**Date:**

**Ahsanullah University of Science and Technology**

Department of Computer Science and Engineering

Third Year, First Semester Final Examination, Fall 2016

Course No: **CSE 3109** Course Title: **Digital System Design**

Time: 3 Hours Full Marks: 70

**[ There are 7(Seven) questions. Answer any 5(Five) questions.]**

**[*Marks allotted are indicated in the right margin within ‘[ ]’.*]**

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| --- | --- | --- |
| 1.a) | What is Modified Booth’s algorithm? Explain with example. | [4] |
| b) | If *m* = 11010 , *r* = 01101 , *x* = 5 and *y* = 5; using the Booth’s multiplication algorithm determine the initial value of A , S and P. Show all the steps of Booth’s algorithm to find the final value of P. | [5] |
| c) | Design a 6 × 6 bit booth’s multiplier. Draw the circuit block diagram. | [5] |
| 2.a) | What is the difference between RAM and ROM? Describe the write and read operations of a RAM. | [4] |
| b) | Prove that the multiplication of two **n-digit** numbers in any base **r** gives a product of no more than **2n** digits in length. | [4] |
| c) | Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number. Derive the PLA program table for this circuit. | [6] |
| 3.a) | What is programmable logic array? Draw the block diagram of PLA. | [3] |
| b) | Draw the LDA and SUB routines of SAP-1 and also their fetch and execution timing diagram. | [5] |
| c) | Describe the architecture of SAP-2. | [6] |
| 4.a) | What is mnemonics? Explain with example. | [2] |
| b) | What is Ring Counter? Draw the symbol and clock and timing signals of a Ring Counter. | [3] |
| c) | How much time delay does this SAP -2 subroutine produce?  MVI B,0AH  LOOP1: MVI C,47H  LOOP2: DCR C  JNZ LOOP2  DCR B  JNZ LOOP1  RET | [3] |
| d) | Serial data is sometimes called a serial data stream because bits flow one after another. In SAP-2 a serial data stream drives bit 7 of port 2 at a rate of approximately 600 bits per second. Write a program that inputs an 8-bit character in a serial data stream and stores it in memory location 2100H. | [6] |
| 5.a) | What is the difference between hard-wired control and microprogram control? What are the advantage and disadvantage in each method? | [4] |
| b) | **Figure 1:** control state diagram for problem 5 b)  x = 0  x = 1  x = 0 x = 0  y = 1 y = 0  x = 1, y = 0  x = 1 x = 1  y = 1 y = 0  x = 1, y = 1  The state diagram of a control unit is shown in Figure 1. It has four states and two inputs x and y. |  |
|  | 1. Design the control using eight D flip-flops. | [2] |
|  | 1. Design the control using three J-K flip-flops and a 3×8 decoder. | [4] |
|  | 1. Design the control using a PLA. | [4] |
| 6.a) | Deign an arithmetic logic unit with three selection variables S2, S1 and S0, that generates the following arithmetic and logic operations. When S2 =0 the arithmetic operations are done and when S2 =1 the logical operations are done.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | S1 | S0 | Cin = 0 | Cin = 1 | Cin = × (don’t care) | | 0 | 0 | F = A | F = A + 1 | F = A+B (OR) | | 0 | 1 | F = A – B – 1 | F = A – B | F = A⊕B (XOR) | | 1 | 0 | F = B – A – 1 | F = B – A | F = AB (AND) | | 1 | 1 | F = A + B | F = A + B +1 | F = A B (NAND) | | [7] |
| b) | The symbolic microprogram for control memory is given below:   |  |  |  | | --- | --- | --- | | ROM  address | Microinstruction | Comments | | 0 | x = 1,if (qs = 1) then ( go to 1), if (qa = 1) then ( go to 2), if ( qs ^ qa = 0) then ( go to 0) | Load 0 or external addres | | 1 | Bs ⃪ Bs’ | qs = 1, start subtraction | | 2 | If ( S = 1) then ( go to 4) | qa = 1, start addition | | 3 | A ⃪ A + B, E ⃪ Cout , go to 0 | Add magnitudes and return | | 4 | A ⃪ A + B’ + 1, E ⃪ Cout | Subtract magnitudes | | 5 | If ( E = 1) then ( go to 0), E ⃪ 0 | Operation terminated if E = 1 | | 6 | A ⃪ A’ | E = 0, complement A | | 7 | A ⃪ A + 1, As ⃪ As’, go to 0 | Done, return to address 0 |   Here L variable loads A and E from ALU, y variable complements Bs , z variable complements As and w variable clears E. And the ALU has the following function table:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | S2 | S1 | S0 | Cin | Output | | 0 | 0 | 1 | 0 | F = A + B | | 0 | 1 | 0 | 1 | F = A - B | | 1 | 1 | 1 | 0 | F = A’ | | 0 | 0 | 0 | 1 | F = A + 1 |   Write the binary microprogram for the control memory and also draw microprogram control block diagram. | [7] |
| 7.a) | What are the values of status bits C and Z after the subtraction of two unsigned numbers (A – B)? | [2] |
| b) | Design an arithmetic circuit that multiplies two fixed-point binary numbers in sign-magnitude representation. The product obtained from the multiplication of two binary numbers whose magnitudes consist of *k* bits each can be up to *2k* bits long. The sign of each number occupies one additional bit. Your design must include the following steps: |  |
|  | 1. Equipment Configuration | [1] |
|  | 1. Derivation of Algorithm | [1] |
|  | 1. Flowchart | [3] |
|  | 1. Control state diagram and Sequence of microoperations | [3] |
|  | 1. Design of Hard-wired Control | [4] |