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UNIVERSITY OF SWAZILAND

Faculty of Science and Engineering

Department of Computer Science

MAIN EXAMINATION
May 2017

Title of Paper: **INTRODUCTION TO LOGIC**

Course Number: **CS235/ CSC201**

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

Instructions to candidates:

*This question paper consists of **FIVE (5)** questions. Answer any **FOUR (4)** questions. Marks are indicated in square brackets.*
All questions carry equal marks.

SPECIAL REQUIREMENTS:

NO CALCULATORS ALLOWED

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

Question 1

(a) With the help of examples, define the following terms as used in logic:

(i) Proposition

(ii) Argument

(iii) Predicate

(iv) Clause [2 marks each]

(b) Let p = "he is happily married," and q = "he is wealthy," and r = "he is smart." Write the following statements in symbolic form:

(i) He is happily married and wealthy but not smart.

(ii) He is not wealthy, but he is happily married and smart.

(iii) He is neither happily married, nor wealthy, nor smart. [2 marks each]

(c) Using truth tables, show that $(A \vee B) \rightarrow C$ is equivalent to $(A \rightarrow C) \wedge (B \rightarrow C)$ [5]

(d) From the truth table of (c) above, find the DNF and CNF of $(A \vee B) \rightarrow C$. [6]

Question 2

(a) Prove the equivalence elimination law using a truth table. [4]

(b) Prove the following using the laws of logical equivalence.

(i) $(P \wedge \neg Q) \vee R \equiv \neg (\neg P \wedge R) \wedge (Q \rightarrow R)$ [5]

(ii) $(A \leftrightarrow B) \equiv \neg(A \wedge \neg B) \wedge (\neg B \vee A)$ [5]

(c) Given $(\neg p \vee q) \Rightarrow (r \vee \neg q)$, rewrite the proposition using only $\neg$ and $\wedge$. [6]

(d) Prove $(B \rightarrow \neg A) \wedge (\neg B \rightarrow \neg A) \rightarrow \neg A$ using inference rules. [5]

Question 3

(a) State one advantage of the Quine-McClauskey method over the Karnaugh map method. [2]

(b) Minimize the function, *f (a, b, c, d)*, using Karnaugh map method. [6]

$$f(a,b,c,d) = acd + a\bar{b}\cdot\bar{c}d + \bar{a}\cdot\bar{b}cd + \bar{a}bc\bar{d}$$

(c) Use NAND gates ONLY to draw the circuit that implements the minimized expression of (b) above. [6]

(d) Using the Quine-McClauskey method, minimize the following functions.

(i) $f(A,B,C) = \bar{A}\bar{B}C + \bar{A}B\bar{C} + AB\bar{C} + ABC$ [4]

(ii) $f(A,B,C,D) = ABCD + A\bar{B}CD + AB\bar{C}D + ABC\bar{D} + A\bar{B}C\bar{D} + \bar{A}BCD + \bar{A}B\bar{C}D$ [7]

Question 4

(a) What is the difference between;

(i) Combinational and sequential circuits.

(ii) Synchronous and asynchronous circuits [2 marks each]

(b) With the aid of a well labelled diagram, describe the operation of the D latch. [6]

(c) Find the 2's compliment representation of-21. [3]

(d) Explain why the 2's complement arithmetic is commonly used as compared to other methods. [3]

(e) The state of a CPU register's contents is 100111.10101. What are its contents if it represents a positive real number? Show all your working. [5]

(f) Explain clearly the difference between a half and full adder. [5]

Question 5

(a) Define suitable predicates and then express the following statement as a logical expression:

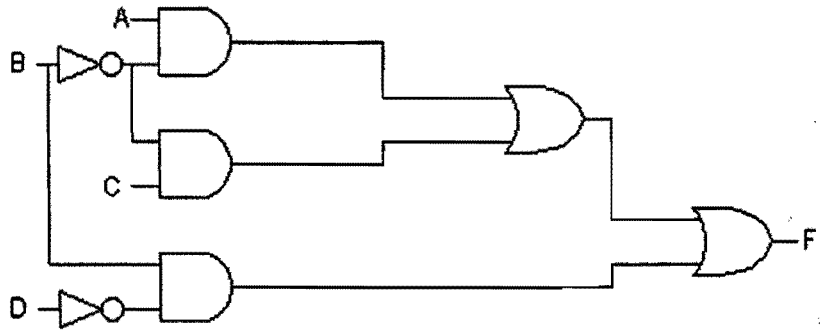
All the boys failed the mathematics test.

[4]

(b) Convert the following into SOP form and minimize using the Karnaugh map method. [6]

$$F = (AB + C)\left(B + \overline{C}\,D\right)$$

(c) Write down and simplify the logic function represented by the circuit diagram below: [4]



(d) With the aid of a well labelled diagram, describe the operation of a half adder. [5]

(e) Determine whether the following are tautologies, contradictory or contingent: [6]

(i) $(p \wedge q) \wedge (\neg p \vee \neg q)$

(ii) $(p \wedge \neg q) \vee \neg p \vee q$