KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE

COURSE CODE: **COMP 223**

COURSE TITLE: **DIGITAL CIRCUIT DESIGN**

STREAM: **Y2S2**

DAY: **THURSDAY**

TIME: **2.00 – 4.00 P.M.**

DATE: **06/08/2009**

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 (30 MARKS)

a. What is a full subtractor? Explain its working using truth tables and a logic diagram. (5 mks)
b. What is a race around condition? How is it eliminated? (2mks)

c. With the aid of a logic circuit, show how an XNOR gate can be realized using NAND gates (6mks)

d. With the aid of diagrams explain the working of an SR flip-flop (6mks)
e. 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 two gents and a lady, or the four members. Design a gating circuit which lights up a bulb when the motion is passed. (4mks)

f. Design a MOD-14 asynchronous counter and explain its working (4mks)

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

QUESTION TWO (20 MARKS)

a. Suppose you have built a system and you are asked to monitor when it malfunctions. There are four conditions you are checking:
   - Temperature; hot/cold
   - Humidity humid/low
   - Light: day/dark
   - Wind windy/calm

   The system malfunctions when:
   - It is cold, humid, and dark
   - It is humid, dark and calm
   - It is hot, low humidity, dark, windy
   - It is cold, dark, windy, and the humidity is low
   - Cold and humid but light and wind are; day and calm respectively,

   i) Draw the truth table for the above conditions (3mks)
   ii) Express the system's behaviour as a function F where F =1 exactly when the system malfunctions (2mks)
   iii) Using sum of products simplify the expression when the system malfunctions by using K-maps. (3mks)
   iv) Draw the simplified logic circuit (2mks)

b. Using K-maps reduce:

   i) $\sum m(0,2,4,5,6,9,10,11,13,14,15)$
   ii) $\prod M(0,1,7,8,10,12,13) + d(9,14,15)$ (6mks)

c. Simplify the following expression:

$F = \overline{ABCD} + \overline{A}BC\overline{D} + AB\overline{CD} + A\overline{BCD} + \overline{AB}C\overline{D} + \overline{A}B\overline{CD}$ +
$ABCD + ABC\overline{D} + \overline{A}BCD + A\overline{B}CD + AB\overline{C}D + \overline{A}B\overline{C}D$ Using Boolean algebra.

(4 mks)

QUESTION THREE (20 MARKS)

a. With the aid of a neat diagram explain the master-slave flip-flop (7mks)
b. With an aid of a diagram explain the working of a D-flip flop. (4mks)

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

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

QUESTION FOUR (20 MARKS)

a. Design a mod-13 synchronous counter using T-flip flops (15mks)

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

QUESTION FIVE (20 MARKS)

a. Draw a circuit of a standard diode - transistor NAND gate and explain its working. (12 mks)

b. 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. Assume the positions are ON=1 and OFF=0.
    i) Draw the truth table for the situation above. (3mks)
    ii) Represent the function F as a function of A, B, C and D. (2mk)
    iii) Simplify the function and design a practical switching circuit. (3mks)