Computer Science I Final Exam
November 2015
Indian Statistical Institute

Tip: Please answer all questions and illustrate clearly the various steps in deducing the answers. Marks will be given for intermediate steps even though your final answer to a question may be incorrect.
Use drawings of trees and stacks wherever necessary.

Good luck!!

Total Marks: 100

Part I - Total 20 marks

1. Consider the following code: - **4 marks**

    ```
    #include <stdio.h>
    union test
    {
        unsigned int x;
        char c[2];
    };
    int main()
    {
        union test t;
        t.x = 5;
        t.c[0] = 4;
        t.c[1] = 1;
        printf("t.x = %d, t.c[0] = %d, t.c[1] = %d\n size of t = %d", t.x, t.c[0], t.c[1], sizeof(t));
        return 0;
    }
    ```
Give the output of the above program.

2. A positive integer is called an Armstrong number if the sum of cubes of the individual digits is equal to that number itself. **5 marks**

    For example:
    1. 153 = 1*1*1 + 5*5*5 + 3*3*3 // 153 is an Armstrong number.
    2. 12 is not equal to 1*1*1+2*2*2 // 12 is not an Armstrong number.

    Write the necessary control structure to determine whether a number is an Armstrong number. You may use the C library function defined in math.h,
        double fmod(double x, double y)
    that returns the remainder of x / y in your implementation

3. The array 90, 60, 50, 40, 13, 45, 23, 16, 9, 3. A new value 70 is inserted into this heap. After insertion, choose the correct new heap from the choices below. Show the heaps before and after insertions and the final heap. 6 **marks**

1. 90, 60, 50, 40, 13, 45, 23, 70, 16, 9, 3
2. 90, 70, 50, 40, 60, 45, 23, 16, 9, 3, 13
3. 90, 60, 70, 50, 40, 13, 45, 23, 16, 9, 3
4. 90, 70, 60, 50, 45, 40, 23, 16, 9, 13, 3

4. Consider the expression a + (b * c) - d ^ (f * g) + h. Deduce the postfix expression showing the stack trace. The associativity of operators +, -, × is left-to-right and that of operator ^ is from right-to-left. The precedence of operators (from highest to lowest) is ^, * , +, -. **5 marks**

Part II - Total 20 marks

5. Answer True or False - **0.5 marks each - 5 marks**
   1. The Stack data structure maintains a FIFO order
   2. The Queue data structure maintains a LILO order
   3. A Binary Tree is a Heap
   4. The number -3 in binary form is written as 1000 0011 in a single byte
   5. To free allocated memory to a char *p the function malloc(p) is used
   6. EOF is the symbol used to denote a NULL pointer
   7. In a MAX Heap, the key value of the child is always greater than that of the parent.
   8. int (* fptr) (int, int) is a pointer to a function
   9. Two matrices can be added only if the number of columns of the first is equal to the number of rows of the second.
   10. Consider, unsigned int X; X = -10 will store the correct value.

6. Consider the following program - **10 marks**

```
#include <stdio.h>

int x=0,y=0,z=0;

void f(int z) {
  x=100; y=100; z=100;
}

void g() {
  printf("\ng. x=%d, y=%d, z=%d",x,y,z);
}

void h() {
  int x=1000,y=1000,z=1000;
    extern x,y,z;
    printf("\nx. x=%d, y=%d, z=%d",x,y,z);
}
```

Give the output of the above program.

```
int s(int i) {
  static int c=0;
  c=c+i;
  return c;
}

main()
{
  int y, i;
  g();
  x=1; y=1; z=1;
  printf("\n1. x=%d, y=%d, z=%d",x,y,z);
  f(10);
  printf("\n2. x=%d, y=%d, z=%d",x,y,z);
  g();
  h();
  printf("\n");
  for(i=0;i<5;i++)
    printf("%d,%d\n",i,s(i));
}
```

7. Consider the declaration below   - **5 marks**

> **int *iptr = 20;**
> **const char *cptr = "I am a string";**

Against each, state which are valid and invalid statements

        (a) char c = *iptr;   _____
        (b) iptr++;   _____
        (c) *iptr = 100;   _____
        (d) cptr[1] = 'b';   _____
        (e) cptr++;   _____

Part III - Total 20 marks
Answer any one of the following:
8. Write a program that outputs the Two's complement representation of the sum of +10 and -75. - **10 marks**

9. Write a function called average which takes a variable number of integer arguments and computes the average of the numbers. Write a driver function to test this function. - **10 marks**

Answer any one of the following:
10. Write a program that reads from two files and merges the contents into a third file. **10 marks.**

    a.The program should first read from the first file and write to the third,
    b. Then read from the second and append to the third file.
    c. Use command line arguments to read file names
    d. Print the merged file

11. Given an array of integers, 32, 95, 41, 0, 100, 8, 63, 7, 54, 99. Do the following: - **10 marks**
    a.   Write a function that implements either bubble sort or Selection sort algorithm.
    b.   Call this function from your main program to sort the above array in ascending or descending order.
    c.   Print the resulting array.

PART IV - Total 40 marks
12. Implement a stack using arrays or linked list - **10+5+5 = 20**
    a.   Write the struct declaration using typedef to host a stack and all necessary stack functions.
    b.   Use the same stack to test if it can reverse a string.
    c.   Now test if the string is a palindrome.

13. Do the following: **10+5+5 = 20 marks**
    a. Implement a binary tree using doubly linked lists
    b. Write a function to print a binary tree in postfix order
    c. Write a function to search the tree in depth-first-search method