(KNOWLEDGE FOR DEVELOPMENT)

KIBABII UNIVERSITY

(KIBU)

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS

YEAR THREE SEMESTER ONE

FOR THE DEGREE IN

(COMPUTER SCIENCE)

COURSE CODE: CSC 312

COURSE TITLE: DESIGN AND ANALYSIS OF ALGORITHMS

DATE: 13/07/2021 **TIME:** 9.00 A.M – 11.00 A.M

INSTRUCTIONS

ANSWER QUESTIONS ONE AND ANY OTHER TWO.

QUESTION ONE [COMPULSORY] [20 MARKS]

a. Define the term algorithm and state the criteria that every algorithm must satisfy. **[4 marks]**

b. Explain the three basic design goals that one should strive when design for a program and how the complexity of a program can be measured. **[4 marks]**

c. Using an array of 100 elements, define best case, worst case and average case time complexities. **[4 marks]**

d. Explain any two factors that the running time of a program depends on factors. **[4 marks]**

e. What is the smallest value of n such that an algorithm who's running times is $100n^2$ runs faster than an algorithm whose running time is 2n on the same machine? **[3 marks]**

f. Explain the characteristic properties associated with a problem that can be solved using dynamic programming. **[3 marks]**

g. Briefly explain the concept of P, NP-hard and NP- complete problems. **[3 marks]**

QUESTION TWO [20 MARKS]

a. What are the general rules followed when analyzing running time of programs. **[3 marks]**

b. Explain the concept of control abstraction in Dynamic Programming. **[2 marks]**

c. Explain the differences between Prim's and Kruskal's algorithm. Link this to efficiency analysis. **[2 marks]**

d. Define Asymptotic Notations? Explain their significance in analyzing algorithms? **[4 Marks]**

e. Explain N-queens problem using Backtracking and draw the state space tree of 4-queens problem **[6 Marks]**

f. Describe the travelling salesman problem and discuss how to solve it using dynamic programming? **[3 marks]**

QUESTION THREE [20 MARKS]

a. Algorithm analysis is the study of an algorithm's efficiency with respect to resource utilization, discuss these resources **[4 marks]**

b. Differentiate between greedy algorithm and dynamic programing and state the nature of problems that can be solved using each approach. **[4 marks]**

c. State fractional knapsack problem and give an algorithm for fractional knapsack problem using greedy strategy. **[4 marks]**

d. Find an optimal solution to the fractional knapsack problem for an instance with number of items 7, Capacity of the sack W=15, profit associated with the items (p1,p2,…,p7)= (10,5,15,7,6,18,3) and weight associated with each item (w1,w2,…,w7)= (2,3,5,7,1,4,1). **[6 marks]**

e. Solve multiplication using Divide and Conquer strategy 12345678 * 21394276 **[4 marks]**

QUESTION FOUR [20 MARKS]

a. Determine the best case and worst-case time complexities of the following two functions **fun1()** and **fun2()**: **[4 marks]**

```
int fun1(int n)
{
if (n <= 1) return n;
return 2*fun1(n-1);
}
int fun2(int n)
{
if (n <= 1) return n;
return fun2(n-1) + fun2(n-1);
}
```

b. Explain Euclid's algorithm for computing gcd(m, *n), hence compute the gcd and the lcm of* (31415 and 14142) **[4 marks]**

c. If the first program P1 takes $100n^2$ milliseconds and the second program P2 takes $5n^3$ milliseconds. Determine and recommend which program P1 or P2 is better and at what condition? **[4 marks]**

d. One of the two software packages, **A** or **B**, should be chosen to process data collections, containing each up to 109 records. Average processing time of the package **A** is $T_A(n) = 0.001n$ milliseconds and the average processing time of the package **B** is $T_B(n) = 500\sqrt{n}$ milliseconds. Which algorithm has better performance in a "Big-Oh" sense? Work out exact conditions when these packages outperform each other. **[4 marks]**

e. Let processing time of an algorithm of Big-Oh complexity O(f(n)) be directly proportional to f(n). Let three such algorithms A, B, and C have time complexity $O(n^2)$, $O(n^{1.5})$, and O(n log n), respectively. During a test, each algorithm spends 10 seconds to process 100 data items. Derive the time each algorithm should spend to process 10,000 items. **[4 marks]**

QUESTION FIVE [20 MARKS]

a. The aim of designing algorithms is to find an algorithm whose upper bound matches the lower bound of the problem. Write down the procedure used to design an algorithm. **[4 marks]**

b. Suppose we use Dijkstra's greedy, single source shortest path algorithm on an undirected graph. What constraint must we have for the algorithm to work and why? **[4 marks]**

c. Consider the following recursive algorithm for computing the sum of the first n cubes.

```
S(n)=1^3+2^3+3^3+. . . +n^3
Algorithm S(n)
    If (n=1) return 1
      Else return (S (n-)+ n*n*n))
end algorithm
```

Set up and solve a recurrence relation for the number of times the basic operation of the algorithm is executed. **[6 marks]**

d. Discuss the following briefly:

i. Parallel algorithms **[3 marks]**

ii. Complexity Theory **[3 marks]**