Unique Paper Code   : 32341102

Name of the Paper   : Computer System Architecture

Name of the Course   : B.Sc. (H) Computer Science

Semester   : I

Duration   : 3 Hours   Maximum Marks: 75

Instructions for the Candidates

Attempt Any Four Questions. All Questions Carry Equal Marks.

Q1.

Given the Boolean function f(A, B, C, D) = Σ (1, 2, 3, 7, 8, 10) and don't-care conditions d(A, B, C, D) = Σ (0, 5, 6, 11, 15)

- Obtain an optimized Boolean expression F in SOP form using Karnaugh map.
- Find complement of the optimized expression F using De-Morgan's Law.
- Draw the logic diagram of the original expression f and the optimized expression F. Compare the total number of gates for both.
- For the optimized expression F, show that F.F' = 0 and F+ F' =1
- Simplify the following expression using Boolean algebra: AB + A(CD+CD′)

Q2.

Perform following operations as directed (Use signed 2's complement representation for negative numbers):

- Convert $(4433)_5$ to decimal and then to binary.
- Convert $(5654)_8$ and $(1199)_{12}$ to binary and then to Hexadecimal
- Add $(6E)_{16}$ and $(C5)_{16}$
- Subtract $(7B)_{16}$ from $(C4)_{16}$
- Give BCD representation of F3EA
- Add 679.6 and 536.8 in BCD
- Specify the value that will be assigned to interrupt flip-flop R in the following register transfer statement

$$(T0 + T1 + T2) (IEN') (FGI') (FGO'): R \leftarrow ?$$

- Explain briefly what will happen when the following micro instruction is executed:

    If (AC(15) = 1) then S ← 0

Q3.

- Write a program to evaluate the arithmetic expression: $x = \dfrac{(B*C+A)}{B}$ using one address instructions.
- Assuming the three bit binary code for a register corresponds to the register number and the binary codes for microoperations supported by the processor are listed in Table 1, give the microinstruction that will be executed if the following 14-bit binary control words are specified to the processor:
    - 01001110010010
    - 01110001101011
    - 10100001110100

OPR SELECT	Operation
00000	Transfer
01011	OR
10010	ADD
10001	AND
10100	Complement

Table -1: Encoding of ALU operations

- Give the excitation table for a flip flop XY whose characteristic table is given as follows:

X	Y	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	Q'(t)

- Draw a space-time diagram for a six-segment pipeline to process five tasks.

Q4.
- Consider the following snapshot of a memory to answer the questions that follow:

Memory

402	800
.	
.	
.	
600	MODE | OPCODE
601	402
.	
.	
.	
800	90

A two word instruction being currently executed is stored at location 600 with its address field at location 601.
- Which addressing mode is being used if the value of operand is 90, 402 and 800 respectively?
- If the effective address obtained by using indexed register addressing mode is 902, what is the content of index register?
- What would be the value of program counter (PC) before and after the execution of the instructions:
  - if the OPCODE of the instruction is ADD?
  - if the OPCODE of the instruction is BUN?
- With reference to the basic computer, identify error(s) / explain why each of the following microoperations cannot be executed in a single clock pulse. Also, specify the correct sequence of microoperations that will perform the operation.
  - TR←M[PC]
  - M[AR]←PC, PC ← AR + 1
  - M[AR] ← DR + 1
  - OUTR ← AC, FGO ← 1

Q5.

- Show the construction of a 4 x 16 decoder using five 2 x 4 decoders with the help of a block diagram. Also give the truth table of the constructed decoder.

- Specify the number of bytes that can be stored in a 128K $\times$ 16 memory. How many address lines and data lines will be required for the specified memory unit? How many 256 x 8 memory chips will be needed to provide a memory capacity of 4096 x 16?

- Identify the type of following I/O interface commands:
  - Check to see if a printer is ready for printing
  - Skip to the beginning of a tape
  - Check for an error during an I/O transfer
  - Write a block of data onto a magnetic disk.

Q6.

- A computer uses a memory unit of 256K words of 32 bits each. A binary instruction code is stored in one word of memory. The instruction has four parts: an addressing mode field to specify one of the four addressing modes, an operation code, a register code part to specify one of the 128 registers and an address part. Calculate the number of bits in each part of the instruction and indicate them by drawing the instruction format.

- Which flip-flop will need to be disabled in case processor is not in a position to serve any interrupts? Which flags are checked to determine whether the source of interrupt is from an input device or an output device respectively?
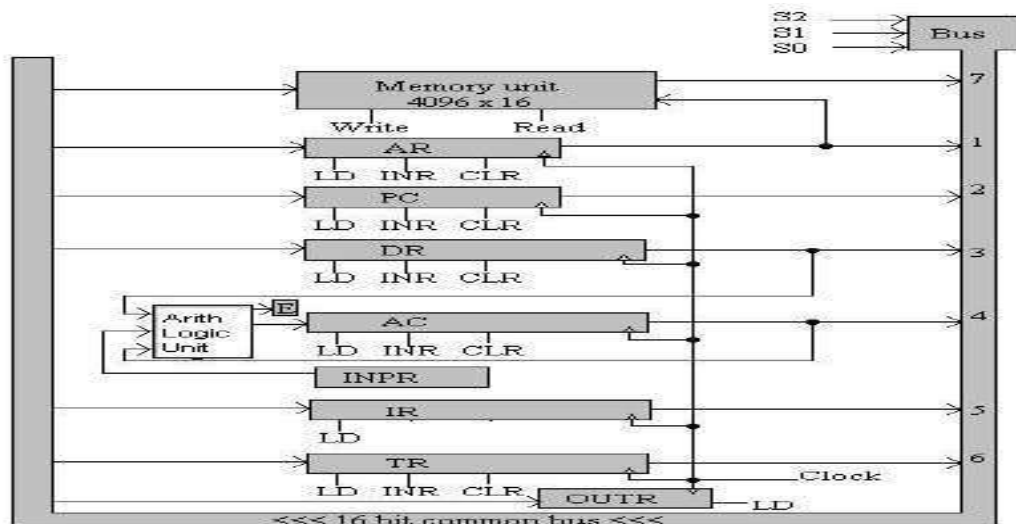

Figure I. The Common Bus System

- Consider the common bus system of the basic computer depicted in Figure I. The control inputs given in Table II are active in the common bus system at a time instant t_0. Give register transfer statements to specify the register transfer(s) that will be executed during the next clock transition t_1.

	S_2	S_1	S_0	LD of register	Memory	Adder
I.	0	0	1	PC	-	-
II.	1	0	0	DR	Read	-
III.	0	1	1	AC	-	Add
IV.	1	1	1	TR	Read	-

Table II Control Inputs active in Common Bus System at time instant t_0

- The following register transfer operations are to be executed in the common bus system (Figure 1). For each transfer, specify the binary value that must be applied to the selection inputs S_2, S_1, S_0, the register whose LD control input must be active (if any), a memory read/write operation (if required) and the operation in adder and logic circuit (if any) in the tabular format as shown in Table II:
  - PC←AR
  - M[AR] ←DR
  - AC ← AC + M [AR]

- Which instruction is required to transfer the control from main program to an I/O program located at memory address X? Which instruction is required at the end of an I/O program to transfer the control back to an address Y where return address is stored?

This question paper contains 3 printed pages.

Roll No._____

Sr. No. of Question Paper	:	
Unique Paper Code	:	32341101
Name/Title of the paper	:	**Programming Fundamentals using C++**
Name of the Course	:	**B. Sc. (H) Computer Science**
Semester	:	**I (DSC-1) (Admissions 2019 onwards)**
Duration of Examination	:	**3 Hours**
Maximum Marks	:	**75**

Instructions for Candidates

1. Attempt any FOUR out of SIX questions.

2. All questions carry equal marks.

3. All parts of a question must be answered together.

4. If required, you may make suitable assumptions and state them clearly.

5. **The data types of variables/data members/arrays and return types of the functions/member functions should be assumed suitably unless explicitly mentioned.**

Q1. Write a program in C++ that provides a user-defined class **NewFloat** with a data member **floatData** of type **float**. The class also comprises the following members:

- default and parameterized constructors

- an inline member function **printData()** that prints the details of an object of the class

- a member function **deciData()** that returns the decimal part of **floatData**

- operator overloading to perform the following operations:

  - post increment (**++**) increments **floatData** by 1.

  - less than (**<**) on a pair of objects of the class. The function returns 1 if the data member of the object on the LHS of the operator is less than the data member of the object on the RHS of the operator and 0 otherwise.

  - int cast to convert the float data member of an object into an integer

Q2. Write a program in C++ that defines an m x n two dimensional array containing integer elements, where m and n represent the numbers of rows and columns respectively. The numbers of rows and columns should be defined as constants. The program should provide the following user-defined functions with appropriate parameters:

- **setArrData(...)**: The function accepts elements from the keyboard and stores them into the array.

- **printArrData(...)**: The function prints the array values on the screen.

- **getAverage(...)**: The function accepts the array, number of rows and number of columns as parameters and returns the average of all values in the array.

- **findMax(...)**: The function accepts the array, number of rows and number of columns as parameters and prints the greatest element from each column of the array.

Q3. Write a program in C++ that reads some text entered through the keyboard till the end of file (eof) character is entered. The words in the text are written to different text files as per the following conditions:

- The words beginning with any of the lowercase vowels (a, e, i, o, u) are written to a file **fileV.txt**.

- The words beginning with a digit (0 – 9) are written to a file **fileD.txt**.

- All other words are written to a file **fileRest.txt**.

Sample input:
```
Buy 1 kg apples And 17 oranges immediately
^Z
```

Sample output:
```
fileV.txt: apples oranges immediately
fileD.txt: 1 17
fileRest.txt: Buy kg And
```

Q4.   Write C++ statements for the following tasks:

a. Write the prototype of a function **funP** that accepts two arguments- a constant one dimensional array of integers and a float; and returns a pointer to a double.

b. Accept three strings through command line arguments. If the number of integers entered is less than or greater than three, the program exits after displaying the message **"Wrong number of inputs!"**.

c. Interchange values of two integer variables using pointers.

d. An anonymous object of a derived class **Derv** is to be pointed to by a reference of its base class **Base**.

e. Write the prototype of a friend function **funObjs(...)** having references to two objects of a class **MyClassOne** as parameters and an object of a class **MyClassTwo** as return type.

Q5.   Define an abstract class **Human** comprising sthe following members- **name** and **age** (with appropriate data types), a parameterized constructor and a pure virtual function **printDetails()**.

The program also defines two concrete classes- **Adult** and **Child** inheriting publicly from the class **Human**.

Class **Adult** has a data member- **voterID** (with appropriate data type).

Class **Child** has a data member- **schoolName** (with appropriate data type).

Define parameterized constructors for both the classes **Adult** and **Child**. The constructors should also have following validation check for the age input.

- The age of an adult should be more than or equal to 18 years.

- The age of a child should be in the range 0 to 18 (excluding both numbers).

Override **printDetails()** function for both the derived classes.

Define **main()** function to declare one object each for classes **Adult** and **Child** respectively and print the details of the objects.

Q6. Write a C++ program that prompts a user for three integers- the first denoting a month (1 to 12), the second denoting a day (1 to 31) and the third denoting a year. The output is displayed as **"month day, year"** string where month represents the name of the month.

For example, if inputs are **12**, **15** and **2020** respectively, the output is **December 15, 2020**.

A parameterized function **convertDate(...)** is defined to accept above three integers as arguments and return the appropriate string.

If the user enters any number other than a valid month number (integers from 1 to 12) as a first input, then the program throws an error (exception) of the type string. Write an exception handler that handles the exception by displaying a message **"Not a valid month"** and exits.

If the user enters any number other than a valid day number (integers from 1 to either 28, 30, or 31, depending on the month) as second input, then the program throws an error (exception) of the type integer. Write an exception handler that handles the exception by displaying a message **"Not a valid day"** and exits.

If the user enters month value 2, day value 29 and a non-leap year as third input, then the program throws an error (exception) of the type double. Write an exception handler that handles the exception by displaying a message "**Not a leap year"** and exits.