401H

M.Sc. (INFORMATICS) / 1st Semester 2014

Paper IT12 – COMPUTER ARCHITECTURE

Attempt any 5 questions.
Question No.1 is compulsory.

1.

a. Define the following terms: (5)
   i. Logic gate
   ii. Digital computer
   iii. Flip-flop
   iv. Excitation table
   v. Decoder

b. Obtain the 6's complement for the following numbers: (5)
   i. $(12345)_6$
   ii. $(12345)_7$
   iii. $(123456)_6$
   iv. $(123456)_7$
   v. $(101010)_6$

c. Convert the following infix expression into postfix notation. Once converted to postfix, evaluate the resulting expression using Stack. Show the stack contents after each step performed during evaluation. (5)
   *X = ((33+3)*2)*((45+1) - (2*4))*

2.

a. The following memory units are specified by the number of words times the number of bits per word. How many address lines and input-output data lines are needed in each case? Also specify the number of bytes stored in each case. (5)
   i. 2K X 16
   ii. 64K X 8
   iii. 16M X 32
   iv. 4G X 64

b. Design an arithmetic circuit with one selection variable S and two n-bit data inputs A and B. The circuit generates the following four arithmetic operations in conjunction with the input carry C_{in}. Draw the logic diagram for the first 2 stages. (5)

S	$C_{in} = 0$	$C_{in} = 1$
0	D = A+B (add)	D = A+1 (increment)
1	D = A-1 (decrement)	D = A+B'+1 (subtract)

c. The following program is stored in memory unit of the basic computer. Show the contents of the AC, PC, and IR (in hex), at the end, after each instruction is executed. All numbers listed below are in hex. (5)

Location	Instruction
010	CLA
011	ADD 016
012	BUN 014
013	HLT
014	AND 017
015	BUN 013
016	C1A5
017	93C6

3.

a. Design and explain the working of a Micro-program sequencer for control memory. (7)

b. Simulate a 4-input XOR gate and explain the working with the help of a truth-table. (3)

c. A computer uses a memory unit with 256K words of 32 bits each. A binary instruction code is stored in one word of memory. The instruction has four parts: an indirect bit, an operation code, a register code part to specify one of 64 registers, and an address part.

i. How many bits are there in the operation code, the register code part, and the address part?

ii. Draw the instruction word format and indicate the number of bits in each part

iii. How many bits are there in the data and address inputs of the memory? (5)

4.

a. What is the radix of the numbers if the solution to the quadratic equation $x^2 - 10x + 31 = 0$, is x=5 and x=8? (3)

b. Define a 5-variable K-map used for simplifying Boolean expressions. Use it to simplify the following expression: (8)

$$F(a,b,c,d,e) = a'b'c'd'e' + a'b'c'd'e + a'b'c'de + a'b'cde + a'bcde + abcde + abcde' + abcd'e' + abc'd'e' + ab'c'd'e'$$

c. A two-word instruction is stored in memory at an address designated by the symbol W. The address field of the instruction (stored at W+1) is designated by the symbol Y. The operand used during the execution of the instruction is stored at an address symbolized by Z. An index register

contains the value X. State how Z is calculated from the other addresses if the addressing mode of the instruction is:

i. Direct
ii. Indirect
iii. Relative
iv. Indexed

(4)

5.

a. Draw a 3-to-8 line decoder using NAND gates. (3)

b. Using a flowchart explain the simulation/flow of a computer operation (instruction cycle and interrupt cycle). (8)

c. A 36-bit floating-point binary number has eight bits plus sign for the exponent and 26 bits plus sign for the mantissa. The mantissa is a normalized fraction. Numbers in the mantissa and exponent are in signed-magnitude representation. What are the largest and smallest positive quantities that can be represented, excluding zero? (4)

6.

a. Convert the following numbers with the indicated bases to decimal: (3)

i. $(12121)_6$
ii. $(4321)_7$
iii. $(198)_{12}$

b. What is wrong with the following register transfer statements? (3)

i. xT: AR ← A'R', AR ← 0
ii. yT: R1 ← R2, R1 ← R3
iii. zT: PC ← AR, PC ← PC + 1

c. Write a subroutine to subtract two numbers. In the calling program, the BSA instruction is followed by the subtrahend and minuend. The difference is returned to the main program in the third location following the BSA instruction. (5)

d. Define the following terms: (4)

i. Micro-operation
ii. Micro-instruction
iii. Micro-program
iv. Micro-code