THARAKA UNIVERSITY COLLEGE

(A Constituent College of Chuka University)

UNIVERSITY EXAMINATIONS

THIRD YEAR EXAMINATION FOR THE AWARD OF DEGRE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

COSC 312: COMPONENTS AND DESIGN TECHNIQUES FOR DIGITAL SYSTEMS

STREAMS: BSC (COSC) **TIME: 2 HOURS**

DAY/DATE: WEDNESDAY 08/04/2020 **11.30 AM – 1.30 PM**

INSTRUCTIONS:

1. Answer **all questions** in section A and any other **two questions** from section B.
2. No Reference Material is allowed in the exam Room.
3. All Mobile phones should be switched off in the exam room.
4. In case a diagram is required to illustrate your answer then make use of it
5. Write legibly.

SECTION A (COMPULSORY)

QUESTION 1(COMPULSORY) [30 MARKS]

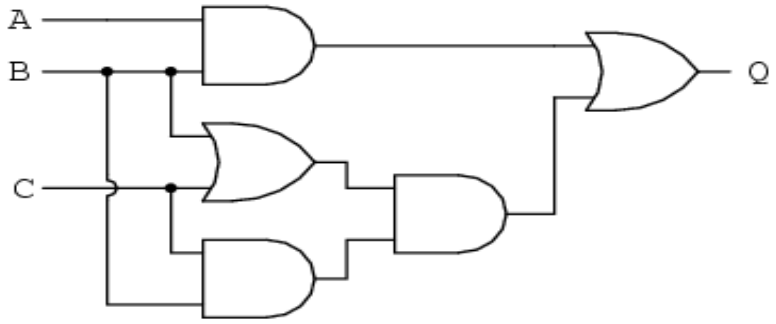
a) Citing an example of digital component in each case, explain THREE scale integrations in designing of digital logics/ components. (6marks)

b) Design a simple circuit incorporating three LEDs, such that each one of the three LEDs lights when inputs 00, 01 and 11 respectively are applied on the circuit's inputs A and B. (5marks)

c) Use Karnaugh maps SOP to minimize the following circuit. (6 marks)

$$X = \bar{A}\bar{B}\bar{C}\bar{D}\bar{E} + \bar{A}\bar{B}\bar{C}\bar{D}E + \bar{A}\bar{B}C\bar{D}\bar{E} + \bar{A}\bar{B}C\bar{D}E + \bar{A}B\bar{C}\bar{D}E + \bar{A}BC\bar{D}\bar{E} + \bar{A}BCDE + A\bar{B}\bar{C}\bar{D}\bar{E} + A\bar{B}\bar{C}\bar{D}E + A\bar{B}C\bar{D}E + ABC\bar{D}E + ABCDE + \bar{A}BCDE$$

d) Below is a digital circuit. Use it to answer the questions below: -



i) Simplify the above circuit (show the simplification process) (5marks)
ii) Draw a resultant circuit after the simplification. (2marks)

e) With reference to electronic circuit boards.

i) Differentiate between Printed circuit board and printed wire board (3marks)

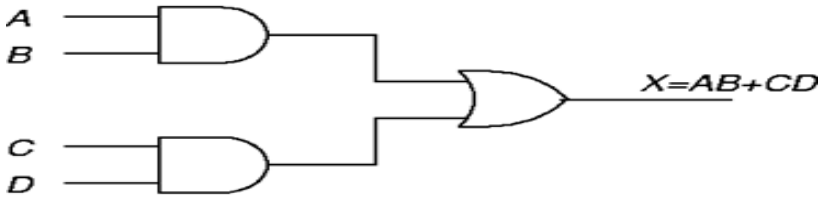
ii) Explain three characteristics of a good material to be used in designing a circuit board substrate. (3marks)

SECTION B (Answer **two question** from this section**)**

QUESTION 2 [20 MARKS]

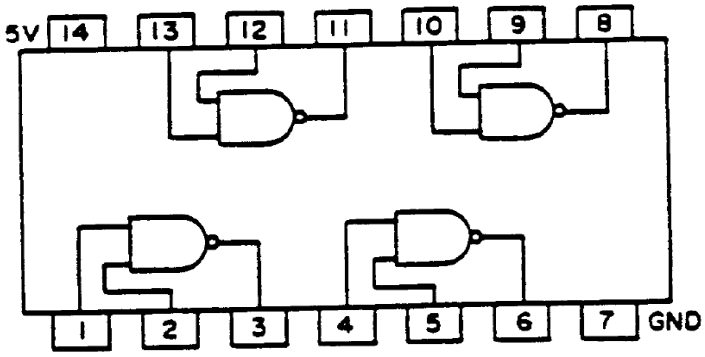
a) Use Boolean algebra (clearly indicating the Boolean law applied) to prove the equivalence of the following circuits.
i) $A + \overline{A}\,B = A$
ii) $A + A\,B = A + B$ (8 marks)

b) Use the circuit below to answer the following questions



i) Draw the above circuit using NAND gates only (6marks)

ii) If you are only provided with a single 7400 NAND gate IC shown below. Illustrate how you will use the IC in implementing the above circuit on a PCB. (6marks)



QUESTION 3 [20 MARKS]

a) With reference to decoders
   i) Draw a circuit diagram of a 3 to 8 decoder using INVERTERs and AND gates only (5marks)

   ii) Draw a truth table of the above decoder (4 marks)

b) With regard to VHDL explain the following.

   i) Explain what is VHDL (2 marks)
   ii) Outline TWO advantages of VHDL in digital electronics (4 mark)
   iii) Using "*ieee.std_logic_1164.all"* library, model the behaviour of XOR logic gate (5marks)

QUESTION 4 [20 MARKS]

a) With the help of a digital circuit diagram, explain how a digital upwards counter functions (8marks)

b) With regard to the principle of universality of NOR gates, using sketch diagrams, and how each universality is reached, show how NOR gates could be used as: -
   i) Inverter
   ii) OR gate
   iii) AND gate
   iv) NAND gate (12marks)

QUESTION 5 [20 MARKS]

a) Using a TTL diagram, explain the design and operation of an AND gate. (6marks)

b) A certain student was tasked with designing an FSM of an elevator using the following data.

   The elevator can be at one of two floors: Ground or First. There is one button that controls the elevator, and it has two values: Up or Down. Also, there are two lights in the elevator that indicate the current floor: Red for Ground, and Green for First. At each time step, the controller checks the current floor and current input, changes floors and lights in the obvious way.

   i) Draw an FSM diagram of the above scenario (3marks)
   ii) Draw a state transition table of the above FSM (5 marks)
   iii) Draw the resultant circuit of the elevator (4marks)

c) Draw a truth table of an XNOR with two inputs (2marks)
