MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SUPPLEMENATRY/SPECIAL EXAMINATION FOR

BACHELOR SCIENCE IN APPLIED PHYSICS AND TECHNOLOGY

SPH 307: DIGITAL ELECTRONICS

DATE: 18/3/2022 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS:

- The paper consists of **two** sections
- Section **A** is **compulsory** (30 marks)
- Answer any **two** questions from section **B** (each 20 marks)

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

a) Define the term *Radix* in number systems. (1 mark)

b) Give one difference between Latch and a flip flop (1 mark)

c) State one advantage of binary number system (1 mark)

d) Show how the universal gates can be used to realize the following logic operations (2 marks)

a. OR gate

b. AND gate

e) Perform the following addition operations:

a. $(AF1B)_{16} + (FFFE)_{16}$ (1 mark)

b. $(67)_8 + (33)_8$ (1 mark)

f) Using Boolean algebra techniques simplify this expression (2 marks)

$A.B + A(B + C) + B(B + C)$

g) Find the gray code of binary number 110110100011 (2 marks)

h) Find the excess-3 equivalent of $(237.75)_{10}$ (2 marks)

i) Convert the decimal number 9673 to BCD. (2 marks)

j) State the DE Morgan's theorems (2 marks)

k) Determine the hexadecimal equivalent of 0100 0011 0110 0010_{BCD} to hexadecimal (2 marks)

i. By subtracting $(00001010)_2$ from $(00001111)_2$, Show how twos compliment overcomes the challenges of ones compliment in arithmetic's (2 marks)

j. Give one differentiate between synchronous and asynchronous counters (1 mark)

k. Show the logic arrangement for implementing a four-input AND gate using two-input AND gates only. (2 marks)

l. Consider an arbitrary number system with the independent digits as 0, 1 and X. What is the radix of this number system? List the first 9 numbers in this number system. (2 marks)

m. Implement the expression $X = \overline{\bar{A}\bar{B}\bar{C} + (D + E)}$ with NOR logic (2 marks)

l) Distinguish between Mealy and Moore state machines (2 marks)

SECTION B (ANSWER ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

a. The following is a message encoded using ASCII code. Decode the message (6 marks)

01000101 01001100 01000101 01000011 01010100
01010010 01001111 01001110 01001001 01000011
01010011

b. Draw a truth table and write the Boolean function of an octal to binary encoder hence show how it can be implemented using OR gates only (10 marks)

c. Table 1 shows a truth table of a control system obtain the simplified expressions for the Sum of Product (SOP) and the Product of Sum (POS) (4 marks)

INPUTS			OUTPUT
A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Table 1

QUESTION THREE (20 MARKS)

a) Implement a 2 to 4 decoder using two NOT gates and four AND gates, hence write Boolean expression and truth table (6 marks)

b) Define a register and describe any three types of shifts registered in sequential circuits (6 marks)

c) Deduct a Boolean Expression for the combinational logic circuit in Figure 2 and reduce it to its minimum form using K-map. (8 marks)

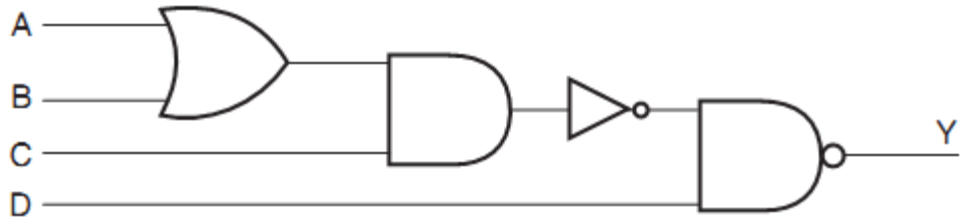

Fig: 2

QUESTION FOUR (20 MARKS)

a) By use of a logic diagram and a truth table describe the operations of SR flip flop and show how a JK flip flop and T flip flop overcomes its drawbacks (5 marks)

b) Using combined logic circuits with a truth table implement a circuit that can be used as a full adder. (5 marks)

c) Suppose the cash room at a store has access restricted to certain employees, each of who has a key, which produces a logic 1 at particular inputs to an unlocking circuit. Only the store manager (M) can enter alone. The assistant manager (A) and the cashier (C) also have access, but only when accompanied by each other, or by the store manager. Write a truth table and the Boolean expression then design a minimized combinational logic circuit that will allow access by producing a logic 1 when the above conditions are met. (10 marks)

QUESTION FIVE (20 MARKS)

a) By use of state and block diagrams, briefly describe the two types of Finite state machines (FSM) (6 marks)

b) Simplify the following Boolean expressions: (6 marks)

i. $A.B.C + A.B.\bar{C} + A.\bar{B}.C + A.\bar{B}.\bar{C} + \bar{A}.B.C + \bar{A}.B.\bar{C} + \bar{A}.\bar{B}.\bar{C} + \bar{A}.\bar{B}.C$

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

c) Figures 3 (a) and (b) are circuit diagrams of switching systems. For each circuit, determine the Truth table and the Logic expression (8 marks)

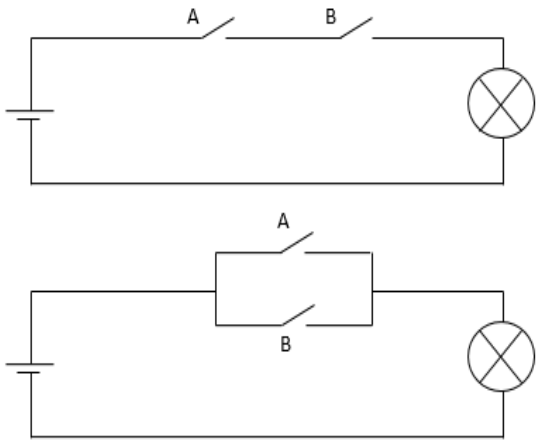

Fig: 3