UNIVERSITY OF SWAZILAND

Faculty of Science

Department of Computer Science

Supplementary Examination - July 2013

Title of Paper: LOGIC FOR COMPUTER SCIENCE

Course Number: CS235

Time Allowed: 3 hours Total Marks:**100**

Instructions to candidates:

*This question paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions. Marks are indicated in square brackets.*

All questions carry equal marks.

SPECIAL REQUIREMENTS:

NO CALCULATORS ALLOWED FOR THIS EXAM

THIS EXAMINATION PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

QUESTION 1

a) i) State 2 limitations of truth tables. [2]

ii) List 3 areas of application of Logic in Computer Science. [3]

b) Explain the difference between the following terms:

i) Propositional logic syntax and propositional logic semantics. [2]

ii) Atomic and Compound propositions [2]

c) Suppose you encounter three members **A, B** and **C** of the island of **TuFa** (remember that the **Tu's** always tell the truth, the **Fa's** always lie). They each give you a statement which we will assume you have translated into propositional logic as follows, where A denotes the statement:

Member **A** says: $\neg (A \vee B \vee C) \wedge (\neg A \vee \neg B \vee \neg C)$

Use the truth table to determine whether A's proposition is a Tautology, a Contradiction or Contingent. To which tribe does this member belong? [10]

d) What is the value of x after each of the following statements are encountered in a computer program, if x = 1 before the statement is reached. **Explain fully.**

i) **if** 2 + 3 = 6 AND 3 + 4 = 7 **then** x:= x + 1 [3]

ii) **if** 2 + 3 = 6 XOR 3 + 4 = 7 **then** x:= x + 1 [3]

QUESTION 2

a) i) Using truth tables, show that $(A \vee B) \rightarrow C$ is equivalent to $(A \rightarrow C) \wedge (B \rightarrow C)$ [4]

ii) From the truth table in i) above, determine the Conjunctive Normal Form (CNF) and the Disjunctive Normal Form (DNF) of $(A \vee B) \rightarrow C$ [6]

b) Three boys, Melusi, Brian and Nkosi are caught, suspected of breaking the glass in a lab.

- Melusi says: "Brian did it; Nkosi is innocent".
- Brian says: "If Melusi is guilty then so is Nkosi".
- Nkosi says: "I didn't do it; one of the others did".

i) Are the statements consistent? [6]

ii) Assuming that everyone is innocent, who told lies? [3]

iii) Assuming that everyone's statement is true, who is innocent and who is guilty? [2]

c) Using laws of equivalence, show that

i) $[\neg p \wedge (p \vee q)] \rightarrow q$ is a tautology. [4]

QUESTION 3

a) A traditional children's riddle concerns **a Farmer** who is traveling with **a sack of Rye**, **a Goose**, and **a mischievous Dog**. The farmer comes to a river that he must cross from east to west. A boat is available, but it only has room for the farmer and one of his possessions. If the farmer is not present, the goose will eat the rye or the dog will eat the goose.
We wish to design a circuit to emulate the conditions of this riddle. A separate switch is provided for the farmer, the rye, the goose and the dog. Each switch has two states, depending on whether the corresponding object is on the east bank or the west bank of the river. The rules of play stipulate that no more than two switches be moved at a time and that the farmer must move (to row the boat) each time switch are moved. The switch for the farmer provides logic signal **F**, which is high if the farmer is on the east bank and low if he is on the west bank. Similarly, logic signals (**G** for the goose, **D** for the dog and **R** for the rye) are high if the corresponding object is in the east bank and low if it is on the west bank.
Construct the truth table for this riddle and hence find the Boolean logic expression based on the sum of products approach for a logic signal **A (Alarm)** that is high any time the rye or the goose are in danger of being eaten. Repeat for the product of sums approach. [12]

b) Convert the following into SOP form and minimize using the Karnaugh map method.
$\mathbf{F} = \overline{A}B + ABC + BC\overline{D}$ [8]

c) Interpret the circuit diagram in ***fig 1*** and then complete the truth table that follows.[5]

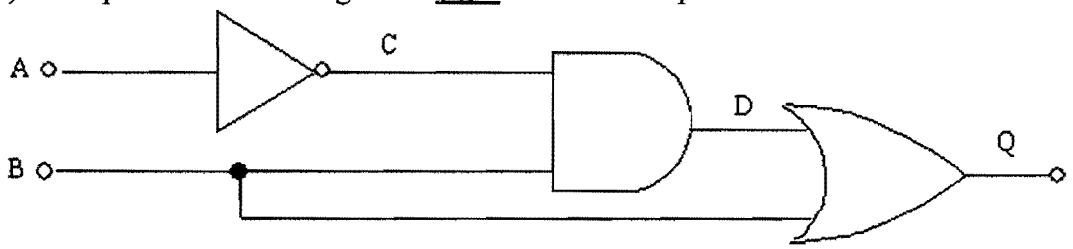

Fig 1:

A	*B*	*C*	*D*	Q
0	0	1	0	
0	1	1	1	
1	0	0	0	
1	1	0	0	

QUESTION 4

a) The state of a CPU register is 0100110101, what is its content if it represents:
   i. Digits in BCD
   ii. Digits in two's compliment [6]

b) Simplify the following expression using Boolean theorems.
$\overline{(\overline{A+B})}+\overline{\overline{C}}$ [4]

c) i) Briefly explain the difference between the Karnaugh map method and the Quine-McCluskey method. [3]

ii) Minimize the function $F(A,B,C,D)=\sum(0,3,5,7,11,13,15)$ using the Quine-McCluskey method. [12]

QUESTION 5

a) Convert
i) 1023.0625_{10} to binary [4]
ii) 769 to BCD [2]
iii) 93 to Hexadecimal [3]
iv) 11011.1011 to decimal [3]

Show all the working.

b) Find the 2's compliment representation of -73. Explain why the 2's complement arithmetic is commonly used as compared to other methods. [6]

c) With the aid of well-labeled circuit diagrams, distinguish between the Half adder and full adder circuits in the way they operate. [7]

QUESTION 6

a) Given **A, A only if B, B only if C. Therefore C.** Prove that the conclusion, **C,** is valid [3]

b) With the aid of clear diagrams explain the operations of the following:

i) 4 to 1 - line Multiplexer [5]
ii) 3 to 8 – line Decoder [5]

c) "If the program is running then there is at least 250K of RAM." Which of the following are equivalent to this statement? [5]

i) If there is at least 250K of RAM then the program is running.
ii) If there is less than 250K of RAM then the program is not running.
iii) The program will run only if there is at least 250K of RAM.
iv) If the program is not running then there is less than 250K of RAM.
v) A necessary condition for the program to run is that there are at least 250K of RAM.

d) Flip flops can be implemented using R-S, D-type or J-K. Explain the behavior of J-K flip-flop. What additional logic is required to convert a J-K flip-flop into a D-type flip flop? [7]

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