UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIGITAL SYSTEMS II

COURSE CODE – EE324

MAIN EXAMINATION

MAY 2013

DURATION OF THE EXAMINATION - 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. There are FIVE questions in this paper. Answer any FOUR questions only.
2. Each question carries equal marks.
3. Show all your steps clearly in any calculations.
4. State clearly any assumptions made.
5. Start each new question on a fresh page.

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Question 1

(i) Explain the differences among:

a. *address lines* and *memory addresses*. [2]
b. A *Boolean equation*, a *state equation*, a *characteristic equation*, and a *flip-flop input* equation. [4]

(ii) A PN flip-flop has four operations: clear to 0, no change, complement, and set to 1, when inputs P and N are 00, 01, 10, and 11, respectively.

a. Tabulate the characteristic table. [2]
b. Tabulate the excitation table. [2]
c. Derive the characteristic equation. [3]
d. Show how the PN flip-flop can be converted to a D flip-flop. [4]

(iii) Specify the size of a ROM (number of words and number of bits per word) that will accommodate the truth table of a binary multiplier that multiplies two 5-bit numbers. [3]

(iv) With the aid of diagram (or diagrams), explain how a Master-Slave D flip-flop works. Explain the rationale for having this type of circuit edge-triggered rather than level-triggered. [5]

Question 2

Derive the state table and Boolean expressions for the outputs O_0 to O_2 in the circuit diagram shown in Figure Q2. [25]

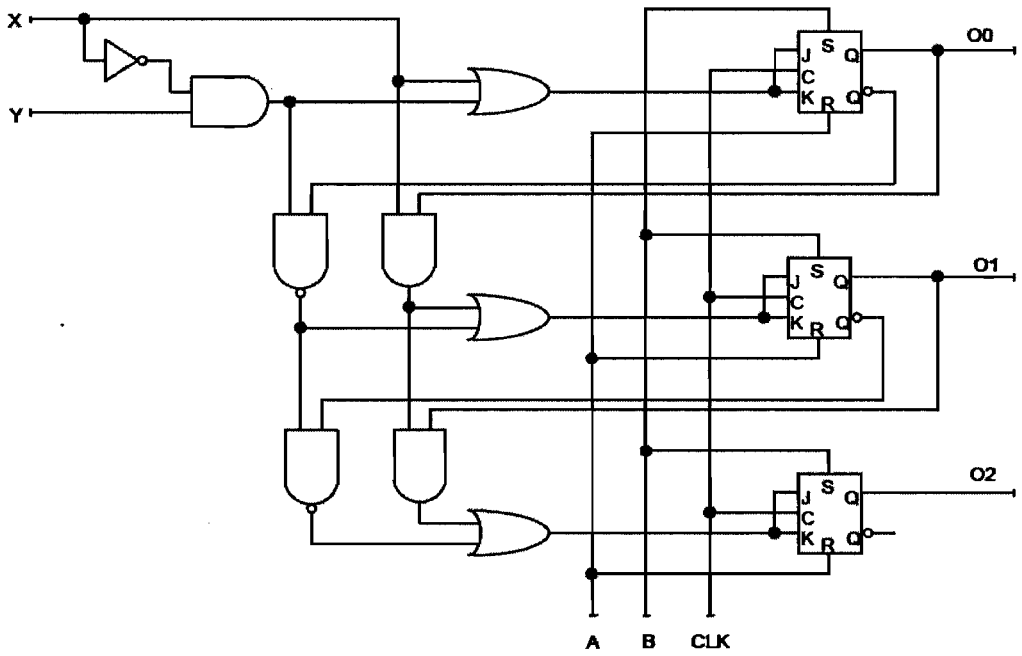

Figure Q2. Circuit diagram for Question 2

Question 3

Using only a shift register and a ROM of suitable sizes, design a *Mealey* sequential circuit that detects the sequence 10001. Explain how your design satisfies the behavioural requirement of the sequence detector .

[25]

Question 4

Design a sequential circuit for digital system that counts the number of people in a room. People enter the room from one door with a photocell that changes a signal x from 1 to 0 when the light is interrupted. They leave the room from a second door with a similar photocell that changes a signal y from 1 to 0 when the light is interrupted. The room has a capacity of 7. The digital system control the entrance to the room such that if the room is full it sets high some output z that locks the entrance door. The entrance door remains locked until at least one person leaves the room to make the number of occupants less than 7.

[25]

Question 5

Design a sequential circuit which determines the first player to press their button in a THREE-contestant game. The circuit must have FOUR inputs connected to pushbutton and THREE outputs connected to lamps. THREE of the FOUR inputs are for each of the THREE contestants. The other input is the Game Conductor's RESET/CLEAR button as shown in Figure 3 below. Accordingly, the THREE outputs correspond to each contestants and they are connected to lamps.

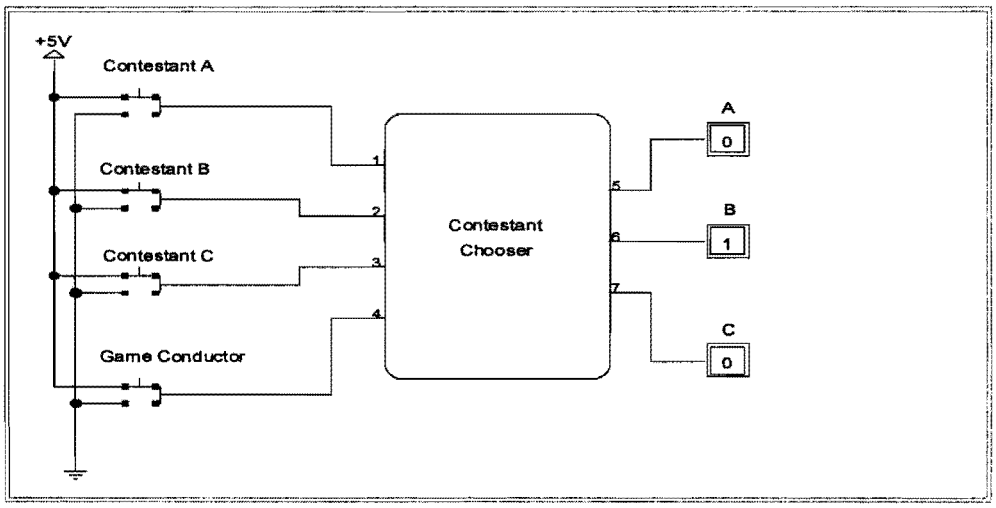

Figure 5: Contestant Chooser (circuit for Question 5)

A lamp corresponding to the first contestant to press their button remains ON until the RESET button is pressed by the Game Conductor. If any of the other TWO contestants press their buttons their lamps are not switched ON – your circuit must make sure that only one of the contestant's lamp is switched ON at a time.

Explain how your design meets the requirements of the Contestant Chooser. **[25]**

END OF PAPER