Department of Information and Communication Engineering
Pabna University of Science and Technology
Faculty of Engineering and Technology
B.Sc. (Engineering) 2nd Year 2nd Semester Examination-2017
Session: 2015-2016 & 2014-2015

Course Code: **ICE-2201** Course Title: **Data Structure and Algorithm**

NB:
1. Answer any **SIX**(THREE from each PART) questions.
2. Figures in the right margin indicate marks.
3. Parts of the same question should be answered together and in the same sequence.
4. Separate answer script must be used for answering the question of **PART-A** and **PART-B**.

Time: 3 Hours **Total Marks: 70**

PART-A

1. a) Consider the pattern $P = a^3ba$. Construct the table and the corresponding labeled directed graph used in the "fast" pattern matching algorithm. 6

   b) Suppose A is a sorted array with 400 hundred elements, and suppose a given element x appears with the same probability in any place in A. Find the worst case running time $f(n)$ and the average case running time $g(n)$ to find x in A using the binary search algorithm. $5\frac{2}{3}$

2. a) Let n denote a positive integer. Suppose a function L is defined recursively as follows 5

   $$L(n) = \begin{cases} 0, & if\ n = 1 \\ L(\lfloor n/2 \rfloor + 1) & if\ n > 1 \end{cases}$$

   i). Find $L(25)$. ii) What does this function do?

   b) Consider the following stacks of city names: $6\frac{2}{3}$

   STACK: London, Berlin, Rome, Paris, _____, _____.

   i) Describe the stack as the following operations take place:

   A) PUSH(STACK, Athens)
   B) POP(STACK, ITEM)
   C) POP(STACK, ITEM)
   D) PUSH(STACK, Dhaka)
   E) PUSH(STACK, Tokyo)
   F) POP(STACK, ITEM)

   ii) Describe the stack if the operation POP(STACK, ITEM) deletes London.

3. a) What is transitive closure? Write a procedure that finals the shortest path from a given node NA to a given node NB. $4\frac{2}{3}$

   b) Discuss the standard ways of traversing a binary tree T with root R with examples. 4

   c) Describe merge short algorithm. 3

4. a) Construct a 3-way search tree for the list of keys in the order shown below. What are your observations? $5\frac{2}{3}$

   List A: 10, 15, 20, 25, 30, 35, 40, 45
   List B: 20, 35, 40, 10, 15, 25, 30, 45

   b) Consider the following 4-digit employee numbers 6

   9614, 5882, 6713, 4409, 7148

   Find the 2-digit hash address of each number using

   i) the division method with $m = 97$;
   ii) the midsquare method
   iii) the folding method without reversing; and
   iv) the folding method with reversing.

PART-B

5.	a)	What do you mean by feasible solution? Give the general method of Greedy algorithm.	5
	b)	Give an algorithm for Greedy Knapsack. Consider $n = 7,\ m = 20,$ $(p1, p2, p3, p4, p5, p6, p7) = (10, 5, 15, 7, 6, 18, 2)$ and $(w1, w2, w3, w4, w5, w6, w7) = (2, 3, 5, 7, 1, 4, 2)$. Obtain the optimal solution for this Knapsack instance.	$6\frac{2}{3}$
6	a)	Write algorithm for travelling salesperson problem using dynamic programming.	$5\frac{2}{3}$
	b)	Schedule two jobs on 4 machine using flow shop scheduling technique. The time required by each operation of these jobs is given by following matrix. $$J = \begin{bmatrix} 3 & 0 \\ 0 & 3 \\ 4 & 2 \\ 5 & 2 \end{bmatrix}$$	6
7	a)	Differentiate between dynamic programming and divide and conquer paradigm.	$3\frac{2}{3}$
	b)	Explain the concept of backtracking with the help of suitable example.	3
	c)	Solve 8-queen's problem for a feasible sequence (8, 2, 5, 3).	5
8	a)	State the problem of graph coloring with example.	$3\frac{2}{3}$
	b)	Prove that the size of the set of all subsets of n elements is 2^n.	4
	c)	Write down the general iterative backtracking method. On what factors does the mentioned backtracking algorithm depend?	4

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Time: 3 Hours **Total Marks: 70**

PART-A

1. a) Define data structure. Name different types of data structure. List operations that can be performed on these data structures. $3\frac{2}{3}$

   b) Using the bubble sort algorithm, find the number of comparisons (C) and the number of interchanges (D) which alphabetize the n = 7 letters in RAJAPUR. 3

   c) Write down the algorithm for binary search. Validate the algorithm with a suitable data set. 3

   d) Calculate the total number of moves for the Tower of Hanoi for n=15 disks. 2

2. a) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows 5

$$Q(a,b) = \begin{cases} 0, & \text{if } a < b \\ Q(a-b,b)+1 & \text{if } b \le a \end{cases}$$

   i) Find the value of $Q(2,3)$ and $Q(14,3)$.

   ii) What does this function do? Find $Q(5861,7)$

   b) Define binary tree and complete binary tree with example. $6\frac{2}{3}$

   A binary tree T has 9 nodes. The inorder and preorder traversals of T yield the following sequences of nodes. Draw the tree T.

   Inorder: E A C K F H D B G

   Preorder: F A E K C D H G B

3. a) Define B tree. Construct a B tree of order 3 by inserting the following keys in the order shown into an empty B tree: M Q A N P W X T G E J 5

   b) Suppose the 7 data items are assigned the following weights: $6\frac{2}{3}$

   $(A,13), (B,2), (C,19), (D,23), (E,29), (F,5), (G,9)$.

   Find a 2-tree with a minimum weighted path length P. What is the Huffman coding for the 7 letters?

4. a) Write the insertion sort algorithm. Apply this insertion sort algorithm to sort the following numbers: 99, 77, 33, 44, 11, 88, 22, 66, 55 $5\frac{2}{3}$

   b) Consider the following 4-digit employee numbers 6

   9614, 5882, 6713, 4409, 7148

   Find the 2-digit hash address of each number using

   I) the division method with m=97;

PART-B

5. a) What is a greedy algorithm? Write down its advantages and disadvantages.

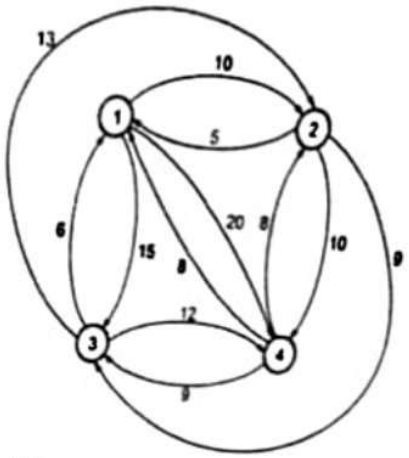
b) What is a recursive algorithm? Write an algorithm for tower of Hanoi puzzle to move n disk from tower x to tower y.

c) Define minimum-cost spanning tree. Illustrate with an example the Prim's algorithm to obtain a minimum-cost spanning tree.

6. a) Describes Bellman-Ford algorithm with example.

b) Explain Dijkstra's algorithm for finding the shortest path.

7. a) For the given diagraph, obtain optimum cost tour for the travelling salesperson problem.



b) Solve 0/1 Knapsack problem for the instance $n=4$, $m=21$, $(p1, p2, p3, p4) = (2, 5, 8, 1)$ and $(w1, w2, w3, w4,) = (10, 15, 6, 9)$.

8. a) State the principle of backtracking.

b) Give a formal definition of the n-queen's problem. Find all possible solution to 4-queen's problem. Establish the relationship between the two solutions.

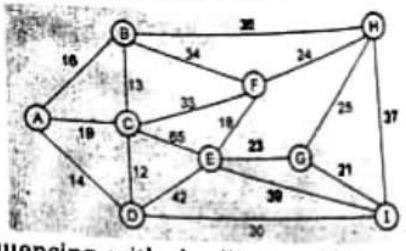
c) What do you understand by graph coloring? Describe backtracking algorithm to find all Hamiltonian cycles in a graph.

II) the midsquare method
III) the folding method without reversing; and
IV) the folding method with reversing.

PART-B

5. a) Define an algorithm. Explain the features of an efficient algorithm. 4
   b) Elaborate on asymptotic notations with examples. $3\frac{2}{3}$
   c) Calculate the time complexity of $1 + 3 + 5 + 7 + \cdots\cdots\cdots\cdots\cdots + 999$. 4

6. a) State the general principle of the greedy algorithm. What is the drawback of the Greedy algorithm? $3\frac{2}{3}$
   b) Consider the following weighted graph. Give the list of edges in the MST in the order that Prim's algorithm inserts them. Start Prim's algorithm from vertex A. 4



   c) Explain how job sequencing with deadline problems can be solved using the Greedy approach. 4

7. a) Write the general procedure of dynamic programming. State the principle of optimality. $3\frac{2}{3}$
   b) Solve the all pairs shortest path problem for the digraph with the following weight matrix. 6

$$\begin{bmatrix} 0 & 2 & \infty & 1 & 8 \\ 6 & 0 & 3 & 2 & \infty \\ \infty & \infty & 0 & 4 & \infty \\ \infty & \infty & 2 & 0 & 3 \\ 3 & \infty & \infty & \infty & 0 \end{bmatrix}$$

   c) State the 0/1 knapsack problem.

8. a) What is backtracking? Write general recursive algorithm for backtracking. 2
   b) Differentiate between backtracking and branch and bound. Draw state space tree for the given sum of subset problem: $5\frac{2}{3}$
   Set of elements= {3, 5, 6, 7} and $d = 15$. 6

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B.Sc. (Engineering) 2nd Year 2nd Semester Examination-2018
Session: **2016-2017**

Course Code: **ICE-2201** Course Title: **Data Structure and Algorithm**

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1. Answer any **SIX** (three from each part) questions.
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Time: 3 Hours **Total Marks: 70**

PART-A

1. a) What are the differences between a Stack, Queue and Array? 4
   b) Mention the advantage of sparse matrix. Suppose an integer occupies 4 bytes of memory space. Then Calculate the memory space required to store a 2D-array **int LA[30][50]**. If the starting address (base address) of **LA** is 2000H, then calculate the address of **LA[11][15]**. $3\frac{2}{3}$
   c) Explain the process of insertion an item into a linked list in the middle. 4

2. a) Write down the properties of stack and queue data structures. Write an algorithm to insert an item into a stack. 4
   b) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows: 4

$$Q(a,b) = \begin{cases} 0, & if\ a < b \\ Q(a-b,b)+1, & if\ a \geq b \end{cases}$$

   (i) Find the value of $Q(2,3)$ and $Q(14,3)$
   (ii) What does this function do? Find $Q(5861,7)$
   c) What are the most commonly used operations on a link list? Is it possible to apply binary search algorithm in a sorted linked list? Write a program segment to insert an item of a node in a linked list at any position. $3\frac{2}{3}$

3. a) Given that following list of 12 numerical data : 5
   44, 33, 11, 55, 77, 90, 40, 60, 99, 22, 88, 66.
   Use the quicksort algorithm to find the final position of the first number 44.
   b) Write an ADT to implement stack of size N using an array. The elements in the stack are to be integers. The operations to be supported are PUSH, POP and DISPLAY. Take into account the exceptions of stack overflow and stack underflow. $6\frac{2}{3}$

4. a) Define "extended binary tree". Explain with an example, how to convert a binary tree to an extended binary tree. $3\frac{2}{3}$
   b) Construct a 3-way search tree for the list of keys in the order shown below. What are your observations? 4
   List A: 10, 15, 20, 25, 30, 35, 40, 45
   List B: 20, 35, 40, 10, 15, 25, 30, 45
   c) Apply selection sort algorithm to sort the following elements: 4
   77, 33, 44, 11, 88, 22, 66, 55, 99

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Time: 3 Hours **Total Marks: 70**

PART-A

1. a) Define data structure. Name different types of data structure. List operations that can be performed on these data structures. $3\frac{2}{3}$
   b) Using the bubble sort algorithm, find the number of comparisons (C) and the number of interchanges (D) which alphabetize the n = 7 letters in RAJAPUR. 3
   c) Write down the algorithm for binary search. Validate the algorithm with a suitable data set. 3
   d) Calculate the total number of moves for the Tower of Hanoi for n=15 disks. 2

2. a) Let a and b denote positive integers. Suppose a function Q is defined recursively as follows 5

$$Q(a,b) = \begin{cases} 0, & if\ a < b \\ Q(a-b,b)+1 & if\ b \le a \end{cases}$$

   i) Find the value of $Q(2,3)$ and $Q(14,3)$.
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   b) Define binary tree and complete binary tree with example. $6\frac{2}{3}$
   A binary tree T has 9 nodes. The inorder and preorder traversals of T yield the following sequences of nodes. Draw the tree T.
   Inorder: E A C K F H D B G
   Preorder: F A E K C D H G B

3. a) Define B tree. Construct a B tree of order 3 by inserting the following keys in the order shown into an empty B tree: M Q A N P W X T G E J 5
   b) Suppose the 7 data items are assigned the following weights: $6\frac{2}{3}$
   $(A,13),(B,2),(C,19),(D,23),(E,29),(F,5),(G,9)$.
   Find a 2-tree with a minimum weighted path length P. What is the Huffman coding for the 7 letters?

4. a) Write the insertion sort algorithm. Apply this insertion sort algorithm to sort the following numbers: 99, 77, 33, 44, 11, 88, 22, 66, 55 $5\frac{2}{3}$
   b) Consider the following 4-digit employee numbers 6
   9614, 5882, 6713, 4409, 7148
   Find the 2-digit hash address of each number using
   I) the division method with m=97;

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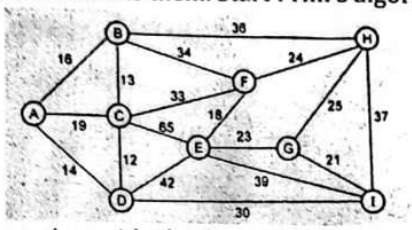
II) the midsquare method
III) the folding method without reversing; and
IV) the folding method with reversing.

PART-B

5. a) Define an algorithm. Explain the features of an efficient algorithm. 4
   b) Elaborate on asymptotic notations with examples. $3\frac{2}{3}$
   c) Calculate the time complexity of $1 + 3 + 5 + 7 + \cdots \ldots \ldots \ldots \ldots \ldots + 999$. 4

6. a) State the general principle of the greedy algorithm. What is the drawback of the Greedy algorithm? $3\frac{2}{3}$
   b) Consider the following weighted graph. Give the list of edges in the MST in the order that Prim's algorithm inserts them. Start Prim's algorithm from vertex A. 4



   c) Explain how job sequencing with deadline problems can be solved using the Greedy approach. 4

7. a) Write the general procedure of dynamic programming. State the principle of optimality. $3\frac{2}{3}$
   b) Solve the all pairs shortest path problem for the digraph with the following weight matrix. 6

$$\begin{bmatrix} 0 & 2 & \infty & 1 & 8 \\ 6 & 0 & 3 & 2 & \infty \\ \infty & \infty & 0 & 4 & \infty \\ \infty & \infty & 2 & 0 & 3 \\ 3 & \infty & \infty & \infty & 0 \end{bmatrix}$$

   c) State the 0/1 knapsack problem. 2

8. a) What is backtracking? Write general recursive algorithm for backtracking. $5\frac{2}{3}$
   b) Differentiate between backtracking and branch and bound. Draw state space tree for the given sum of subset problem: 6
   Set of elements= $\{3, 5, 6, 7\}$ and $d = 15$.

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Faculty of Engineering and Technology
B.Sc. (Engineering) 2nd Year 2nd Semester Examination-2020
Session: 2018-2019

Course Code: **ICE-2201** Course Title: **Data Structure and Algorithm**

NB: 1. Answer any **SIX** (THREE from each PART) questions.
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Time: 3 Hours **Total Marks: 70**

PART-A

1. a) Consider the pattern $P = aaabb$. Construct the table and the corresponding labeled directed graph used in the "fast" pattern matching algorithm. 6

b) Suppose A is a sorted array with 300 hundred elements, and suppose a given element x appears with the same probability in any place in A. Find the worst case running time $f(n)$ and the average case running time $g(n)$ to find x in A using the binary search algorithm. 5.67

2. a) Let Q be an empty queue and S an empty stack. If elements A1, A2, A3 are placed in the queue and elements A4 and A5 are pushed onto the stack, and if all the elements from the queue are then dequened and placed onto the stack, which element is on the top of the stack? Finally, depict the contents of S and Q 2.5

b) Consider the following arithmetic expression in postfix notation: 4

7 5 2 + * 4 1 5 - / -

i) Find the equivalent prefix form of the above by showing the state of the stack and other variables as they change.

ii) Obtain the computed value of the expression from its postfix notation.

c) What is recursion? Let J and K be integers and suppose $Q(J, K)$ is recursively defined by

$$Q(J,K) = \begin{cases} 5 & if\ J < K \\ Q(J-K, K+2) + J & if\ J \geq K \end{cases}$$ 2.5

Find $Q(2,7), Q(5,3)$.

d) Explain queue underflow and overflow with suitable illustration. 2.67

3. a) Draw all the possible dissimilar trees T where: 6
i) T is a binary tree with 3 nodes ii) T is a 2-tree with 4 external nodes

b) Explain the process of polyphase merge sort. 5.67

4. a) Define binary tree and complete binary tree with example. 3.67

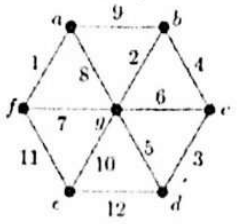
b) Construct a 3-way search tree for the list of keys in the order shown below. What are your observations? 4
List A: 10, 15, 20, 25, 30, 35, 40, 45
List B: 20, 35, 40, 10, 15, 25, 30, 45

c) Apply selection sort algorithm to sort the following elements: 4
77, 33, 44, 11, 88, 22, 66, 55, 99

PART-B

5. a) From a computational viewpoint, is it easy or hard to find the chromatic polynomial of an arbitrary graph? Explain. 3

b) Consider the following edge-weighted graph. 4.67



i) Use the greedy algorithm to find a minimum-weight spanning tree of this graph. What is the weight of such a spanning tree? Show your working.

ii) How would you modify the greedy algorithm to find a maximum-weight spanning tree? No justification is necessary, but the modification needs to be clearly explained.

c) Consider following instance for simple knapsack problem. Find the solution using greedy method. 4

N=8;

P={11, 21, 31, 33, 43, 53, 55, 65}

W={1, 11.21, 23, 33, 43, 45, 55}

M=110

6. a) Apply Greedy method to solve the optimal storage on tapes problem if $n = 3$ and $(l_1, l_2, l_3) = (5,10,3)$. 5

b) What are differences between Prim's algorithm and Kruskal's algorithm? 2

c) Explain how job sequencing with deadline problems can be solved using the Greedy approach. 4.67

7. a) Write the general procedure of dynamic programming. State the principle of optimality. 3.67

b) Solve the all pairs shortest path problem for the digraph with the following weight matrix. 6

$$\begin{bmatrix} 0 & 2 & \infty & 1 & 8 \\ 6 & 0 & 3 & 2 & \infty \\ \infty & \infty & 0 & 4 & \infty \\ \infty & \infty & 2 & 0 & 3 \\ 3 & \infty & \infty & \infty & 0 \end{bmatrix}$$

c) State the 0/1 knapsack problem. 2

8. a) State and explain Graph coloring problem? How backtracking approach is useful for assigning different colors to adjacent vertices? 5

b) Briefly Explain the concept of backtracking. 2

c) Solve 8-queen's problem for a feasible sequence (8, 2, 5, 3). 4.67

Department of Information and Communication Engineering
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B.Sc. (Engineering) 2nd Year 2nd Semester Examination-2022
Session: 2020-2021, 2019-2020

Course Code: **ICE-2201** Course Title: **Data Structure and Algorithm**

NB:
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Time: 3 Hours **Total Marks: 70**

PART-A

1. a) Differentiate between data type and data structure. Why should you have good knowledge on data structures as an ICE student? 4
   b) How does a point array can save memory when stores a variable sized group of data? Discuss with necessary figures. 3
   c) An array ICE[-4.....6, -2.....12], stores elements in Row Major Wise, with the address ICE[2][3] as 4142. If each element requires 2 bytes of storage, find the Base address. $4\frac{2}{3}$

2. a) Define AVL search tree. Explain LL rotation and RR rotation for the balancing of an AVL search with example. 5
   b) What is m-way search tree? Insert the following keys in the order shown below into an initially empty m-way search tree of order 4. $6\frac{2}{3}$

   G S F L Q X Z V R A I J W

3. a) Explain the linked representation of the graph. $6\frac{2}{3}$
   b) Write down the algorithm for topological sorting. Explain it with a graph. 5

4. a) Explain different pass of selection sort algorithm using some data items. Find the complexity of selection sort algorithm. $6\frac{2}{3}$
   b) Consider the following 4-digit employee numbers 5
   9814, 7887, 4793, 5509, 7249.
   Find the 2-digit hash address of each number using
   I) the division method with $m = 97$;
   II) the midsquare method.

PART-B

5. a) Define an algorithm. Explain the features of an efficient algorithm. 3
   b) Explain briefly Big oh, Big omega and Big Theta notation. $3\frac{2}{3}$
   c) Derive the recurrence relation for Fibonacci series algorithm and carry out the time complexity analysis. 5

6. a) State the general principle of Brute Force and Divide and Conquer approach. 2
   b) How many comparisons will be made by the brute force string matching algorithm in searching for each of the following patterns in the binary text of 1000 zeros? I) 00001 II) 10000. 4
   c) Write down the algorithm to construct a convex hull based on divide and conquer strategy. $5\frac{2}{3}$

7. a) Algorithms A and B spend exactly $T_A(n) = C_A n log_2 n$ and $T_B(n) = C_B n log_2 n$ microseconds respectively, for a problem size n. Find the best algorithm for processing $n = 2^{20}$ data items if the algorithm A spends 10 microseconds to process 1024 items and the algorithm B spends only 1 microsecond to process 1024 items. 3

b) What do you mean by dynamic programming? Given two sequences of characters, find out the length along with procedure of the longest common subsequence of both sequences BDCAB and ABCBD. $3\frac{2}{3}$

c) Draw a state transition diagram for the string matching automation that accepts all strings ending in the string "acabaca". 5

8. a) Devise an algorithm to make for 1655 using the greedy strategy. The coins available are {1000, 500, 100, 50, 20, 10, 5}. 4

b) What is N-Queen's problem? Draw the state space tree for 4-queen's problem. 4

c) Consider a set $S = \{5, 10, 12, 13, 15, 18\}$ and $sum = 30$. Use the backtracking model to arrive at the solution of this sum of subset problem. $3\frac{2}{3}$