

## UNIVERSITY EXAMINATIONS

1<sup>ST</sup> SEMESTER 2022/2023 ACADEMIC YEAR

SECOND YEAR EXAMINATION FOR THE DEGREE  
BACHELOR OF SCIENCE (COMPUTER SCIENCE)

COMP 212: DIGITAL ELECTRONICS II

**STREAM: R**

**TIME: 2 HRS**

**DAY: TUESDAY [8.30AM – 10.30AM]**

**DATE: 06/12/2022**

**THIS QUESTION PAPER CONSISTS OF FOUR (4) PAGES**

**PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.**

**Instructions to Candidates:**

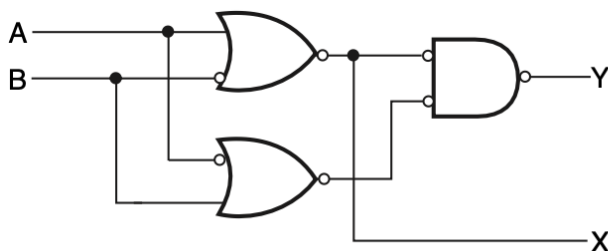
*This paper consists of Five Questions.*

**Question ONE is Compulsory. Answer Question one and any other two questions.**

*Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used / calculated must be stated clearly.*

**QUESTION ONE (30 Marks)**

- a) Define Flip-Flops outlining its applications **(3 marks)**
- b) How do you characterise or define a combinational circuit? How does it differ from a sequential circuit? Give two examples each of combinational and sequential logic devices. **(4 marks)**
- c) Prove that the logic diagram below performs the function of a half-subtractor provided that Y represents the DIFFERENCE output and X represents the BORROW output.



- (4 marks)**
- d) Show the logic implementation of an R-S flip-flop having active HIGH R and S inputs. Draw its truth table and mark the invalid entry. **(4 marks)**
- e) Given the relevant Boolean expressions for half-adder and half-subtractor circuits, design a half-adder-subtractor circuit that can be used to perform either addition or subtraction on two one-bit numbers. The desired arithmetic operation should be selectable from a control input. **(5 marks)**
- f) Briefly describe the operational aspects of bistable, monostable and astable multivibrators. Which multivibrator closely resembles a flip-flop? **(4 marks)**
- g) Using an 8-to-1 MUX, implement the Boolean function given by the equation  $f(A,B,C) = \Sigma 2,4,7$  citing the hardware implementation and the truth table. **(6 marks)**

**QUESTION TWO (20 marks)**

- a) What is a multiplexer circuit? Briefly describe the applications of a multiplexer? **(3 marks)**
- b) What is an encoder? How does a priority encoder differ from a conventional encoder? **(3 marks)**
- c) Using negative-edge triggered T-Flip flops, give the circuit diagram of a 3-bit ripple counter. **(5 marks)**
- d) You are required to carry out combinational circuit designs, explain the main practical constraints that are necessary for your consideration. **(4 marks)**
- e) Implement the product-of-sums Boolean function expressed by  $\prod 1,2,5$  by a suitable multiplexer **(5 marks)**

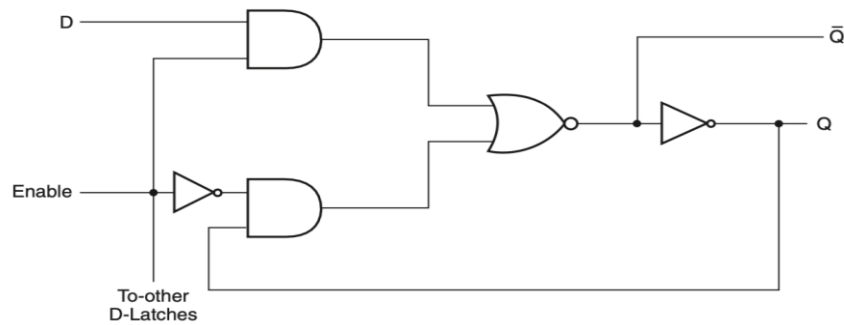
**QUESTION THREE (20 marks)**

- a) With the aid of a well labelled diagram, tables and logic equations, Describe the following Flip Flop features:
  - i. State diagram
  - ii. Characteristic table
  - iii. Excitation table
  - iv. Characteristic equation **(6 marks)**
- b) Show how an 8x1 multiplexer could be employed as a 2x1 multiplexer. Give a suitable circuit **(4 marks)**
- c) Implement a full adder circuit using a 3-to-8 line decoder. **(6 marks)**
- d) Determine the number of flip-flops required to construct. **(4 marks)**
  - i. a MOD-10 ring counter
  - ii. a MOD-10 Johnson counter. Also, write the count sequence in the two cases.

**QUESTION FOUR (20 marks)**

- a) The Figure shows the internal logic circuit diagram of one of the four D latches of a four-bit D latch in IC 7475.
  - i) Give an argument to prove that the Q output will track the D input only when the ENABLE input is HIGH.
  - ii) Prove that the Q output holds the value it had just before the ENABLE input went LOW during the time the ENABLE input is LOW. **(6 marks)**





- b) Flip Flops can be used to achieve counting, with the aid of block diagram and waveforms show how 3 flip flops can be connected to achieve up-counting. **(4 marks)**
- c) Nakuru County Government has requested for a security system to be installed at the gates of key offices. The system is controlled by the state of Four Sensor Switches W,X,Y and Z. The Alarm of the system is to be OFF on when: **(6 marks)**
- All sensor switches are OPEN
  - Any one switch is OPEN and the remaining three CLOSED
  - X and Y OPEN, W and Z CLOSED
  - W and Z OPEN, X and Y CLOSED

Assuming Switch closed = logic 0 and Switch open = 1. Design the logic circuit to switch Alarm OFF using NAND gates only

- d) An eight-bit binary ripple UP counter with a modulus of 256 is holding the count 01111111. What will be the count after 135 clock pulses be? **(4 marks)**

### QUESTION FIVE (20 marks)

- a) Explain 3 important differences between Serial and Parallel interfaces and give one example of each **(6 marks)**
- b) Differentiate between:
- i. synchronous and asynchronous inputs
  - ii. level-triggered and edge-triggered flip-flops
  - iii. active LOW and active HIGH inputs. **(6 marks)**
- c) Logic Families components are the basic building blocks for Integrated Circuits (ICs), explain 4 Main Characteristics of such components. **(4 marks)**
- d) You are required to carry out combinational circuit designs, explain the main practical constraints that are necessary for your consideration **(4 marks)**