Prathik

M.Sc. (Informatics) – I Semester - 2013
IT 12- Computer Architecture

Time: 3 Hrs. **Max. Marks: 75**

Note: Attempt any 5 questions. Question No. I is compulsory.

Q1. Attempt any 5 parts. Each part carries 3 marks.

a. Explain the significance of "Timing and Control Signals" in the working of a basic computer?

b. What are the different types of Interrupts that can be encountered during program execution?

c. Simplify the following Boolean function in product-of-sums form by means of a four-variable Karnaugh map. Draw the logic diagram with (a) OR-AND gates; (b) NOR gates.

$F(w, x, y, z) = \sum (2, 3, 4, 5, 6, 7, 11, 14, 15)$

d. A digital computer has a common bus system for 16 registers of 32 bits each. The bus is constructed with multiplexers.

i. How many selection inputs are there in each multiplexer?

ii. What sizes of multiplexers are needed?

iii. How many multiplexers are there in the bus?

e. Show how a 9-bit micro-operation field in a micro-instruction can be divided into subfields to specify 46 micro-operations. How many micro-operations can be specified in one micro-instruction?

f. Match the options in column 1 to appropriate values in column 2:

1	2
ECL	High component Density 2
MOS	Low Power Consumption 3
CMOS	High Speed Operation 1

Q2.

a. Write a program loop (assembly language), using a pointer and a counter, which clears to 0 the contents of hexadecimal locations 500 to 5FF. (5)

b. Show the hardware that implements the following statement. Include the logic gates for the control function and a block diagram for the binary counter with a count enable input. (3)

$$xyT_0 + T_1 + y'T_2: AR \leftarrow AR + 1$$

c. What is the difference between a direct and an indirect address instruction? How many references to memory are needed for each type of instruction to bring an operand into a processor register? (3)

d. What is the difference between serial and parallel register? The content of a 4-bit register is initially 1101. The register is shifted six times to the right with the serial input being 101101. What is the content of the register after each shift? (4)

Q3.

a. Define the working of a Stack. Convert the following infix expression into prefix notation. Once converted to prefix, evaluate the resulting expression (in prefix notation) using Stack. Show the stack contents after each step/operation performed during evaluation. (7)

$$X = 2 + (3 * 6) - (5 * 2)$$

b. Design a 4-input *"Even Function"*. An Even function is generated in a combinational circuit; when, the output is HIGH if the inputs have an even number of HIGH inputs. The output is LOW, otherwise. (4)

c. Draw and explain the circuit diagram for a 4-bit binary counter with parallel load and synchronous clear? (4)

Q4.

a. Design a digital circuit that performs the four logic operations of exclusive-OR, exclusive-NOR, NOR, and NAND. Use two selection variables. Show the logic diagram of one typical stage. (5)

b. Write a program (assembly language) to multiply two unsigned positive numbers, each with 16 significant bits, to produce an unsigned double-precision product. (5)

c. A relative mode branch type of instruction is stored in memory at an address equivalent to decimal 750. The branch is made to an address equivalent to decimal 500.
   i. What should be the value of the relative address field of the instruction (in decimal)?
   ii. Determine the relative address value in binary using 12 bits. (Why must the number be in 2's complement?)
   iii. Determine the binary value in PC after the fetch phase and calculate the binary value of 500. Then show that the binary value in PC plus the relative address calculated in part (ii) is equal to the binary value of 500. (5)

Q5.

a. Define a 6-variable Karnaugh map used for simplifying Boolean expressions. Use it to simplify the following expression: (7)

$F(a,b,c,d,e,f) = \sum (0, 1, 2, 3, 14, 16, 17, 18, 36, 37, 38, 39, 40)$

b. An 8-bit register contains the binary value 10011100. What is the register value after arithmetic shift right? Starting from the initial number 10011100, determine the register value after an arithmetic shift left, followed by a circular shift left, followed by a logical shift left, followed by another arithmetic shift left. Also state whether there is an overflow while each operation is being performed. (3)

c. A computer has 16 registers, an ALU with 32 operations, and a shifter with eight operations, all connected to a common bus system.

iv. Formulate a control word for a micro-operation.

v. Specify the number of bits in each field of the control word and give a general encoding scheme.

vi. Show the bits for the control word that specify the micro-operation R4 ← R5 + R6. (5)

Q6.

a. Suppose we have a number system with *"radix = 9"*. Explain in detail how to obtain the 9's complement and 8's complement in this number system. Also, calculate the 9's and 8's complement for the following: (8)

vii. $(26358700)_9$

viii. $(12345678)_9$

b. Define the following terms: (3)

ix. Combinational circuit

x. OR logic gate

xi. Sequential circuit

c. An instruction at address 021 in the basic computer has I = 0, an operation code of the AND instruction, and an address part equal to 083 (all numbers are in hexadecimal). The memory word at address 083 contains the operand B8F2 and the content of AC is A937. Go over the instruction cycle and determine the contents of the following registers at the end of the execute phase: PC; AR; DR, AC, and IR. Repeat the problem six more times starting with an operation code of another memory-reference instruction. (4)