Computer Science I Final Exam
November 2016
Indian Statistical Institute

Good Luck!!

Part I - Answer 10 of the following - 2 marks each

1. In what order does one add and delete from a Stack?

2. Calling a function by using the address of a variable is called …….

3. Big O notation is used to express the …… complexity of an algorithm

4. To open a file in both read & write mode without losing existing file content, use …….

5. The first argument, generally referred to as argc, in main(int argc, char *argv[]) gives the …….. on the command line

6. A 3x3 matrix can be implemented in C using …… arrays.

7. To retain the value of a variable in a recursive function across all calls, declare it as …….

8. The maximum key value is stored in the …….. of a MAX Heap

9. Consider the code

```
x = 5; y = 4;
int *ptr = &x;
(*ptr)++ * y;
printf("%d", x);
```

   Output is …….

10. The format specifier for printing a long double is …….

11. Consider the statement,

const char *cptr = "I am a string";

***(**cptr+=5) will give …… character.

12. The declaration

```
Struct date {
```

```
        unsigned int day: 2;
        unsigned int month: 10;
        unsigned int year;
    };
```

is an example of using ……. in a C program.

Part II Answer any 5 of the following - 2 marks each

True or False ?

1. int i, i << 1 multiplies i by 2
2. Insertion Sort splits an array successively and sorts the elements before merging them back.
3. Every node in a Binary Tree has a maximum of 3 children.
4. A circular queue has fixed Front and Rear pointers
5. Breath First Search algorithm searches all nodes on the current level before accessing nodes at the next level
6. The following nested loop has a Big O = $O(N^2)$

```
for(int i = 0; i < N; i ++)
{
    for(int j = i + 1; j < N; j++)
    {
        printf("%d %d \n", i, j);
    }

}
```

7. Two matrices can be added only if the number of columns of the first is equal to the number of rows of the second.

Part III - Answer any 12 of the following - 5 marks each

1. Write a Struct to encapsulate a node in a doubly linked list. Each node holds an integer data value and pointer to the next and previous nodes. Typedef the struct.
2. Write a Union to hold an integer, a character and a floating point value. What is the sizeof() of the Union, assuming int is 8 bytes.
3. Write a function that receives two integers by reference and swaps the integer values. The function returns void.
4. Show the Two's complement addition of -64 and 12.
5. Write a function that takes two integer values p and c that represent values of a parent and child in a heap respectively. Write a function that returns 0 if this is a MAX heap and 1 if its a MIN heap.
6. What is the output of the following program?

```
#include <stdio.h>
int main()
{
        int a = 10;
```

```
        float b = 55.0;
        float *p = &b;
        int *q = &a;
        printf("%f %f", *p / *q, *p * *q);
        a = 2.5;
        printf("%f %f", *p / *q, *p * *q);
        return 0;
}
```

7. I have 5 numbers 8, 3, 12, 9, 0, 5, 2, 7 on which I perform the following
   1. push(), push(), pop(), push(), push(), pop(), push(), push(), pop(), push()
   2. what remains on the stack?

8. Calloc is a function in stdlib.h that allocates n blocks of contiguous memory, X bytes per block. It returns a pointer to the beginning of the allocated block of memory. Write your own version of calloc() using malloc(). Call it mycalloc which has a signature:
   void * mycalloc(unsigned n, unsigned X);

9. Convert the following while loop into a recursive function

```
int i = 1, f  = 1;
while (i < 10)
{
      f = f * i++;
}
```

10. Consider the following recursive function fun(x, y). What is the value of myfun(3, 4)

```
int myfun(int x, int y)
{
  if (x == 0)
    return y;
  return myfun(x - 1,  x + y);
}
```

11. What does the program below print?

```
#include<stdio.h>
void output(int x)   {
    if (x > 4000)
        return;
    printf("%d \n", x);
    output(2*x);
    printf("%d \n", x);
}

int main()
{
    output(1000);
    return 0;
}
```

12. Consider the following program:

```
#include <stdio.h>
int x = 100;
void testscope()  {
        int i = 7;
        printf("function scope %d \nglobal scope %d \n", i, x);
}
int main(void) {
        // your code goes here
        int i = 100, x = 5;
        printf("main scope %d \nglobal scope %d \n", i, x);
        testscope();
        if (i) {
                int i = 30;
                printf("block scope %d \nglobal scope %d \n", i, x);
        }
        return 0;
}
```

Provide the output of the above program

13. Write an *if-else* block to test for bitwise AND of two numbers X and Y

14. Write a function that uses a Stack data structure S to reverse a string str. Assume that *void push(Stack S, char c), char pop(Stack S)* and *char peek(Stack S)* are already implemented.

Part IV - Answer any two of the following - 10 marks each

15. 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 order.

16. Consider the expression 7 * (1 + 3) - 4 * 2 ^ 2 ^ 3 - 5 + 15 / 3.
    1. 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 ^, * , +, -.
    2. Evaluate the resulting postfix expression

17. The array 100, 94, 87, 75, 70, 65, 43, 36, 12, 9, 3. A new value 90 is inserted into this heap. Show the heap before the insertion, the intermediate heap and the final heap after the sort.