SVKM'S NMIMS

MUKESH PATEL SCHOOL OF TECHNOLOGY MANAGEMENT& ENGINEERING/

SCHOOL OF TECHNOLOGY MANAGEMENT

Academic Year: 2023-2024

Program/s: BTech/ MBA Tech/ BTech-Integrated Year: II/IV Semester: IV/VIII

Stream/s: ____CS/Computer

Subject: Design and Analysis of Algorithms Time: 3 hrs (10 am to 1 pm)

Date: 24/Apr/ 2024 No. of Pages: 04

Marks: __100_______

Final Examination/Re-Examination (2022-23)

Instructions: Candidates should read carefully the instructions printed on the question paper and on the cover of the Answer Book, which is provided for their use.

1) Question No. _1___ is compulsory.
2) Out of remaining questions, attempt any __4___ questions.
3) **In all ___5_ questions to be attempted.**
4) All questions carry equal marks.
5) **Answer to each new question to be started on a fresh page.**
6) **Figures in brackets on the right hand side indicate full marks.**
7) **Assume Suitable data if necessary.**

Q1		Answer briefly:	[20]
CO- 1; SO-2; BL-1	a.	Define the term Algorithms? "The choice of algorithmic design paradigm is an important aspect of algorithm synthesis". Justify the statement by giving suitable examples.	[5]
CO-2; SO-2; BL-3	b.	Illustrate the control abstraction for Divide and Conquer algorithm. Also specify the generic complexity representation for divide and conquer based recursions.	[5]
CO- 2; SO-2; BL-2	c.	State the difference between optimal solution and feasible solution. Explain giving a specific example when Greedy paradigm does not produce an optimal solution, rather gives an approximate (near optimal) solution in reasonable time.	[5]
CO- 3; SO-1; BL-3	d.	Interpret the control abstraction of the Dynamic Programming approach.	[5]
Q2	a. CO-2; SO-1; BL-4	Differentiate between Divide and Conquer Technique and Greedy Algorithmic Paradigm on the following parameters (i) Basic Approach (ii) Optimality (iv) Problem Decomposition (iii)Typical Problems (v) Memory usage.	[5]

	b.
	CO- 1,4; SO-1; BL-3
		Compute time complexity and space complexity for following function.
		Multiply (A,B,n)
		{
		for(i=0;i<n;i++)
		{
		for(j=0;j<n;j++)
		{
		C[i,j] = 0;
		for(k=0; k<n; k++)
		{
		C[i,j] = C[i,j] + A[i,k] * B[k,j]; }}
		}
		}
			[5]

c.

CO-1;
SO-1;
BL-1,3

With reference to Asymptotic Notations

i) Define Big-Oh, Theta and Omega Asymptotic notations.

ii) Sketch the Worst-case time complexity relation between Linear, Logarithmic, Exponential, Log Linear, Constant, Polynomial and Factorial function.

iii) Prove that $10n^2 + 4n + 2 = O(n^2)$

[10]

Q-3

a.

CO-1;
SO-1;
BL-3

State the Master's Theorem for Decreasing functions. Also Solve the following recurrence relation using Master's theorem-

$T(n) = 2T(n/4) + n^{0.51}$

[5]

b.

CO-3;
SO-1;
BL-6

Consider the instance of a sum of subset problem where X= {3,5,6,7} and Y= {15}. Generate state space tree to find the possible subset of X that sum to Y using Backtracking.

[5]

c

CO-2;
SO-1;
BL-
1,3

With reference to Divide and Conquer algorithmic paradigm

i) Use algorithmic explanation to show how Divide and Conquer technique can be used to sort an array of numbers using Merge Sort.

ii) Derive the recurrence relation for Merge Sort using the algorithm

Solve the recurrence relation using Master's Theorem to derive the worst time complexity of Merge Sort.

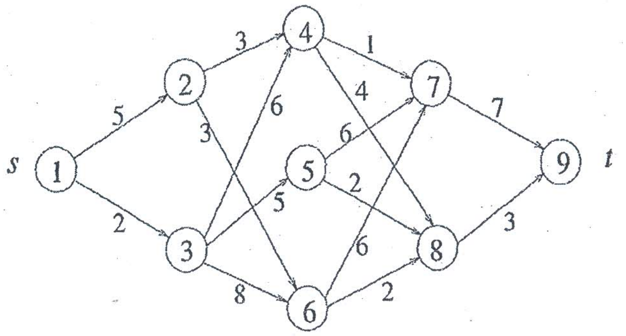
[10]

Q-4

a.

CO-3;
SO-1;
BL-
1,3

i) Solve for a minimum cost path from 's' to 't' in the multistage graph of the Figure given below. Adopt a forward approach.



ii) State the Recurrence relation for solving the Multistage Graph problem by Forward Approach.

[10]

b.

CO-2;
SO-2;
BL-3,5

Assume that the numbers given below represent counts of letters in hundreds from a file. For example, in the file there will be exactly 20 * 100 occurrences of the letter 'a', 11*100 occurrence of the letter 'c', etc. accordingly the frequencies list is as follows:

Letter	a	c	d	e	o	m	s	t	u
frequency	20	11	2	10	15	8	10	22	2

[10]

Based on the given data perform the below mentioned task.

a) Solve for optimal Huffman code based on the following set of frequencies.

1) Draw the tree.
2) Fill in the table with the Huffman encoding for each letter.
3) Encode the file using the Huffman codes produced above
4) Calculate the total length of encoded bits using Huffman coding.

Letter	Encoding	
	Huffman	Fixed length
a		
c		
d		
e		
o		
m		
s		
t		
u		

b) Solve for Fixed Length Encoding.

1) Fill in the table the fixed-length encoding for each letter.
2 Calculate the total length of encoded bits using fixed-length coding.

Justify which of the encoding scheme is best and why?

Q5

a.

CO-1,4; SO-1; BL-1,3

i) State the conditions which make a decision problem belong to

a. Class P
b. Class NP
c. Class NP -Hard
d. NP Complete.

Depict the relationship between these classes using a Venn diagram.

ii) What do you mean by Time Complexity and Space Complexity? Solve for the time complexity of the following code:

```
var a = 0, b = 0, i, j, k, N;
for (i = 0; i < N; i++) {
  for (j = 0; j < N; j++) {
      a = a + j;
  }
}
for (k = 0; k < N; k++) {
  b = b + k;
}
```

[10]

b.

CO-3; SO-2; BL-1,3

i) State the problem statement of Matrix chaining multiplication Problem. Also write the recurrence relation to solve Matrix chaining multiplication Problem using Dynamic programming.

Consider the following 4 matrices

A : 4 x 4

B : 4 x 5

[10]

C : 5 x 2
D : 2 x 4

Using Dynamic Programming approach to solve Matrix chaining Multiplication problem

i) compute the values for x, y and z in the table below. Show all the computations involved.

ii) Derive the correct order of Matrix Multiplication to reduce the computational complexity.

	1	2	3	4
1	0	x	y	z
2		0	40	72
3			0	40
4				0

Q6

a.

CO-2;
SO-2;
BL-3,5

i) Discuss the algorithm of Fractional Knapsack problem using Greedy Approach.
ii) Find and justify the worst-case time complexity of the greedy fractional knapsack.
iii) Apply the algorithm to solve the following scenario:
Ramesh wants to buy vegetables from the market, and he can carry a maximum weight of 28 kg in his bag. What vegetables should he take if he can even take fractions of any item?
Given Profit P = {9, 5, 2, 7, 6, 16, 3} and Weight W = {2, 5, 6, 11, 1, 9, 1}

[10]

b.

CO-3;
SO-2;
BL-1,6

With reference to n-Queen problem, answer the following questions

i) State the problem statement of n-queen's problem.

ii) Explain the Backtracking paradigm of problem solving, in general.

iii) Generate a state-space tree for the 4 queen's problem using backtracking approach.

[10]

Q7

a.

CO-3;
SO-1;
BL-3

i) State the Recursive Formulation/Recurrence Relation for the Length of Longest Common Subsequence (LCS) using Dynamic Programming.
ii) Find out the similarity between the two strings by computing the length of the longest common subsequence (LCS) between them using Dynamic Programming further, print the longest common subsequence.

. String1 = "google"
String2 = "profile"

[10]

b.

CO-1;
SO-1;
BL-3

Solve the recurrence relation using both recursion tree and substitution method-

T(n) = T(n-1) + log n , when **n>0**

[10]