The King Hussein School for Computing Sciences
Department of Computer Science

Structured Programming - Spring 2023

Second Exam

Full Name: **Student ID:**

Question	Points	Score
1	PART 1.A: 4	
	PART 1.B: 4	
	PART 2: 3	
2	PART 1: 4	
	PART 2: 4	
3	6	
Total	25	

Circle your section:

○ Dr. Ammar Alrashdan	(section 1)
○ Dr. Osama Alhaj Hasan	(section 2)
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○ Mr. Alaa Altarazi	(section 13)
○ Mr. Alaa Altarazi	(section 14)

Monday 15/5/2023

Question 1 (11 points)

PART 1. Implement each of the following functions (assume that N is a globally defined constant).

A. [4 points] Function **identity**(...) receives a 2D array of integers of size NxN and returns 1 if the main diagonal is all 1s and all the other elements are zeroes (and returns 0 otherwise).

Examples.

```
1     1 0     1 0 0     1 0 0 0
      0 1     0 1 0     0 1 0 0
              0 0 1     0 0 1 0
                        0 0 0 1
```

These are all identity matrices

B. [4 points] Function **shift**(...) receives a 2D array of size NxN and shifts all the rows one position down. The first row becomes all zeroes and the last row is lost.

Example.

```
1 1 1 1              0 0 0 0
2 2 2 2   becomes    1 1 1 1
3 3 3 3              2 2 2 2
```

PART 2. Answer the question below assuming that a, b and c are 2D arrays of size NxN.

```
for (int i = 0; i < N; i++) {
     for (int j = 0; j < N; j++) {
          int sum = 0;
          for (int k = 0; k < N; k++) {
               sum += a[i][k] * b[k][j];
          }
          c[i][j] = sum;
     }
}
```

A. [1 points] What will be stored at c[0][0] after the code finishes execution if a[][] and b[][] are shown on the right?

1	2
1	2

a

1	1
2	2

b

B. [2 points] What will be stored at c[2][1] after the code finishes execution if a[][] and b[][] are shown on the right?

5	7	1	1
3	2	0	0
2	3	4	2
4	9	1	1

a

0	1	6	1
0	2	6	1
5	3	8	9
1	2	8	4

b

Question 2 (8 points)

PART 1. [4 points] Convert the iterative function shown below to a recursive function and then show how your recursive function can be called. You are allowed to add or remove parameters.

```
int f1(int n, int a[]) {
  int sum = 0;
  int flag = 1;
  for (int i = n-1; i >= 0; i--) {
      if (flag == 1)
          sum += a[i];
      flag *= -1;
  }
  return sum;
}
```

Show how your function can be called on an array named a of size n.

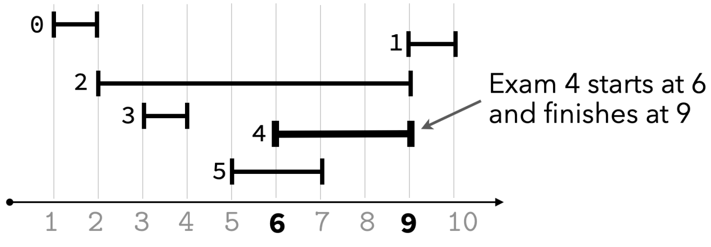
PART 2. [4 points] What is the output of the following program?

```
int trace1(int n1, int n2) {
    if (n1 < n2) return 0;
    return 1 + trace1(n1 - n2, n2);
}

int trace2(int n) {
    if (n <= 0) return 0;
    return n + trace2(n - 1)
             + trace2(n - 1);
}

int main() {
    printf("%d\n", trace1(4, 1));
    printf("%d\n", trace1(55000, 5));
    printf("%d\n", trace2(2));
    printf("%d\n", trace2(4));
    return 0;
}
```

Question 3 (6 points)

Implement function `int min_overlap(int start[], int finish[], int n)`, which returns the index of the exam with the minimum number of overlaps with other exams. Each exam is represented using an entry in the arrays `start[]` and `finish[]`, where `start[i]` is the start time of exam `i` and `finish[i]` is the finish time of exam `i`.

In the example below, the exams with the minimum number of overlaps are exams **0** and **1** (0 overlaps). You can return **0** or return **1**, because both exams have the minimum number of overlaps.



Exam 4 starts at 6 and finishes at 9

Exam **0**:	No overlaps
Exam **1**:	No overlaps
Exam **2**:	Overlaps with exams 3, 4 and 5
Exam **3**:	Overlaps with exam 2
Exam **4**:	Overlaps with exams 2 and 5
Exam **5**:	Overlaps with exams 2 and 4

start[]=	1	9	2	3	**6**	5
finish[]=	2	10	9	4	**9**	7
	0	1	2	3	**4**	5

Provide your answer in the following page.