Date of Examination: 25/10/2021

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department/School: Computer Science and Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination: Fall 2020
Year: 3rd   Semester: 1st
Course Number: CSE3109
Course Name: Digital System Design

Time: 02(Two) Hours   **Full Marks: 50**
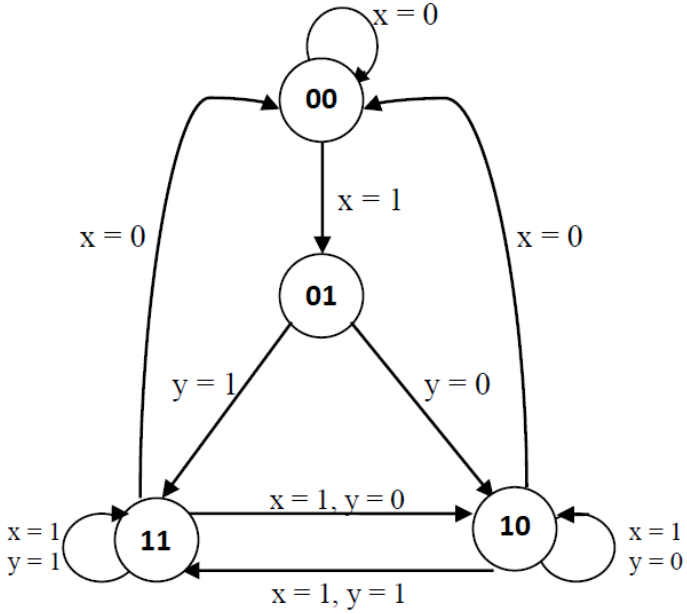
<u>**Use single answer script**</u>

Instructions:	i)	Answer script should be hand written and should be written in A4 white paper. You must submit the hard copy of this answer script to the Department when the university reopens.
	ii)	You must write the following information at the top page of each answer script: **Department:** **Program:** **Course no:** **Course Title:** **Examination:** **Semester (Session):** **Student ID:** **Signature and Date:**
	iii)	Write down Student ID, Course number and put your signature on top of every single page of the answer script.
	iv)	Write down page number at the bottom of every page of the answer script.
	v)	Upload the scan copy of your answer script in PDF format through provided **google form** at the respective course site (i.e., **google classroom)** using institutional email within the allocated time. Uploading clear and readable scan copy (uncorrupted) is your responsibility and must cover the full page of your answer script. However, for clear and readable scan copy of the answer script student should use only one side of a page for answering the questions.
	vi)	You must avoid **plagiarism,** maintain **academic integrity, and ethics**. You are not allowed to take any help from another individual and if taken so can result in stern disciplinary actions from the university authority.
	vii)	Marks allotted are indicated in the **right margin.**
	viii)	Necessary **charts/tables** are attached at the end of the question paper. You may use graph papers where necessary.
	ix)	Assume any reasonable data if needed.
	x)	Symbols and characters have their usual meaning.
	xi)	Before uploading rename the PDF file as **CourseNo_StudentID.pdf** For example, CSE 3109_180204001.pdf
	xii	The answer script **(one single pdf file)** must be uploaded at designated location in the provided **google form link** available in the google classroom.

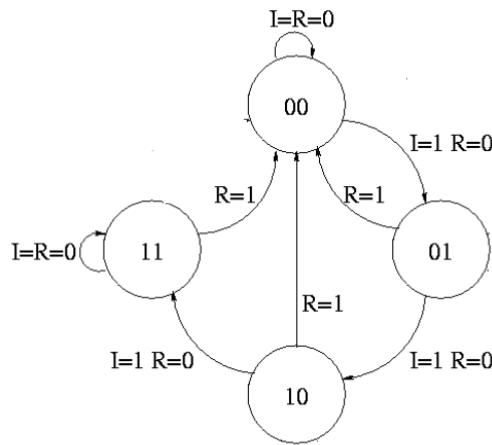| **Question 1. [Marks: 12.5]**		
a)	Design an arithmetic circuit with two selection variables, S_1 and S_0, which generates the following arithmetic operations. Draw the logic diagram of one typical stage.	**[6]**

S_1	S_0	$C_{in} = 0$	$C_{in} = 1$
0	0	F = A + B	F = A - B
0	1	F = A - 1	F = A + 1
1	0	F = B' - 1	F = B' + 1
1	1	F = A + B'	F = A + B' +1

b)	Write short notes on the following topics: i. Overflow Flag ii. Zero Flag	**[3]**
c)	Alex claims that the decrement operation can activate the final carry bit if the operand is zero. Do you agree with him? Explain with proper examples.	**[3.5]**

Question 2. [Marks: 12.5]		
a)	Design a combinational circuit that compares two 4-bit numbers to check if they are equal. The circuit output is equal to 1 if the two numbers are equal and 0 otherwise. Derive the equation of the circuit.	**[2.5]**
b)	Design a 2-bit counter using D flip-flops for the state diagram shown in **Figure 1**. Use K-maps to derive the equations.	**[6]**

Figure 1: State Diagram for problem 2(b)

c)	What are the differences between SRAM and DRAM? Design a combinational circuit using a ROM with AND-OR-Invert Gates that generates the following output: $$F_1 (X, Y, Z) = \Sigma (0, 1, 2, 4, 5)$$ $$F_2 (X, Y, Z) = \Sigma (1, 3, 6, 7)$$	**[4]**

	Question 3. [Marks: 12.5]	
a)	Why Double Handshake I/O is better than Single Handshake I/O? Write a control word for 8255 PPI configuring Port B and Port C_L as an output port and Port A and Port C_u as an input port and 8255 working in mode 0. Mention the significance of each bit position.	**[2+2]**
b)	If we want to display the number: 74082, what will be the current required to drive the LEDs and the decoders in a directly driving seven segment LED?	**[3]**
c)	Assume that SAP-2 has a clock frequency of 2 MHz. How much delay will the following SAP-2 subroutine produce? The required number of T-states for MVI = 7, DCR = 4, JZ = JNZ = 10 or 7, RET = 10. <table><tr><td></td><td>MVI A, 0AH</td></tr><tr><td>LOOP1:</td><td>MVI B, 64H</td></tr><tr><td>LOOP2:</td><td>MVI C, 47H</td></tr><tr><td>LOOP3:</td><td>DCR C</td></tr><tr><td></td><td>JNZ LOOP3</td></tr><tr><td></td><td>DCR B</td></tr><tr><td></td><td>JNZ LOOP2</td></tr><tr><td></td><td>DCR A</td></tr><tr><td></td><td>JNZ LOOP1</td></tr><tr><td></td><td>RET</td></tr></table>	**[5.5]**
	Question 4. [Marks: 12.5]	
a)	Perform Modified Booth multiplication on 1010110011 x 1010110011.	**[8]**
b)	Write a program for SAP-1 to solve the following arithmetic problem: $$18 - 16 + 25 + 30$$ The numbers are in decimal form. Consider these numbers stored from memory address 9H.	**[4.5]**
	Question 5. [Marks: 12.5]	
a)	Hand assemble the following program in SAP-2 starting from address 1162H. MVI B, AFH DCR B JNZ 2000H JMP 1105H HLT	**[4]**
b)	Write a program that subtracts $(865)_{10}$ from $(2897)_{10}$ and stores the answer in the H and L registers.	**[3]**
c)	What is the purpose of using PORT C of 8255PPI? Write the steps of the data transfer in Input Mode 1 on Port B of 8255PPI. Mention necessary pin numbers, also draw the appropriate timing diagram.	**[1+4.5]**
	Question 6. [Marks: 12.5]	
a)	Consider a sequential circuit with two T flip-flops A and B, two inputs x and y, and one output z is specified by the following next-states and output equation: $$A(t+1) = x'y + xB$$ $$B(t+1) = x'A + yB$$ $$z = AB$$	**[6.5]**

	Design a state table for the two T flip-flops and determine the functions of these two T FFs. You must simplify the functions using K-map.	
b)	The state diagram of a control unit is shown in **Figure 2**. It has four states and two inputs I and R. You must represent the 00 state as T_0, 01 state as T_1, 10 state as T_2, and 11 state as T_3. Design the control using a PLA.	**[6]**

Figure 2: State Diagram for problem 6(b)