THE UNIVERSITY OF THE
SOUTH PACIFIC

CS214: Design & Analysis of Algorithms
STEMP

Final Examination
Semester II, 2022

F2F/Blended Mode

Duration of Exam: 3 hours + 10 minutes

Reading Time: 10 minutes

Writing Time: 3 hours

Total Marks: 40

The exam covers the following learning outcomes:
CLO – 1: Evaluate the efficiency of algorithms (32.5%)
CLO – 2: Assess the suitability of different algorithms/data structures for solving a given problem (17.5%)
CLO – 3: Solve computationally difficult real world problems using appropriate algorithmic techniques (50%)

Instructions:

1. Write your answers in the space provided in this Question Paper.
2. Answer all questions. There are 9 questions and all questions are compulsory.
3. This exam is worth 40% of your overall mark. The minimum mark to pass the final exam is 16/40.
4. The total number of pages including this cover sheet is 13.
5. This is a closed book exam. No printed materials and electronic devices are allowed.

ID:____________________________ **Name:**____________________________

SeatNo: ________________________ **Campus:** ____________________________

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1. Why is it important to be very selective when it comes to chosing the data structures for your algorithm? Support your argument by giving some example(s). Is there any one-size-fits-all kind of data structure? [8 mins] (2+1+1 = 4 marks)

2. Determine the time complexity of the following code. Show your working. (3+3 marks)

   a) Find the worst case time complexity [12 mins]:

```
final int P = 100;
final int Q = 50;

for (int i = 0; i < P; i++) {
    for (int j = 0; j < Math.min(i,Q); j++) {
        System.out.println(j);
    }
}
```

b) Determine the best time complexity [10 mins]:

```
int a = 0;
for (i = 0; i < N; i++) {
    for (j = 0; j < 10; j++) {
        a = a + i + j;
    }
}
```

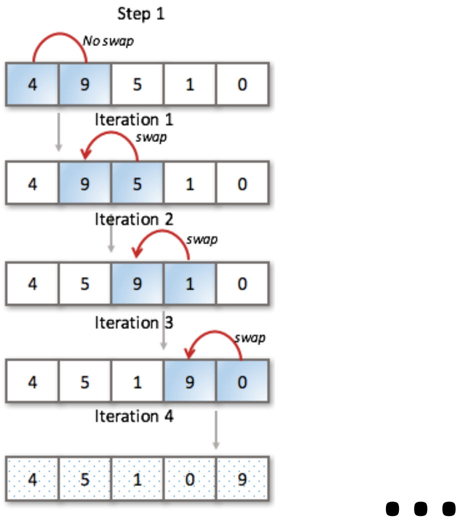
3. How would you determine the big O order of a given algorithm empirically? [5 mins]
(3 marks)

4. A variation of the *bubble sort* algorithm and an example illustrating what it does are shown below. Using this algorithm answer the following questions:

```
static void bubbleSortSimple (int S[]){

    int n = S.length;
    int temp;

    for (int j = 1; j < n; j++) {
        for ( int i=0; i < n-1; i++ ) {
            if (S[i+1] < S[i]) {
                temp = S[ i ];
                S [ i ] = S [ i+1 ];
                S [ i+1 ] = temp;
            }
        }
    }
}
```



a. Evaluate the Big O order of the best and worst time complexity for this algorithm? Show all working. [6 mins] (3 marks)

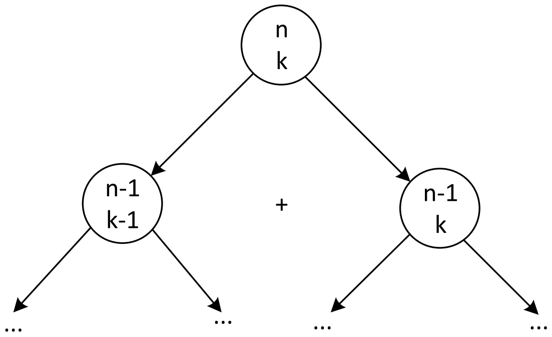
b. Under what condition(s) you will attain the best and worst time complexities? [6 mins] (3 marks)

(answer both questions 5.1 and 5.2 here)

5. Determine is the best case time complexity for the calculation of Binomial Coefficient using divide & conquer approach? Are you satisfied with the time complexity of your solution? If not, then how would you improve it further? Justify. [15 mins] (4 marks)

```
int bin (int n, int k){
    if (k == 0 || n==k)
        return 1;
    else
        return bin(n-1, k-1) + bin(n-1, k);
}
```

Hint: It has only every-case time complexity.



6. What kind of algorithmic design paradigm you will choose for the following large problems that can be practically implemented. Please justify your answer: [5 mins]

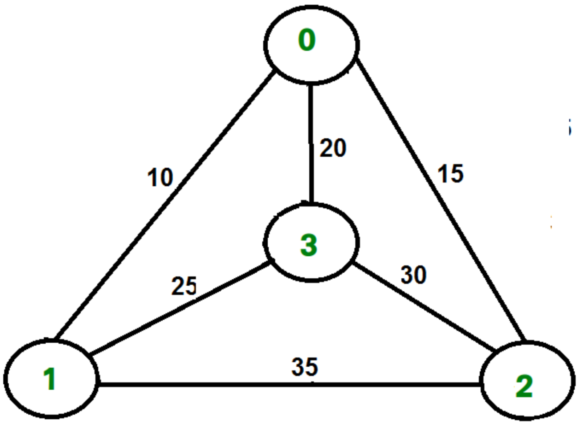
Traveling salesman problem

The traveling salesman problem (TSP) is a problem in graph theory requiring the most efficient (i.e., least total distance) path a salesman can take through each of the cities. TSP in an NP-hard problem.

NQueen Problem

The n-queens problem is about finding how many different ways queens can be placed on a chessboard so that none attack each other. The n-Queen problem becomes intractable for large 'n' values and is thus placed in NP (Non-Deterministic Polynomial) class problem.? (3 marks)

7. Using the Best-First Search with Branch-and-Bound Pruning Algorithm for the Traveling Salesperson problem to find an optimal tour and the length of the optimal tour for the graph below. [15 mins] [4 marks]



8. Draw the Huffman tree corresponding to the encoding table below. Additionally, find the possible values of I from 1-25. [15 mins]. (4 marks)

Character	Frequency	Code
B	2	01111
F	1	01110
H	3	0110
I	?	00
L	5	010
M	15	10
S	15	11

9. Consider the 0-1 knapsack problem with four different item having different weight and profit value;

   item 1 (2kg, $3)
   item 2 (1kg, $5)
   item 3 (3kg, $5)
   item 4 (8kg, $9)
   item 5 (2kg, $3)

   The knapsack has a capacity of 8 kg.

   Do the following by showing your **complete working**: [30 mins]

   a. Apply greedy approach to compute the optimal profit in filling the knapsack (2 marks)

b. Apply a dynamic programming approach to solve the same problem. (2 marks)

c. Apply the backtracking approach for the above knapsack problem. Show the State Space tree. (2 marks)

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EXTRA SHEET

END