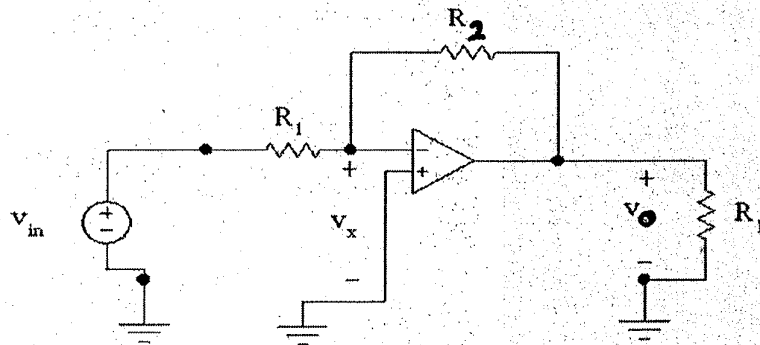


Figure Q3 (b)

- (c) A circuit known as a summer is shown in Figure Q3 (c). Calculate the following i. and ii. for the given circuit (8 marks).

- i. Output voltage V_o
- ii. Output current i_o

Use the ideal op-amp assumption and the following values when solving the above.

$$V_A = 2V, V_B = 1V, R_A = 5k\Omega, R_B = 2.5k\Omega, R_f = 10k\Omega \text{ and } R_L = 5k\Omega.$$

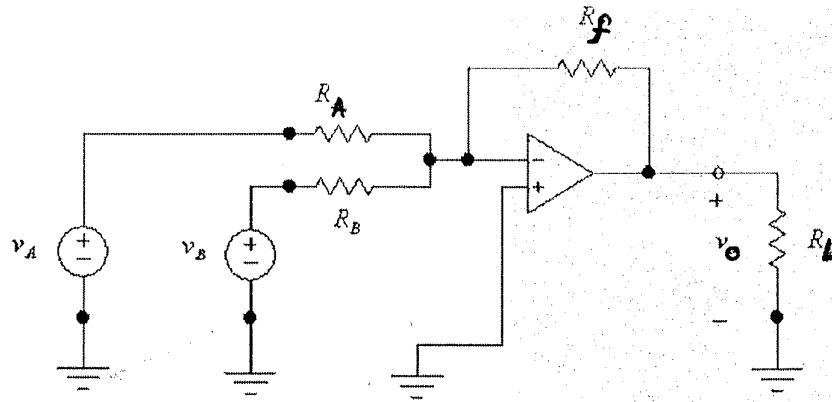


Figure Q3 (c)

Question 04

- (a) Write short answers on following using diagrams as applicable (9 marks)
- Range of an analogue to digital converter (A-D converter)
 - Binary-weighted-input DAC
 - R – 2R Ladder
- (b) Draw the circuit diagram of a full wave rectifier using 4 diodes with the corresponding waveforms (input and output). Make sure to label each component carefully (5 marks)
- (c) Consider the RL circuit given in Figure Q4 (c). Find an expression for the current $i(t)$ (6 marks).

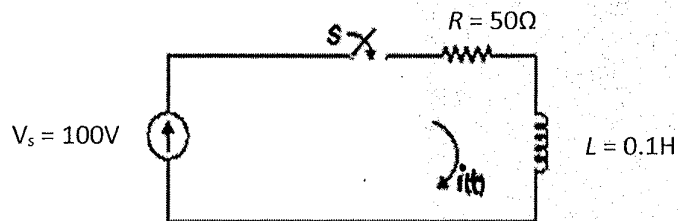


Figure Q4 (c)

Question 05

- (a) Consider the number 54_{10} to answer the following i. to iii. (6 marks).
- Determine the binary number of the above
 - Determine the -54_{10} using the sign-and-magnitude method
 - Determine the -54_{10} using the 1's complement method

(b) Prove the following Boolean identity using Boolean theorems (4 marks).

$$A + \bar{A}B = A + B$$

(c) Consider the following Boolean expression $X = AB + ABC + A\bar{B}\bar{C} + A\bar{C}$. Without minimizing the expression, draw the logic diagram for X (4 marks).

(d) Use the K-Map technique and minimize the following Boolean expression (6 marks).

$$Out = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}BCD + AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}CD$$

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