CS 1713
Introduction to Computer Programming II
Final

<table>
<thead>
<tr>
<th>Question</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td></td>
</tr>
<tr>
<td>Question 2</td>
<td></td>
</tr>
<tr>
<td>Question 3</td>
<td></td>
</tr>
<tr>
<td>Question 4</td>
<td></td>
</tr>
<tr>
<td>Question 5</td>
<td></td>
</tr>
<tr>
<td>Question 6</td>
<td></td>
</tr>
<tr>
<td>Question 7</td>
<td></td>
</tr>
<tr>
<td>Question 8</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

NAME: __________________________

**Instructions**
1. Do **All** of the 8 problems
3. You have 120 minutes for the exam
4. Show all your work
5. Do not separate exam papers

<table>
<thead>
<tr>
<th>Easy</th>
<th>Difficulty Level</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>1</td>
<td>2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>
1. (20 pts) What is the output of the following program? Show what is printed when `printlist()` functions are called. Show all your work.

```c
#include <stdio.h>
#include <stdlib.h>

struct node
{
    int info;
    struct node *next;
};

typedef struct node node;

void mystery (node *head)
{
    if (head == NULL)
        return;
    while (head->next != NULL)
        head = head->next;
    printf(“%d
”,head->info);
}

int main()
{
    node *head,*ptr,*ptr2;

    head = (node*)malloc(sizeof(node));
    head->next = (node*)malloc(sizeof(node));
    head->info = 12;
    head->next->info = 9;
    head->next->next = NULL;
    mystery(head);
    ptr = head->next;
    head->next = NULL;
    mystery(head);

    ptr2 = (node*)malloc(sizeof(node));
    ptr2 -> next = NULL;
    ptr2->info = 17;
    head -> next = ptr2;
    mystery(ptr2);
    ptr->info = 5;
    ptr2->next = ptr;
    mystery(head);
}
```
2. (20 pts) Write a function to find a valley element in an array. A valley element is an element that is less than its neighbors. Given an input array where \( num[i] \neq num[i + 1] \), find a valley element and return its index. The array may contain multiple valleys, in that case return the index to any one of the valleys. You may assume that \( num[-1] = +\infty \) and \( num[n] = +\infty \). So, \( num[0] \) and \( num[n - 1] \) could be peaks as well. For example, in array \([2, 1, 0, 1]\), 0 is a valley element and your function should return the index number 2.

In below function prototype, \( n \) is the size of the array

```c
int valley(int num[], int n)
{
```
3. (20 pts) Consider the following declaration of array of pointers

```c
int *data1[8];
int *data2[12];
```

Write a program fragment (for and if statements) to find out if there are two pointers in array `data1` and `data2` that point to the same location. If such pointers exist write the indexes of the arrays that point to the same location. Sample output is given below.

data1[3] and data2[5] point to the same location
4. (20 pts) What is the output of the following program. Show all your work.

```c
#include <stdio.h>

struct triangle
{
    float width;
    float height;
};

typedef struct triangle triangle;

int main()
{
    triangle t1={3,4};
    triangle t2={1,2};
    triangle t3={4,6};
    triangle *tptr1=&t2;
    triangle *tptr2=&t1;

    printf("1 %f %f\n",t2.width, t2.height);
    printf("2 %f %f\n",tptr2->width, tptr2->height);

    tptr1 = &t3;
    printf("3 %f %f\n",(*tptr1).width, (*tptr1).height);

tptr2->width = 5;
    tptr1 = tptr2;

    printf("4 %f %f\n",tptr1->width, tptr1->height);

    t1 = t2;
    printf("5 %f %f\n",t1.width, t1.height);
}
```
5. (20 pts) Write a function to compute and return the count of most frequent character in a substring from positions i. If all the characters are different the function returns 1.

    highcount("apple",0,2) returns 2
    highcount("apple",0,1) returns 1

Prototype of the function is given below.

```c
int highcount(char *str, int i, int j) {
    
```
6. (20 pts) Span of a linked list is the difference between the largest and smallest elements in the linked list. Write a function `span()` to compute the span of a linked list. Node declaration of the linked list is given below.

```c
struct node
{
    int info;
    struct node *next;
};
typedef struct node node;
```

Span of the following list is 12-5=7.

```
int span(node *ptr)
{

```
7. (20 pts) What is the output of the following program? Show all your work.

```c
#include <stdio.h>

int function1(int a, int b)
{
    if (a % b == 2)
        return a;
    else
        return (function1(a+b,a-b));
}

int main()
{
    int x,y;

    x = 7; y = 2;
    printf("Out1 = %d\n",function1(7,2));

    x = 8; y = 3;
    printf("Out1 = %d\n",function1(8,3));

    x = 11; y = 5;
    printf("Out1 = %d\n",function1(11,5));

}
```
8. (20 pts) Write a function to find the lowest common ancestor in a binary search tree and return a pointer. Lowest common ancestor between two nodes $a$ and $b$ in tree $T$ is defined as the lowest node in $T$ that has both $a$ and $b$ as descendants. Node structure is given below.

```c
struct node {
    int key;
    struct node *left, *right;
};
typedef struct node node;
```

Consider the following tree as an example. lowest common ancestor of 4 and 8 is 6. lowest common ancestor of 4 and 14 is 10.

```
        10
       / \
      6   14
     /   / \
    4   8   12  16
```

```c
node *lca(node *ptr, int a, int b) {
}
```