KABARAK UNIVERSITY

EXAMINATIONS

2009/2010 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE

COURSE CODE: **COMP 223**

COURSE TITLE: **DIGITAL CIRCUIT DESIGN**

STREAM: **Y2S2**

DAY: **TUESDAY**

TIME: **2.00 - 4.00 P.M.**

DATE: **08/12/2009**

INSTRUCTIONS:

1. Answer **QUESTION ONE** and **any other two** questions.
2. Question One carries 30 marks while the others carry 20 marks each.
3. **Do not put any mark on the question paper**

PLEASE TURN OVER

QUESTION ONE (30mks)

a. What is a full subtractor? Explain its working using truth tables and a logic diagram. (5mks)

b. With the aid of a logic circuit diagram,

   i. show how a NOR gate can be realized using NAND gates only (3mks)

   ii. show how an XOR gate can be realized using NOR gates only (3mks)

c. In a committee of four members (two ladies and two gents), a motion is passed if there are two ladies or two gents and a lady or the four members. Design a gating circuit which lights up a bulb when the motion is passed. (6mks)

d. State and prove demorgan's theorem (3mks)

e. With the aid of diagrams explain the working of a multiplexer (4mks)

f. What is the difference between combinational and sequential circuits? Give examples (3mks)

g. Find the minterms of $\bar{A}$ D+ $\overline{A}CD + B\overline{C}$ (3mks)

QUESTION TWO (20mks)

a. A farmer employs a servant to look after his farm house. He instructs the servant to keep watch on his goat so that she doesn't harm the kitchen when the entrance is open. He is also required to see that no wild animal may pounce upon the grazing goat. For this, the farmer gives the servant a switch board , with three switches marked as Door Open(DO), Goat Near the Door(GN) and Wild Animal Nearby(WN) and instructs the servant to press the appropriate switch depending on what he sees. The switch board has an alarm bell that rings when the condition demands the farmer's attention. Suggest a suitable switching circuit design for the switch boards. (6 mks)

b. Given the truth table below:

W	X	Y	Z	F
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

i) Use sum of products method of K-map simplification to get the simplified circuit.

(3 mks)

ii) Suppose the minterms 3, 11, and 12 are changed to don't cares. What is the simplified sum of products?

(1 mk)

c. Using K-maps reduce:

i) $\sum m(0,2,4,5,6,8,9,10,11,13,14,15)$ (3mks)

ii) $\sum m,1,3,4,7,8,10,12,13) + d(9,14,15)$ (3mks)

d. Simplify the following expression using boolean algebra. (4 mks)

$$\bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}D + A\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + A\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}$$

QUESTION THREE (20mks)

a. With the aid of a neat diagram explain the master-slave flip-flop (9mks)

b. With the aid of a neat diagram ,explain the serial-in serial-out shift register (5mks)

c. What is a half-adder? Explain using truth tables and a circuit diagram. (4 mks)

d. State and explain any three applications of flip flops (2mks)

QUESTION FOUR (20mks)

a. Design a mod-14 synchronous counter using T-flip flops;

(i) State table (8 mks)

(ii) K-map reduction (4 mks)

(iii) Circuit diagram (3 mks)

b. Design and explain a 3 to 8 line decoder using NAND gates (5mks)

QUESTION FIVE (20mks)

a. With the aid of a diagram explain the diode-transistor logic (9mks)

b. With an aid of a diagram and transition tables explain the JK flip flop (5mks)

c. A light bulb is to be controlled by four switches, the bulb glows whenever switches A, B and C are in the same positions. When B and C are in different positions, the bulb glows depending upon the position of switch D. It also glows when C and D are on regardless of the position of A and C. Design a practical switching circuit for the above conditions (6mks)