

Q. No. CS - 301 / 106

B. Tech./Odd  
2017-18/Reg

2017-18

**DATA STRUCTURES**

**CS - 301**

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Answer any *five* questions from the following :

1. Compare between the following search techniques with respect to their *data structures, applicability in real life scenarios* and *number of comparisons in best and worst cases*. No algorithm is required.
  - (i) Binary search
  - (ii) Search in BST
  - (iii) Search in AVL Tree. 14
2. (a) Give two examples of ADT and explain a data structure for each of them.  
  
(b) Insert the set of elements {100, 220, 63, 68, 65} to construct a BST starting from a null tree taking one element at a time from left to right. Draw the tree for each steps. 6+8
3. (a) Define binary tree recursively.  
  
(b) Can we use an array to store a binary tree? Justify your answer.

P.T.O.

( 2 )

- (c) Find out the maximum and minimum height of a binary tree, where  $n$  is the number of nodes in the binary tree. 3+5+6
4. Find out the following :
- (a) Relation between number of edges  $E$  and number of nodes  $N$  of any tree
- (b) Maximum number of nodes in a binary tree of height  $h$ .
- (c) Number of leaves  $N_0$  in terms  $N_2$  for a binary tree, where  $N_i$  is the number of nodes having degree  $i$ . 4+5+5
5. (a) Show the disadvantages of implementing non-circular queue using array. Explain the possible solutions.
- (b) Write down the algorithms for insertion and deletion operations for a circular queue using array. Consider the possible underflow and overflow situations.
- (c) Write a short note on priority queue. 4+6+4
6. (a) Write a recursive algorithm for Binary Search.
- (b) Explain the termination conditions for successful and unsuccessful cases for Binary Search.
- (c) Explain by a binary decision tree that the maximum number of comparisons required for successful and unsuccessful cases for Binary Search with 16 elements is the same. 3+4+7
7. Explain the difference between *bubble sort* and *selection sort* along with their time and memory requirements. Consider also the best and the worst cases. You don't need to write any algorithm. 14

( 3 )

8. (a) Compare between array and linked list regarding their advantages and disadvantages.
- (b) Write the algorithm of quick sort, using first element as pivot. What are the conditions for best and worst cases and find the number comparisons for both the cases. 6+8
-



( 2 )

- (b) Simplify the Logic function using Quine-McCluskey minimization technique and write the expression.

$$f(a,b,c,d) = \sum_m (0,1,3,7,8,9,11,15)$$

3. (a) A clocked synchronous sequential circuit using positive-edge-triggered D FFs has an input  $X$  and an output  $Y$ . The excitation equation are :

$$D_1 = Q_1 \cdot \bar{X} + \bar{Q}_1 \cdot Q_0 \cdot X + Q_1 \cdot \bar{Q}_0 \cdot X,$$

$$D_0 = Q_0 \cdot \bar{X} + \bar{Q}_0 \cdot X \text{ and } Y = Q_1 \cdot Q_0 \cdot X.$$

(i) circuit as well as (ii) state diagram.

- (b) A boolean operator  $\odot$  is defined as follows :

$1 \odot 1 = 1, 1 \odot 0 = 0, 0 \odot 1 = 0$  and  $0 \odot 0 = 1$ . Is this ' $\odot$ ' operator associative?

4. (a) Realise the function of four variables

$$f(A,B,C,D) = \sum_m (0,3,5,6,9,10,12,15) \text{ using } 8:1 \text{ multiplexer.}$$

- (b) Prepare the truth table for the circuit of Figure 2 and describe that it acts as a T-type Flip-Flop.

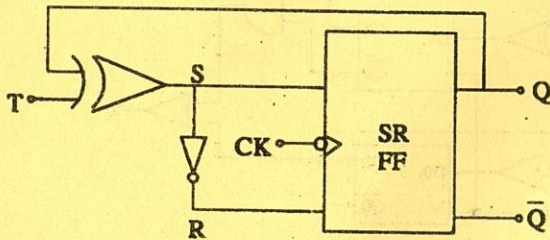


Figure 2 (Ref. Que 4)

( 3 )

5. (a) What is Race-around condition in Flip-flops? Explain with clock pulse diagram. How can it be avoided?

- (b) Minimize the expression  $f(A, B, C, D) = \prod_M (1,2,3,5,6,7,9,10,11,13,14,15)$  using K-maps and realise using NOR gates only.

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Q. No. CS - 331 /

B. Tech./Odd

2017-18/Reg

2017-18

**DATA STRUCTURES**

**CS - 331**

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Subparts of a question must be attempted together and in order.

10+(12×5)

**Group - A**

Answer all questions. 10

1. Total number of increment and decrement operations during partition in quicksort is
  - (a)  $O(n^2)$
  - (b)  $O(n^2+n+1)$
  - (c)  $O(n^3+n)$
  - (d)  $O(n)$
2. Selection sort is quadratic due to for each  $i$  from 1 to  $n-1$ , there is
  - (a) Two exchange and  $n-1$  comparisons
  - (b) One exchange and  $n$  comparisons
  - (c)  $n$  exchange and 1 comparison
  - (d) One exchange and  $n-i$  comparisons

P.T.O.

( 2 )

3. Time complexity of search operation in circular linked list is

(a)  $O(m+n)$

(b)  $O(n)$

(c)  $O(n^2+m)$

(d)  $O(n^3+n)$

4. Which of the following is not the part of ADT description?

(a) Data

(b) Operations

(c) Both of the above

(d) None of the above

5. Best case time complexity for insertion sort

(a)  $O(n)$

(b)  $O(n^2)$

(c)  $O(n^3+n)$

(d) None of the above

( 3 )

6. How many possible ways a binary tree can be traversed irrespective of left associative of nodes?

(a) 5

(b) 6

(c) 3

(d) 9

7. Which of the following is the required condition for binary search algorithm?

(a) The list must be traverse in both directions

(b) There should be the direct access to the middle element in any list / sublist

(c) There must be mechanism to traverse the list in single direction

(d) None of above

8. What should be stored onto stack during the conversion of Infix to Postfix expression?

(a) Operand and left parenthesis

(b) Operator and operand

(c) Operator and left parenthesis

(d) None of above

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9. Which of the following statement is false?
- (a) Arrays are dense lists and static data structure
  - (b) data elements in linked list need not be stored in adjacent space in memory
  - (c) pointers store the next data element of a list
  - (d) linked lists are collection of the nodes that contain information part and next pointer
10. The maximum number of nodes in a binary tree of depth  $d(\geq 1)$  is
- (a)  $(2^d - 1)$
  - (b)  $2^{d-1}$
  - (c)  $(2^d - 2^{-d})$
  - (d) None of above

**Group - B**

Answer any five questions.

1. (a) Write the differences between array and linked list. 3
- (b) Write an algorithm for Quick sort and explain with a suitable example. Derive the time complexity of Quicksort algorithm with proper explanation when elements are found to be sorted in the given input array. 5+2+2=9

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2. (a) Write an algorithm for upper triangular sparse matrix multiplication. 3
- (b) What is the importance of asymptotic notations in data structures? Define Big-Oh and Big-Omega notations. 1+4=5
- (c) Apply merge sort on the following sequence of numbers to rearrange them in ascending order. Clearly display each step and explain. 4
- 12, 130, 50, 21, 11, 750, 86, 89, 462, 32, 17, 66, 91
3. (a) What is the difference between binary tree and binary search tree (BST)? Write the algorithm for insertion operation of a new node in binary search tree and comment on time complexity of the algorithm. Construct a BST for the given elements : 4
- 15, 5, 3, 17, 13, 16, 21, 10, 12, 25, 7, 18.
- Clearly explain each of the insertion operation during construction of BST. Now, find out the inorder traversal sequence of the constructed BST. 2+3+1+3+1=10
- (b) State the advantages of circular queue over linear queue. 2
4. (a) Define strictly binary tree and complete binary tree. Prove that for the nonempty binary tree if  $n_0$  is the number of terminal nodes and  $n_2$  is the number of nodes having degree 2, then  $n_0 = n_2 + 1$ . Also show

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that the total number of nodes in a strictly binary tree is  $(2n_0 - 1)$ .

- (b) Write down the recursive procedures/algorithm for the Postorder tree traversal technique.
- (c) Construct the original binary tree which satisfies following both traversal sequences :

Postorder : B E D C A

Inorder : B A C E D 7+2+3=12

- 5. (a) Write an algorithm that uses stack to evaluate a given postfix expression. Evaluate the following postfix expression using your algorithm :  $A B C - D ^ *$   
Where symbols  $-$ ,  $*$ , and  $^$  are subtraction, multiplication, and exponentiation operators respectively. Assume,  $A=5$ ,  $B=8$ ,  $C=3$ , and  $D=3$ .
- (b) Two stacks of positive integers are needed, one containing the odd number elements and other containing even number elements. The total number of elements in the odd-value stack and the even-value stack combined are not more than 100 at any time, but we cannot predict how many are in each stack. Both stacks are to be implemented in one array such that there will be no overflow until all the space is actually used.
  - (i) Draw a diagram of how the double-stack will look like.
  - (ii) Write an algorithm for PUSH operation; it should store the new element into the correct stack according to its value. 7+5=12

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- 6. (a) Write an algorithm to create a singly linked list with  $n$  elements and explain your algorithm with suitable example. What is the advantage of circular linked lists over singly linked lists?  
8+4=12
  - (b) Write an algorithm to insert a new node (with info element is X) after a particular node (with info element is Y) in a doubly linked list. If Y is not exists in the doubly linked list, then insert Y after the last node.  
6×2=12
7. Write short notes on (any two) :
- (a) Abstract Data Type
  - (b) Binary Search
  - (c) Linked list implementation of stack
  - (d) Recursive vs. Iterative algorithms.
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2017-18

**DATABASE MANAGEMENT SYSTEM  
(DBMS)**

**CS 501**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

*Answer any five questions from the following:*

1. (a) Design an ER schema for keeping track of information about votes taken in the U.S. House of Representatives during the current two-year congressional session. The database needs to keep track of each U.S. STATE'S name (e.g., Texas, New York, California) and includes the Region of the state (whose domain is {Northeast, Midwest, Southeast, Southwest, and West}). Each CONGRESSPERSON in the House of Representatives is described by their Name, and includes the District represented, the StartDate when they were first elected, and the political Party they belong to (whose domain is {Republican, Democrat, Independent, Other}). The database keeps track of each BILL (i.e., proposed law), and includes the BillName, the dateofVote on the bill, whether the bill passed or failed (whose domain is {YES, NO}), the Sponsor (the congressperson(s) who sponsored-i.e., proposed-the bill). The database keeps track of how each congressperson voted on each bill (domain of vote attribute is {Yes, No, Abstain, Absent}). Draw an ER schema diagram for the above application. State clearly any assumptions you make.

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(b) Discuss the terms "security of a database" and "integrity of a database" with the help of appropriate examples. Critically compare the relative advantages and disadvantages of a Relational Database vis-à-vis hierarchical database. 3 + 3

2. (a) A small private school wants to keep track of students, courses and faculty. It also has a number of parents and private contributors. Describe the advantages for this school of using a DBMS for all its records. 2

(b) Consider the following relations for a database that keeps track of auto sales in a car dealership (option refers to some optional equipment installed on an auto):

CAR (Serial-No., Model, Manufacturer, Price)

OPTIONS (Serial-No., Option-Name, price)

SALES (Salesperson-id, Serial-No., date, Sale-price)

SALESPERSON (Salesperson-id, Name, Phone)

First, specify the foreign keys for the above schema, stating any assumptions you make. Next, show an example of an insertion in the SALES and SALESPERSON relations that violates the referential integrity constraints and another insertion that does not. Then specify the following queries in relational algebra: 3 × 4

(i) For the salesperson named 'Jane Doe', list the following information for all cars she sold:

Serial#, Manufacturer, Sale-price.

(ii) List the Serial# and Model for cars that have no options.

(iii) Considering the natural join operations between SALESPERSON and SALES. What is the meaning of left outer join for these tables (do not change the order of relations): Explain with example.

(iv) Write a query in relational algebra involving selection and one set operation and say in words what the query does.

3. (a) Explain the term "foreign key" with the help of an example and highlight its importance in design of databases. Under what conditions can an attribute of a binary relationship type be migrated to become an attribute of one of the participating entity types? What is a view in SQL? Discuss the problems that may arise when one attempts to update a view. 3 + 2 + 1 + 1

(b) Consider a disk with block size  $B = 512$  bytes. A block pointer is  $P = 6$  bytes long and a record pointer is  $P_r = 7$  bytes long. A file has  $r = 30,000$  EMPLOYEE records of fixed length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), DEPARTMENT CODE (9 bytes), ADDRESS (40 bytes), PHONE (9 bytes), BIRTHDATE (8 bytes), SEX (1 byte), JOBCODE (4 bytes), SALARY (4 bytes). An additional byte is used as a deletion marker.

(i) Suppose the file is ordered by the key field SSN and we want to construct a primary index on SSN. Calculate the number of block accesses needed to search for the retrieval a record from the file.

(ii) Suppose the file is not ordered by the key field SSN and we want to construct a secondary index on SSN. Repeat the same for the secondary index and compare it with the primary index. 3 + 4

4. (a) Consider the relation : CAR\_SALE(Car#, Date\_sold, Salesman#, Commission%, Discount\_amt).

Assume that a car may be sold by multiple salesmen and hence {Car#, Salesman#} is the primary key. Additional dependencies are Date\_sold  $\rightarrow$  Discount\_amt and Salesman#  $\rightarrow$  Commission%.

Based on the given primary key, is this relation in 1NF, 2NF or 3NF? Why or why not? How would you successfully normalize it completely? 6

- (b) Consider the following database relations containing attribute Book\_id, Subject\_category\_of\_book, Name\_of\_Author, and Nationality\_of\_Author, with Book\_id as the primary key.

(i) What is the highest normal form satisfied by this relation?

(ii) Suppose the attribute Book\_title and Author\_address are added to the relation and the primary key is changed to {Name\_of\_Author, Book\_title}. What will be the highest normal form satisfied by the relation? 5

- (c) For the relation  $R = (L, M, N, O, P)$ , the following dependencies hold:

$M \rightarrow O$ ,  $NO \rightarrow P$ ,  $P \rightarrow L$  and  $L \rightarrow MN$  and  $R$  is decomposed into  $R_1 = (L, M, N, P)$  and  $R_2 = (M, O)$ .

Is the above decomposition is a loss-less join decomposition? Explain. 3

5. (a) Explain why PJNF is a normal form more desirable than is 4NF. 4

- (b) Discussed how serializability is used to enforce concurrency control in a database system. Why is serializability sometimes considered too restrictive as a measure of correctness for schedules? What is recoverable schedule? Why is recoverability of schedules desirable? Are there any circumstances under which it would be desirable to allow non recoverable schedule? Explain your answer. 2 + 2 + 2 + 2 + 2

6. (a) Show that two-phase locking protocol ensures conflict serializability, and that transaction can be serialized according to their lock points. 5

(b) What is cascading rollback? When a transaction is rolled back under timestamp ordering, it is assigned a new timestamp. Why can it not simply keep its, old timestamp? 2 + 3

(c) Compare the deferred-and-immediate modification versions of the log based recovery schemes, in terms of ease of implementation and overhead cost. 4

7. Write short notes on: 7 + 7

(i) Codd Rules and

(ii) Distributed Database.

2017-18

**THEORY OF COMPUTATION**

**CS 502**

*Full Marks : 70*

*Time : 3 hours*

*All questions carry equal marks.*

*Subparts of a question must be attempted together and in order.*

*Answer any seven questions.*

1. (a) Give a CFG for constructing strings with equal number of a's and b's.  
(b) Convert the grammar constructed above to CNF.
2. (a) Show that the following grammar is ambiguous.

$$S \rightarrow aSbS \mid bSaS \mid \epsilon$$

- (b) Give the rightmost derivation for the string "abba" in the grammar given below. At every step of the derivation, mention clearly the production rule you have applied.

$$S \rightarrow AA$$

$$A \rightarrow aB$$

$$B \rightarrow bB \mid \epsilon$$

3. (a) Remove unit productions and useless symbols from the following grammar.

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow C|b$

$C \rightarrow D$

$D \rightarrow E$

$E \rightarrow a$

- (b) Give a minimized DFA for the complement of the regular set expressed by the regular expression  $100^*(10 + 01)$
4. Construct a Turing machine for the multiplication of two natural numbers expressed in unary notation, using subroutine concept. Clearly mention the initial and final IDs of the machine and the IDs when calling and returning from the subroutine. Explain the strategy.
5. (a) Prove by example that context – free languages are not closed under intersection.
- (b) Prove that the language accepted by a finite automaton with 'n' states is infinite if and only if the finite automaton accepts a string of length L, where  $n \leq L < 2n$ .
6. Construct a PDA for non-empty palindromes over the input alphabet  $\{x, y, z\}$ .
7. Use the Pumping Lemma for regular sets to prove that the following language is not regular.  $L = \{0^n 1^n | n \geq 1\}$ .
8. (a) Give a left linear and a right linear grammar for the language expressed by the regular expression  $(0+1)^*00$

- (b) Construct a minimized finite automaton for the language described by the regular expression given above.
9. (a) Give an unrestricted grammar for
- $$L = \{ww | w \in \{0, 1, 2\}^*\}.$$
- (b) Show the derivation of the string "20012001" using the above grammar. At every step underline the substring being rewritten in the subsequent step and also mention the production rule used to do so.
10. Explain the following :
- (a) Inverse Homomorphism in Regular Sets.
- (b) Mealy Machines.
- (c) Multitape Turing Machines.
- (d) Reversal operation in CFGs.
- (e) Recursive sets.

2017-18

**COMPILER DESIGN**

**CS 503**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

*Answers should be brief and exactly to the point.*

Answer Q. No. 1 and not more than any five from the rest.

1. (A) Pick up the wrong statement(s):

(a)

- (i) JAVA compiler produces intermediate code.
- (ii) Optimization gain is the ratio of change in run time and change in compilation time.
- (iii) Common Sub expression Elimination is an example of optimization through equivalent code writing.
- (iv) Common sub expression elimination follows constant propagation.
- (v) For compilation of completely optimized source code, there is no change in either compilation or run time.

(b)

- (i) Bootstrapping is required if the compiler is written in machine language.
- (ii) Bootstrapping is required if the compiler is written in some intermediate language.

(iii) Bootstrapping is to make the compiler executable in different machines.

(iv) Cross compiler produced through bootstrapping is useless.

(c)

(i) LL(1) parser finds the deriving production sequence.

(ii) LL(1) parsing technique has to remove right recursion.

(iii) LL(1) parsing tables blank entries are due to semantic error(s) in sentences.

(iv) "1" in LL(1) parser indicates one input symbol is sufficient to find out the deriving production.

(d)

(i) Operator Precedence Parser is one type of top down parser.

(ii) Shift reduce conflict should occur in shift reduce parser if the sentence is ambiguous.

(iii) In Operator Precedence Parser there is no shift reduce conflict even if the sentence is ambiguous.

(iv) Shift Reduce Parser is one type of Operator Precedence Parser.

(e)

(i) LR(1) parser is having much larger number of states in comparison to LR(0)

(ii) Both LR(0) and LALR have exactly same number of states.

(iii) Both LALR and LR(1) can detect shift reduce conflict only.

(iv) The number of lookaheads in both LR(0) and LALR items are exactly equal.

(B) Type "Yes" or "No" for the following statements:

(i) In reserved word strategy a transition diagram is needed to identify a keyword.

(ii) JAVA Compiler does not require JVM

(iii) The grammar of any HLL can never be a context free grammar.

(iv) Ambiguous sentence may be successfully parsed by LR(k) parser

(v) "Augmented grammars" as well as "Reduced grammars" are equivalent grammar.

(vi) Optimization reduces both compilation time and execution time.

(vii) The blank entries in LL(1) parsing table indicates syntactic as well as semantic errors.

(viii) Multiply defined entries in LL(1) table is due to ambiguous language.

(ix) Shift reduce conflict in LR(0) parser is only due to ambiguous grammar.

(x) In LR(k) parser, each item has (k+1) different components.  $2 \times 5 + 10 = 20$

2. Draw the NFA and thereby minimized DFA for the Lexical Analyzer which has to accept the following tokens:

(i) a\*b

(ii) baba

(iii) a<sup>+</sup>b\*

3. Why the compiler has to detect useless grammar symbols and useless productions in a grammar? Find the useless grammar symbols and useless productions in the following grammar with justification. Find the language produced by the grammar.

$$S \rightarrow xyz|Xyzz$$

$$A \rightarrow Xz|xYx$$

$$Y \rightarrow yYy|XZ$$

$$Z \rightarrow Zy|z$$

10

4. Find the three address code and basic block for the following C code segment. Properly justify why that would be a basic block

```
for ( i=0; i<500 ; i++)
```

```
{  ....
```

```
  ....
```

```
  do
```

```
  {
```

```
    ....
```

```
    ....
```

```
  }while (i < 5000)
```

```
    ....
```

```
    ....
```

```
  }
```

10

5. Find the First and Follow of all the grammar symbols of the grammar and draw the predictive parsing table:

$$S \rightarrow S+T|T$$

$$T \rightarrow T*F|F$$

$$F \rightarrow id$$

Hence find out whether the grammar is ambiguous or not.

10

6. For the following grammar list canonical collection of all LR(0) items and hence draw the LR(0) GOTO Graph. 10

$$S \rightarrow S+A$$

$$A \rightarrow B$$

$$B \rightarrow a|b|c$$

7. What are the different techniques to design a Symbol Table? What are their advantages and disadvantages? What are the different techniques of logical deletion of a symbol from the table? 10



**Operating Systems (CS-504)**Answer any five

Full Marks: 70

Time: 3 hours

Q1. (a) Mention the key performance metric used in each of the following type of operating systems: real-time OS, batch multiprogramming OS, time-shared multiprogramming OS, distributed OS.

(b) Explain the significance of spooling.

(c) Explain the significance of zombie process.

(d) ULT may not useful if we have multiple processors in the system – Justify.

(e) Explain the drawbacks of using semaphores.

(f) Increase of page frames will reduce the number of page faults.

(g) State the drawbacks of File allocation Table (FAT). (7\*2)

Q2. (a) Write the pseudo code of the fork() system call.

(b) Mention how many times Hello will be printed in the following code:

```
void main(void)
{
    fork();  fork() && fork();
    !fork() || fork();
    printf("Hello");
}

```

Explain your answer with suitable process hierarchy diagram.

(c) Write the different entries of the U-area mentioning their significance.

(d) What are events that can cause a process to switch from running state to some other states? (4+5+3+2)

Q3.(a) Write a code in proper syntax where a parent process accepts two integers x and y as inputs and creates two child threads to multiply and add respectively the two numbers.

(b) How is TCB different from PCB in terms of information they store?

(c) In KLT overhead of thread switching is more than in ULT – Justify.

(d) State the use and significance of pthread\_join function. (7+3+2+2)

Q4.(a) Assume four processes A, B, C & D where A & D belongs to the same group and B and C forms separate groups each. If the time quantum is 30 secs, base priority is 100 and 30 ticks are generated in each sec. Illustrate in details how and which process will be scheduled in each time quantum for 1<sup>st</sup> consecutive 8-time quantum.

(b) State the deadlock avoidance algorithm. What are the basic problems in implementing this algorithm in practice?

(c) Mere detection of the presence of a cycle in resource allocation graph may not be enough to detect deadlocks – Justify with an example. (6+6+2)

- Q5. (a) State the narrow bridge problem and propose a solution using monitor. How many and what type of semaphores you would have used if the same need to be implemented using semaphores.
- (b) State the sleeping barber problem and propose a solution using semaphore.
- (c) We may not be able to solve the producer-consumer using a single binary and a single general semaphore – Justify.  $((5+2)+5+2)$

- Q6. (a) State how the indexed allocation technique is used to resolve the problems of contiguous allocation. What is the essential difference in the approach used in FAT and inode based file allocation.
- (b) Assume the sequence of cylinder/track numbers requested is as following:  
98, 120, 65, 147, 12, 89, 200, 55  
Show the sequence of access to the requests for the following disk scheduling strategies: FIFO, SCAN, N Step-SCAN, SSTF.
- (c) Explain briefly how buddy list help in free space management.  $((3+2)+6+3)$

- Q7. Consider the following sequence of page numbers referred by a process:  
d, c, b, a, d, c, c, d, c, b, c, a  
Show the number of page faults incurred by the following page replacement strategies:  
LRU, FIFO, Optimality, LFU
- (b) Explain how paging-based segmentation is implemented.
- (c) Explain how clock algorithm approximates the LRU algorithm.  $(5+6+3)$

- Q8. Write Short notes:  $(7+7)$
- (a) Signal handling in OS
- (b) Lamport's bakery algorithm and its use.

Q. No. CS 543 / 075

B. Tech / Odd  
(17-18) / Reg

2017-18

**DATABASE MANAGEMENT SYSTEMS  
(DBMS)**

**CS 543**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

Answer *all* questions from Group A and  
any *three* from Group B

**GROUP A**

Choose the correct alternative. (2 × 5 = 10)

1. Which of the following indicates the maximum number of entities that can be involved in a relationship ?
  - (a) Minimum cardinality,
  - (b) Maximum cardinality,
  - (c) ERD,
  - (d) Greater Entity Count (GEC).
2. A primary key, if combined with a foreign key creates
  - (a) parent child relationship between the tables that connect them,
  - (b) many-to-many relationship between the tables that connect them,

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[ Turn Over ]

- (c) network model between the tables that connect them,  
 (d) None of these.

3. Let  $R_1(\underline{A}, B, C)$  and  $R_2(\underline{D}, E)$  be two relation schema, where the primary keys are shown underlined and let  $C$  be a  $f.k$  in  $R_1$  referring to  $R_2$ . Suppose there is a no violation of the above referential integrity constraint in the corresponding relation instances  $r_1$  and  $r_2$ . Which one of the following relational algebra expressions would necessarily produce an empty relation?

(a)  $\Pi_D(r_2) - \Pi_C(r_1)$ ,

(b)  $\Pi_C(r_1) - \Pi_D(r_2)$ ,

(c)  $\Pi_D(r_1 \bowtie_{C=D} r_2)$

(d)  $\Pi_C(r_1 \bowtie_{C=D} r_2)$

4. SQL views can be used to hide

- (a) columns and rows only,  
 (b) complicated SQL syntax only,  
 (c) both of the above can be hidden by an SQL view,  
 (d) None of the above.

5. If a denormalization situation exists with a one-to-one binary relationship, which of the following is true ?

- (a) All fields are stored in one relation,  
 (b) All fields are stored in two relations,  
 (c) All fields are stored in three relations,  
 (d) All fields are stored in four relations.

## GROUP B

Answer any *three* questions from followings:

6. (a) Consider the following set of requirements for an university database that is used to keep track of student's transcripts. 10

- The university keeps track of each student's name, roll no, registration no, current address and phone, permanent address and phone, birth date, sex, department and degree (B.Sc, B.Tech, M.Tech). Some user applications need to refer city, state and pin code of the student's permanent address, Both roll no and registration no have unique values for each student.
- Each course has a course no, year, semester, instructor(s) timings and classroom and offering department.
- Each instructor has id no, name, department and title, id no has unique value.
- Each department is described by a name, departmental code, and office phone no.

Construct an ER diagram for this application. Write all assumptions that you make about the mapping constraints.

(b) Explain the concept of specialization and generalization with an example. Discuss the terms "security of a database" and "integrity of a database" with the help of appropriate examples. Critically compare the relative advantages and disadvantages of a Relational Database vis-à-vis hierarchical database. 3 + 3 + 4

7. (a) State the differences between the following with examples: 3 + 3

(i) Cartesian Product (X) and Natural Join [ $\bowtie$ ],

(ii) Projection and Generalized Projection

(b) Explain with two examples why the set  $\{\sigma, \Pi, U, -, X\}$  is called the complete set of relational algebra operation.

4

(c) Assume that a Consumer item lease Company which leases various household items to its clients for their use for a specific period of time, maintains the following tables :

2.5 × 4

Clients (clientID, name, address, contact Phone)

Itemlist (itemID, itemName, itemCost, purchase Date)

Leaselist (clientID, transactionNO, itemID, startDate, returnDate, amountTobeCharged)

Please Note: A client may lease an item many times. Amount to be charged is calculated as per a fixed rate multiplied by number of days item is leased. All items have unique itemID. However, two or more items may have same name.

Write the following SQL queries on the tables:

- Find all the client names that have not got any item leased during the last month and no leased item is pending with them.
- Find the list of all the items that were leased or returned last month.
- Find the names of all those clients who have given the business to the company in the decreasing order of total amount paid by a client.

- Find the client who has been leased at least two items.

8. (a) State the difference between primary and secondary index structure. 4

(b) Consider a disk with block size  $B = 512$  bytes. A block pointer is  $P = 6$  bytes long and a record pointer is  $P_r = 7$  bytes long. A file has  $r = 30,000$  EMPLOYEE records of fixed length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), DEPARTMENT CODE (9 bytes), ADDRESS (40 bytes), PHONE (9 bytes), BIRTHDATE (8 bytes), SEX (1 byte), JOBCODE (4 bytes), SALARY (4 bytes). An additional byte is used as a deletion marker.

(i) Calculate the blocking factor (bfr) and the number of file blocks in B. 2

(ii) Calculate the average time it takes to find a record by doing linear search on the file. 1

(iii) Suppose the file is ordered by the key field SSN and we want to construct a primary index on SSN. Calculate the number of block accesses needed to search for the retrieval a record from the file. 3

(iv) Explain the following terms "Fully functional dependency" and Non-transitive dependency with examples. Use Armstrong's axioms to prove the soundness of the decomposition rule. 3 + 3 + 4

9. (a) What do you mean by BCNF used in the process of normalization? Why 3NF is more preferable than BCNF in certain cases? Why denormalization is needed? 2 × 3

(b) Consider a relation  $R(A, B, C, D, E)$  with the following functional dependencies: 4

$AB \rightarrow C, CD \rightarrow E, DE \rightarrow B$

Is AB a candidate key of this relation ? If not, is ABD ? Explain your answer.

(c) Consider the relation R, which has the attributes that hold schedules of courses and sections at a University;  $R = \{\text{Course No., Sec No., Offering Dept., Semester, Year, Days-Hours, Room No., No. of Students, Credit-Hours, Course Level, Instructor SSN}\}$ . Suppose that the following functional dependencies hold on R:

$\{\text{Course No.}\} \rightarrow \{\text{Offering Dept., Credit-Hours, , Course Level}\}$

$\{\text{Course No., Sec No., Semester, Year}\} \rightarrow \{\text{Days-Hours, Room No., No. of Students, Instructor SSN}\}$  and  $\{\text{Days-Hours, Room No., Semester, Year}\} \rightarrow \{\text{Instructor SSN, Course No., Sec No.}\}$

Determine the key of R. How would you normalize this relation ? 6

(b) Suppose that we decompose the schema  $R = (A, B, C, D, E)$  into  $R_1 = (A, B, C)$  and  $R_2 = (A, D, E)$

Show that this decomposition is lossless join decomposition if the following set F of FDs holds:

$A \rightarrow BC, CD \rightarrow E, B \rightarrow D$  and  $E \rightarrow A$  4

10. Write short notes on— 2 × 10

(i) Relational Calculus and

(ii) Multivalued dependency.

2017-18

## SOFT COMPUTING

CS 710

Full Marks : 70

Time : 3 hours

*The figures in the margin indicate full marks.*Answer *five* questions, taking at most *two* questions from each Group NN and Group GA.

1. (a) Give examples of fuzzy rules with two input fuzzy variables and one output fuzzy variable for
- classification and
  - function approximation problems.
- (b) Given two fuzzy relations  $R$  and  $S$ , between
- type of books Mathematics (M), History (H) and Geography (G) and their Page no. (Pn), Examples (Ex) and Figures (Fg) in the book
  - type of contents (Pn, Ex, Fg) and the demands Low (L), Medium (M) and High (H)

Find the fuzzy relation which will show the demands (L, M, H) of those books (M, H, G). 5 + 9

$R$	Pn	Ex	Fg
M	.6	.9	.1
H	.99	.01	.2
G	.4	.1	.8

$S$	L	M	H
Pn	.4	.95	.2
Ex	.2	.5	.88
Fg	.3	.6	.96

G/12-80

[ Turn Over ]

2. (a) P is a set of 4 people, and the fuzzy sets Tall and Young, given below, show their corresponding membership degrees.

$$P = \{p_1, p_2, p_3, p_4\}, \text{ Tall} = \{0.2, 0.02, 0.9, 0.4\} \text{ Young} = \{0.9, 0.3, 0.8, 0.01\}$$

Find

- (i) a fuzzy set for those who are tall and young and  
(ii) a fuzzy set for those who are not young.
- (b) In fuzzy logic, Tall  $\neq$  NOT (Short). Explain it logically as well as graphically.
- (c) Write a short note on Fuzzy approximation. 4 + 3 + 7

#### Group NN

3. (a) Draw the architecture of an MLP with one hidden layer. Is the error fed back in MLP ?
- (b) Write the learning algorithm for an MLP, mentioned above. Find the expression for updating the weights between hidden and output layers. 4 + 10
4. (a) What is Cover's theorem ?
- (b) Compare between MLP and RBFN.
- (c) Show that RBFN can be used as a linear classifier for XOR problem. 2 + 6 + 6
5. (a) Explain the architecture of Self Organizing Map (SOM).
- (b) Write down the learning algorithm for SOM. Learning in SOM is unsupervised ? Explain it with the help of above algorithm.

- (c) Topology conserving and density matching are followed in SOM. Explain. 4 + 6 + 4

#### Group GA

6. (a) Mention the differences between Genetic Algorithm and traditional/exact algorithm.
- (b) What is elitist strategy in genetic algorithm (GA) ?
- (c) Design the chromosome and a suitable crossover technique for the travelling salesman Problem (TSP) of 9 cities. 5 + 2 + 7
7. (a) Which operator is responsible in GA to follow the Darwin's principle ? Explain.
- (b) What is the significance of diversity in GA ? Which operator(s) is/are responsible for maintaining diversity in GA ? Explain.
- (c) If we make mutation probability high, it may affect the result ? Justify your answer. What will happen if the mutation probability is very less ? 4 + 5 + 5
8. (a) What are the essential criteria of a problem to be solved with multi-objective (GA) ?
- (b) How convergence and diversity are maintained in NSGA II ? Explain in detail. 4 + 10



**Complex Network Theory (CS-713)**

Answer any five  
Time 3 hrs; FM 70

Q1. (a) Let the set of 'n' nodes be portioned into two non-overlapping subset of nodes containing  $n_1$  &  $n_2$  nodes and 'p' be the probability that there exist an edge between a pair of nodes. Derive the probability that no edge exists between  $n_1$  &  $n_2$  in limiting case when 'n' is very large.

(b) State the basic conditions for the existence of giant component. State its significance.

(c) Derive the mean number of 2nd hop neighbors for Poisson graphs.

(5+4+5)

Q2. (a) Describe the Wu-Huberman algorithm for discovering communities in a large network. Comment on its complexity. Show that it converges.

(b) Describe the Radicchi algorithm for finding communities. Comment on the complexity of any community detection algorithm based on edge-betweenness measure, in general.

((5+2)+(4+3))

Q3. (a) "We can have an estimate of the network diameter using node local parameters" – Justify the statement with proper derivations.

(b) How to quantify the degree of centralization of a network? Do we always prefer a decentralized network?

(c) Comment on the hitting time of any pair of nodes in a n-clique. Show derivation.

(d) State clearly the significance and use of second eigenvector.

(6+3+3+2)

Q4. (a) Explain the significance of rank of a matrix in terms of its topological features.

(b) In a clique one eigen value is (n-1) prove remaining eigen values will be -1 each.

(c) Prove "For any matrix eigen values of A &  $A^T$  are same".

(d) State the advantages of using HITS over pagerank algorithm.

(e) Explain how the pageRank++ and HITS overcomes the sink problem.

(2+3+3+3+3)

Q5. (a) Explain an algorithm to rank papers in a paper-paper citation network where there exists a directed edge from node  $P_i$  to  $P_j$  if paper  $P_i$  cites paper  $P_j$ .

(b) State how SALSA defines the stochastic matrix to implement the probabilistic version of HITS algorithm. Show the stationary value of finding the random walker in a node merely depends on the degree of the node.

(6+(4+4))

Q6. (a) Explain the significance of betweenness centrality, eigenvector centrality, degree centrality.

(b) Derive the expression for the giant component for bipartite networks.

(c) What do you mean by spectrum of a graph? Draw the spectrum of a Clique.

(3+7+4)

Q7. Writes notes:

(a) Shortest path betweenness for a general graph

(b) Page rank algorithm.

(7+7)

2017-18

CAD FOR VLSI

CS 721

Full Marks : 70

Time : 3 hours

*All questions carry equal marks.*

Subparts of a question must be attempted together and in order

Answer any *five* questions.

1. (a) Give an ALAP Schedule for the code given below, assuming no resource constraints are given.

$a := b + (*d)$

$c := a + 2$

$b := 7 * (a + d)$

$e := 1 + c$

- (b) Generate the datapath for the schedule obtained above using the fewest number of registers and multiplexers.

2. (a) Explain the left-edge algorithm for register allocation.  
(b) Explain the concept of scan-based structured DFT with a suitable diagram.
3. (a) Explain dynamic list based scheduling and the priority functions used in it.

- (b) Explain the difference between loop unrolling and loop folding in scheduling loop constructs.
4. (a) Explain how clique partitioning is used for interconnect allocation.
- (b) Explain the differences between a full-custom layout style and a standard cell design style and a gate array design style.
5. (a) A combinational circuit is given below. The primary inputs are a,b,c,d and e and the primary outputs are k and l. Find a test for the fault h stuck-at-1 by the path sensitization method.

Gate	Type	Input List
g	nor	a,b
h	nand	a,b,c
i	not	c
j	nor	i,e
k	and	g,h
l	and	h,j

- (b) Explain why sequential circuit test generation is more complex than combinational circuit test generation.
6. (a) Explain how the running time of Lee's Maze Routing Algorithm can be reduced.
- (b) Describe the cluster growth technique for circuit partitioning.

7. Write short notes on any *four* of the following :
- (a) Group Migration Algorithms.
- (b) Slicing and non-slicing floorplan
- (c) IC Fabrication process.
- (d) Fault collapsing.
- (e) Random Access Scan.

2017-18

ADVANCED GRAPH THEORY

CS 722

Full Marks : 70

Time : 3 hours

*The figures in the margin indicate full marks.*

GROUP A

Answer question No. 1  
(Give explanations also)  $10 \times 2 = 20$

1. (a) Find number of perfect matching in a complete graph with six vertices.
- (b) If  $G$  is an undirected plane graph with 10 vertices and 15 edges. Find number of bounded faces.
- (c) Find maximum number of edges in a bipartite graph of 12 vertices.
- (d) If graph  $G$  has 20 vertices, 100 edges and size of minimum vertex cover is 8. Calculate size of maximal independent set.
- (e) Let,  $G$  is a simple loop less graph on 8 vertices and such that there is a vertex of degree 1, a vertex of degree 2, a vertex of degree 3, a vertex of degree 4, a vertex of degree 5, a vertex of degree 6 and a vertex of degree 7. What is the degree of the last vertex ?

- (f) If a simple graph  $G$  has 3 components and these components have 4,5,6 vertices, then find the maximum number of edge present in the graph.
- (g) Which complete bipartite graphs are Hamiltonian?
- (h) What is the largest integer  $m$  such that every simple connected graph with  $n$  vertices and  $n$  edges contains at least  $m$  different spanning trees ?
- (i) Write down the girths of  $K_9, K_{5,7}, W_8$  and  $Q_5$ .
- (j) Find the vertex covering and independence number of  $K_n$  and  $K_{m,n}$

GROUP B

Answer any five questions.  $5 \times 10 = 50$

- 2. (a) Using an example prove that  $G \cong H$  if and only if  $\overline{G} \cong \overline{H}$  where  $\overline{G}$  = complement of  $G$  and  $\cong$ : isomorphism function.
- (b) Show that, a graph with more than six vertices of odd degree cannot be decomposed into three paths.
- (c) If  $G$  is a simple  $n$ -vertex graph with minimum degree  $(G) \geq (n-1)/2$  then  $G$  is a connected graph.  $3 + 3 + 4 = 10$
- 3. (a) What is line/edge graph ? Find number of edges in line graph  $L(G)$  of graph  $G$ .
- (b) Let,  $T$  be a tree with average degree  $a$ . In terms of  $a$ , determine  $n(T)$  where  $n$  is number of vertices.

- (c) Determine the minimum size of a maximum matching in cycle  $C_n$  where  $n$  is number of vertices.  $5 + 3 + 2 = 10$
- 4. (a) What is topological ordering of a directed graph ? If  $G$  has a topological ordering then show that,  $G$  is a directed acyclic graph (DAG).
- (b) Determine all  $r,s$  such that  $K_{r,s}$  is planar. Also show that, a plane graph has a vertex of degree at most 5.
- (c) For each graph  $G$  below, compute edge chromatic number  $(G)$  and draw line graph  $L(G)$ .  $4 + 3 + 3 = 10$

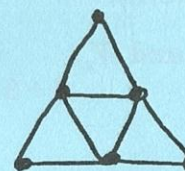


Fig 1

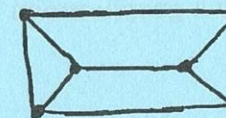


Fig 2

- 5. (a) Show that every separable graph has at least one cut vertex and therefore, has at least two end blocks.
- (b) If  $G_1$  and  $G_2$  are regular graphs, then find  $G_1 \times G_2$ . Also find,  $P_2 \times P_3$ .
- (c) Show that,  $K_3$  is homeomorphic to  $K_{2,2}$   $4 + 3 + 2 = 10$
- 6. (a) Find a cubic graph without a 1-factor. Prove or disprove, Petersen graph is 1 factorable.
- (b) Suppose  $G_1$  has  $v_1$  vertices,  $e_1$  edges and  $G_2$  has  $v_2$  vertices,  $e_2$  edges and  $G_1$  is homeomorphic to  $G_2$ . Show that  $e_1 \cdot v_1 = e_2 \cdot v_2$ .  $2 + 3 + 5 = 10$
- 7. (a) Show that if  $G$  is 3-regular Hamiltonian graph, then

edge chromatic number is 3.

- (b) What is arbitrarily traceable graph ? Draw an arbitrarily traceable and non-arbitrarily traceable graph.
- (c) Explain distance between two spanning trees with a suitable example.  $4 + 3 + 3 = 10$
8. (a) Differentiate maximum matching and maximal matching. If  $G$  is an graph with no isolated vertices, then show that, *maximal matching*  $MM(G) + \text{Minimum edge covering } MEC(G) = |V(G)|$  where  $V$  is set of vertices. Also prove that, if  $G$  is a bipartite graph then *Maximal independent set*  $MIS(G) = MEC(G)$ .
- (b) Draw a graph: union of  $K_{1,3}$  and  $W_4$ .  $2 + 3 + 3 + 2 = 10$

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Q. No. CSC - 01 /

B. Tech./Odd  
2017-18/Reg

2017-18

**INTRODUCTION TO COMPUTING**

**CSC - 01**

Full Marks : 50

Time : Three Hours

*The figures in the margin indicate full marks.*

- Strictly specify the Group name before answering any question. All the parts of a question should be grouped together under the question number.

**Group - A**

Answer any *four* questions.  $5 \times 4 = 20$

1. What do you understand by a null pointer? Is the null pointer same as an uninitialized pointer? What is the difference between a null macro, ASCII null and null string? In which header file the null macro is defined?  
 $1+1+2+1=5$
2. Write a C program to count the occurrences of each digit, white space, and all other characters, using a sequence of *if...else* statement. Then write the same program by replacing *if...else* statement with *switch-case* statement.  
5
3. What is the difference between recursion and iteration? Write a C program to find LCM of two numbers using a recursive function.  $2+3=5$

P.T.O.

( 2 )

4. Differentiate between an array name and an array pointer. Using a program, explain how pointer variables can be used to compare two strings.  $2+3=5$
5. When will you prefer to work with a switch statement? Write a C program to read two numbers. Then find whether the first number is a multiple of the second number.  $2+3=5$
6. Explain the difference between variable declaration and variable definition. Write a program in C to check the occurrence of vowel characters in a given string.  $1+4=5$

**Group - B**

Answer any *three* questions.  $10 \times 3 = 30$

7. (a) How is a member of a union variable assigned an initial value? In what way does the initialization of union variable differ from initialization of a structure variable?
- (b) What is dynamic memory allocation in C? What is the principle difference between the functions malloc( ) and calloc( ) ?
- (c) Write a C program to access the elements of a two dimensional array using pointer to an array.  $2+4+4=10$
8. (a) Write a program to define a structure for a hotel that has the members name, address, grade number of rooms and room charges. Write a function to print the names of the hotels in a particular grade. Also write a function to print the names of a hotel that have room charges less than a specified value.

( 3 )

- (b) Perform  $(24)_{10} - (45)_{10}$  using 2's complement method.  $6+4=10$
9. (a) What is multidimensional array? Write a C program to find sum of two matrices by using the concept of functions.
- (b) Why do we need different types of storage classes? How does a static variable differ from an auto variable? Show with an example.  $1+5+2+2=10$
10. (a) Perform the following operation.
- (i)  $(10101.0011)_2$  to  $(?)_{16}$
- (ii)  $(5c.a3)_{16}$  to  $(?)_2$
- (iii)  $(209.375)_{10}$  to  $(?)_{16}$
- (iv)  $(0.1101010)_2$  to  $(?)_8$
- (b) What is the need of unsigned char? Find the output of the following two program codes :
- (a) `#include<stdio.h>`
- `#define m 5+5`
- `const int n = 5+5;`
- `void main( ) {`
- `int a = 0, b = 0;`
- `a = m * m;`
- `b = n * n;`
- `printf(“%d %d\n”, a, b); }`



( 4 )

(b) #include<stdio.h>

#define SQR(x) (x \* x)

int main ( ) {

int a,b=3;

a = SQR(b+2);

printf("%d\n", a);

return 0; }

(c) Write a C program to keep calculate the sum of the digits of a number until the number is a single digit.

4+1+2+3=10

---

Full Marks: 70

Time: 3 hours

**Answer Question (1) as compulsory and take any five question**

1.
  - a) Do the steps of Image Enhancement in Spatial and Frequency domain remain same? 2
  - b) What are the prerequisites of shape description? 2
  - c) Explain why smoothing and edge detection have conflicting aims. 2
  - d) What are the various factors that influence the brightness of a pixel in an image? 2
  - e) How many number of maximum intensity levels for 8 and 16 bits. 2
  - f) Why median filtering performs well in images corrupted by impulse noise. 2
  - g) Justify the use of second order derivative operator. 2
  - h) How do you define a noise in an image. 1

2.
  - a) A signal  $f(x)$  is defined at the equally spaced set of points  $x = 0,1,2,3$ , is given by 1,2,4,5 respectively. Compute DFT & Amplitude Spectrum of  $f(x)$ .
  - b) Compute 2 DCT and Amplitude Spectrum of the Following Image: 11

1	2
0	1

3. a) Construct a Histogram of the grey levels of the pixels in the following (4 X 4) image :-

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

- Equalize the image and write the resultant image.  
 b) Apply 3 x 3 Median filter to the following (4 X 4) image.

4	9	5	3
3	6	7	5
6	1	9	2
4	9	1	0

4. a) Use Sobel and Prewitt operator on the following (4 x 4) image : 11  
 (Consider the output values at the edge points to be undefined).

10	7	8	9
1	5	6	8
4	8	10	6
10	6	0	2

- b) Can you Justify the use of Laplacian operator in image processing ? Derive the expression of Laplacian Mask. 11

5. a) Consider a Straight line formed by the following noisy line points in the image space : (1,1),(2,2),(3,3), (4,4) and (2,4). Find the straight line using Hough transform. Show all work.

- b) Find the edge corresponding to the minimum-cost path in the sub image shown below. The numbers in brackets are grey levels and outer numbers are spatial co-ordinates. Assume that the edge starts in the first column and ends in the last column. 11

	0	1	2
0	[1]	[2]	[3]
1	[5]	[1]	[7]
2	[4]	[6]	[2]

6. a) Define a chain code using 4 / 8 connectivity in the context of an image. (Take any shape).  
Compute the first difference of the following Chain Code representation:  
101303322130
- b) Explain Dilation and Erosion operator with respect to the following data set:  
 $A = \{(3,3),(3,4),(4,3),(4,4)\}$  and  $B = \{(0,0),(1,0)\}$  11
7. a) The values of feature  $x$  for nine samples from class C1 are 1,2,3,3,4,4,6,6,8. Nine samples from class C2 had values of 4,6,7,7,8,9,9, 10,12. Make a histogram for each class and obtain a decision boundary that minimizes the total number of misclassification for this data set.
- b) Explain K-nearest neighbour algorithm using any ten features for classifying any two types of faces. 11
8. a) Discuss the algorithm of Arithmetic Coding related to image processing and measure the complexity.
- b) Explain the concept of Region Splitting and Merging with suitable examples. 11

2017-1018  
 Subject: Computer Architecture  
 CSE -702

Time 3 Hours

Full Marks- 70

**Answer question (1) as compulsory and take any five from the rest**

- 1) Answer all the questions
- a) Is it possible to achieve parallelism::  
 i)With and within CPU      ii)With many CPU only      iii)Without CPUs  
 iv) All the above
- b) Array processors are put under which of these categories  
 i)SISD      ii)SIMD      iii)MISD      iv)MIMD
- c) A technique in which the output of one pipeline is directly released into another pipeline is called:  
 i) Chaining      ii) Intelligent compiler      iii)Scatter      iv)Gather
- d) The basic principles behind multithreading is to hide:  
 i)Memory Cycles      ii)Memory storages      iii)Memory latency      iv)None of the above
- e) Omega network is a  
 i)Rearrangable network      ii)Blocking network      iii)Non blocking network      iv)None
- f)For an ideal pipe line, effective CPI is :  
 i)1      ii)2      iii)3      iv) 4
- g)Which algorithm is better choice for pipelining:  
 i)hash algorithm      ii)Small algorithm      iii)Merge sort algorithm      iv)None
- h)An n-dimensional hypercube has:  
 i) $n^n$  nodes      ii)n nodes      iii) $2^n$  nodes      iv) None
- i)Latency values must:  
 i)Negative      ii)Positive      iii)Either negative or positive      iv) None
- j)Block in caches are called as :  
 i)Blocks      ii)Block frames      iii)Frames      iv)Pages

10

2. a)Devise a suitable scheme to Implement any Restoring division algorithm through pipelines stages.

b) Prove that an n stage pipelined processor can be at most n times faster than a corresponding non pipelined serial processor.

6+6

3.a)Consider the following Reservation Table:

X					X	
		X				X
X	X		X			
		X		X		

- i) Find All Forbidden latencies and Collision vector. ii)Draw the State Diagram:  
 iii) Evaluate MAL.

b) Explain the effect of different types of Pipeline Hazards. How can they be removed ?

7+5

4. Assume  $P_1$  and  $P_2$  be the two static pipeline and  $T_1$  and  $T_2$  be the reservation table for the pipelines respectively. Let  $C_1(110010)$  and  $C_2(010011)$  be the collision vectors of  $P_1$  and  $P_2$  respectively.

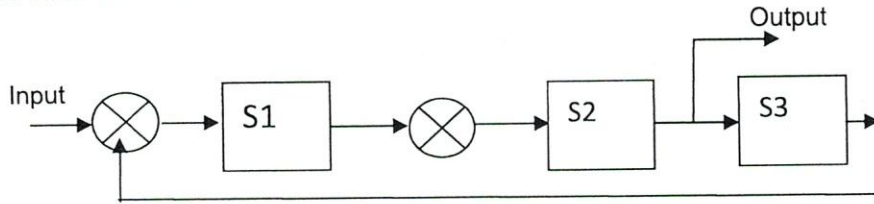
- i) Draw a schematic of a reservation table for a pipeline obtained by chaining  $P_1$  and  $P_2$ .  
 ii) If  $C_1 = 110010$  and  $C_2 = 010011$ , find the collision vector of the chained pipeline.  
 iii) Express the collision vector of the chained pipeline in terms of the collision vector  $C_1$  &  $C_2$   
 iv) Do you think chaining is useful? Why?

12

Contd. (2)

(2)

- 5.a) Consider the following pipe line processor with four stages. All successor stages must be used after each clock cycle. Use suitable clock cycles to implement the State diagram. Also calculate MAL.



8+4

- b) How do you measure the complexity SISD, MIMD class of architecture.
6. a) Illustrate the data routing for a 16 node hypercube machine assuming source node = 10 and destination node = 4. 6 + 6
- b) Draw a data flow graph showing the computations:  
IF  $A > B$  and  $C > D$   
 $X = X + Y$   
ELSE  
 $X = X - Y$
- Explain the Dataflow architecture with an implementation of suitable arithmetic computations.
7. a) Do you find any machine that does not fit into Shores's classification scheme? Explain.
- b) Design a small processor to execute LOAD/STORE and ADD instruction. Show your work. 4+8

Q. No. IT - 301 / 095

B. Tech./Odd

2017-18/Reg

2017-18

**DATA STRUCTURES AND ALGORITHMS**

**IT - 301**

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Attempt any five questions.

1. (a) Explain how choice of data structure affects the performance of implementation of an algorithm.
- (b) A program P reads in 90 integers in the range [0 ... 70] representing the semester marks obtained by 90 students of a class. It then prints the frequency of each score above 40. What would be the best way for P to store the frequencies? Choose the best option. Justify your choice.
  - (i) An array of 40 numbers.
  - (ii) An array of 70 numbers.
  - (iii) An array of 90 numbers.
  - (iv) An array of 30 numbers.
- (c) Name one data structure you have learnt yourself (which was not covered in the syllabus of IT-301). Also mention the source from where you have learnt this. Discuss briefly about the applications of this data structure. 3+4+(1+1+5)

P.T.O.

2. (a) In a competition, four different functions are observed. All the functions use a single for loop (as shown below) and within the for loop, same set of statements are executed. If  $n$  is the size of input (a positive number), which function is most efficient (if the task to be performed within each loop is not an issue)?

(i) for ( $i = 0; i < n; i++$ )

(ii) for ( $i = 0; i < n; i += 2$ )

(iii) for ( $i = 1; i < n; i * = 2$ )

(iv) for ( $i = n; i > -1; i / = 2$ )

(b) Consider the function fun ( ) defined below. For a given linked list p, when does fun ( ) returns 1 ?

```

struct item
{
    int data ;
    struct item * next;
};
int fun (struct item *p)
{
    return ((p == NULL) || (p->next == NULL) ||
    (( p->data <= p->next->data) && fun (p->next) ) ) ;
}

```

Choose the most appropriate option from the following with proper justification.

(i) The elements in the list are sorted in non-increasing order of data value.

(ii) The list is empty.

(iii) The elements in the list are sorted in non-decreasing order of data value.

(iv) The list has exactly one element.

(c) Suppose an implementation of Stack supports an instruction REVERSE, which reverses the order of elements on the stack, in addition to the PUSH and POP instructions. Which one of the following statements is TRUE with respect to this modified stack? Justify your answer.

(i) A queue can be implemented using the above mentioned stack where ENQUEUE takes a single instruction and DEQUEUE takes a sequence of two instructions.

(ii) A queue can be implemented where ENQUEUE takes a sequence of two instructions and DEQUEUE takes a single instruction.

(iii) A queue can be implemented using the above mentioned stack where ENQUEUE takes a single instruction and DEQUEUE takes a sequence of three instructions.

(iv) A queue can never be implemented using the above mentioned stack.

( 4 )

- (d) Consider the following pseudo code. Assume that IntQueue is an queue of integer elements.

```
void fun (int n)
{
    IntQueue q = new IntQueue ( );
    q.enqueue(0);
    q.enqueue (1);
    for (int i = 0; i < n; i++)
    {
        int a = q.dequeue ( );
        int b = q.dequeue ( );
        q.enqueue (b);
        q.enqueue (a + b);
        ptint (a);
    }
}
```

What does the above function do in general? Choose the correct option from the following with proper justification.

- (i) Prints numbers from 0 to  $n-1$
- (ii) Prints first  $n$  Fibonacci numbers
- (iii) Prints first  $n$  Fibonacci numbers in reverse order
- (iv) Prints binary representation of  $n$

3+4+4+3

( 5 )

3. (a) Consider the following expression written in standard infix notation:  $((-a)+(x+y))/(b*(c*a))$ . Rewrite the expression in Reverse Polish Notation. Also draw the expression tree corresponding to the expression and compute the postorder traversal of the expression tree.
- (b) A binary tree  $T$  has 20 leaves. What is the number of nodes in  $T$  having two children? Justify your answer.
- (c) The nodes of a binary tree are labeled with  $a, b, c, \dots, i, j, k$ . The preorder and inorder traversals are "a b d h i e c f g j k" and "h d i b e a f c j g k" respectively. Draw the tree. Briefly explain the steps.  
(2+2+1)+3+6
4. (a) The following numbers are inserted into an empty binary search tree in the given order: 10, 1, 3, 5, 15, 12, 16. What is the height of the binary search tree thus constructed?
- (b) What is the minimum number of nodes in an AVL tree of height 5?
- (c) Design an efficient algorithm to merge two height balanced binary search trees  $B_1$  and  $B_2$  having  $n$  and  $m$  elements respectively. Explain your algorithm with suitable examples. Also mention the time complexity of your algorithm.  
3+3+8
5. (a) Prove that the longest simple path from a node  $x$  in a red-black tree to a descendent leaf has length at most twice that of the shortest simple path from node  $x$  to a descendent leaf.



(b) Consider the array representation of a binary max-heap. Which one of the array shown below represents a binary max-heap ?

(i) 25, 12, 16, 13, 10, 8, 14

(ii) 25, 14, 16, 13, 10, 8, 12

(iii) 25, 14, 12, 13, 10, 8, 16

(iv) 14, 25, 13, 10, 12, 8, 16

(c) Draw the binary tree represented by the array given below. Transform the tree into a binary min-heap without using any sorting algorithm. Show the modified tree H representing the min-heap thus obtained. Also show the array representation of H.

40	33	35	27	12	16	5	7	44	37	20	22	13	32	72
----	----	----	----	----	----	---	---	----	----	----	----	----	----	----

(d) What is the minimum number of comparisons to find the second largest element in a binary max-heap of  $n$  distinct elements ?  $2+4+6+2$

6. (a) What is the maximum number of nodes in an M-way search tree of height  $h$  ?

(b) Consider a B-tree in which the maximum number of keys in a node is 5. What is the minimum number of keys in any non-root node ?

(c) Briefly explain the issues based on which order of a B tree is chosen.

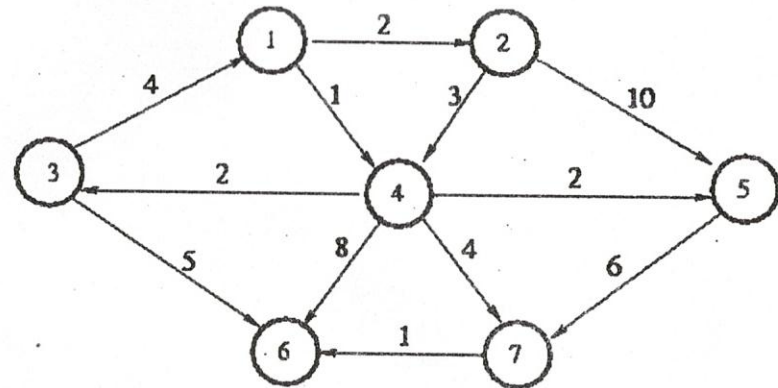
(d) Starting with an empty 2-3-4 tree, insert the items 53, 27, 75, 25, 70, 41, 38, 16, 59, 36, 73, 65, 60, and 46 one by one in the given order. Clearly depict all the steps.  $2+2+3+7$

7. (a) Suppose that a dynamic set  $S$  is represented by a direct-addressed table  $T$  of length  $m$ . Describe a procedure that finds the maximum element of  $S$ . What is the worst-case performance of your procedure?

(b) The keys 12, 18, 13, 2, 3, 23, and 15 are inserted into an initially empty hash table of length 10 using open addressing with hash function  $h(k) = k \text{ mod } 10$  and linear probing. Draw the resultant hash table.

(c) Breadth First Search (BFS) is started on a binary tree beginning from the root vertex. There is a vertex  $t$  at a distance four from the root. If  $t$  is the  $n$ -th vertex in this BFS traversal, then what is the maximum possible value of  $n$ ?

(d) Apply Dijkstra's algorithm to find the shortest path from the node 3 to the node 5 of the graph shown below.  $3+3+3+5$



Q. No. IT - 302 / 073

B. Tech./Odd  
2017-18/Reg

2017-18

**COMPUTATIONAL MATHEMATICS**

**IT - 302**

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers  
in their own words as far as practicable.*

Answer Question No. 1 and any five from the rest.

1. Answer any five :  $2 \times 5 = 10$

- (i) Define a feasible solution.
- (ii) What are the disadvantages of Big M method over two-phase method?
- (iii) Explain how degeneracy in a Transportation Problem may be resolved?
- (iv) What do you mean by an unbalanced assignment problem?
- (v) Distinguish between Pure and Mixed strategies.
- (vi) What is the redundant constrain?

( 2 )

2. (a) Show that the following function whether it is convex, concave or neither

$$f(x) = x_1^2 + x_2^2 - 2x_1x_2$$

- (b) A positive quantity  $b$  is to be divided into  $n$  parts in such a way that the product of  $n$  parts is to be a maximum. 5+7
3. (a) An Air Force is experimenting with three types of bombs  $P$ ,  $Q$  and  $R$  in which three kinds of explosive, viz  $A$ ,  $B$  and  $C$  will be used. Taking the various factors into account, it has been decided to use the maximum 600 kg of explosive  $A$ , at least 480 kg of explosive  $B$  and exactly 540 kg of explosive  $C$ . Bomb  $P$  requires 3, 2, 2 kg, bomb  $Q$  requires 1, 4, 3 kg and bomb  $R$  requires 4, 2, 3 kg of explosives  $A$ ,  $B$  and  $C$  respectively. Bomb  $P$  is estimated to give the equivalent of a 2 ton explosion, bomb  $Q$ , a 3 ton explosion and bomb  $R$ , a 4 ton explosion respectively. Under what production schedule can the Air Force make the biggest bang? 12

4. (a) Write the dual of the following primal LPP

Maximize  $Z = 3x_1 - 2x_3 + 5x_2$

subject to  $3x_1 + 5x_2 \leq -5$

$$-5x_1 + 3x_3 = 4$$

$$4x_3 - 3x_2 = 9$$

and  $x_1, x_2 \geq 0$  and  $x_3$  is in unrestricted in sign.

( 3 )

- (b) The Payoff matrix of a game is given below. Find the solution of the game to  $A$  and  $B$

		B				
		I	II	III	IV	V
A	I	-4	-2	-2	3	1
	II	1	0	-1	0	0
	III	-6	-5	-2	-4	4
	IV	3	1	-6	0	-8

5+7

5. (a) There are three factories  $A$ ,  $B$  and  $C$ , which supply goods to four dealers  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$ . The production capacities of these factories are 1000, 700 and 900 units per month respectively. The requirements from the dealers are 900, 800, 500 and 400 units per month respectively. The per unit return (excluding transportation cost) are Rs. 8, Rs. 7 and Rs. 9 at the three factories. The following table gives the unit transportation costs from the factories to the dealers. Determine the optimum solution to optimize the total returns.

	$D_1$	$D_2$	$D_3$	$D_4$
$A_1$	2	2	2	4
$A_2$	3	5	3	2
$A_3$	4	3	2	1

P.T.O.

( 4 )

(b) The assignment cost of assigning any one operator to any machine is given in the following Table. Determine the optimal assignment.

		Operators			
		I	II	III	IV
Machine	A	10	5	13	15
	B	3	9	18	3
	C	10	7	3	2
	D	5	11	9	7

6+6

6. (a) Solve the following NLPP by using Lagrangian multipliers method.

Minimize  $Z = x_1^2 + x_2^2 + x_3^2$

subject to  $4x_1 + x_2^2 + 2x_3 = 14$

and  $x_1, x_2, x_3 \geq 0$

(b) Construct a network diagram for a project comprising of the activities B, C, E, F, G, H, I, J, L, M, N, P and Q such that the following precedence relationship are satisfied : B < E, F; C, F < G; C < L; E, G < H; H, L < I; H < J; L < M; H, M < N; I, J < P; N < Q.

7+5

7. (a) Determine the relative maximum and minimum (if any) of the following function.

$f(X) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$

( 5 )

(b) The time estimates (in weeks) for the activities of a PERT network are given below.

Job	1-2	1-3	2-4	2-5	3-5	4-6	5-6
a	1	1	2	1	2	2	3
m	1	4	2	1	5	5	6
b	7	7	8	1	14	8	15

(i) Draw the project network.

(ii) Determine the expected project length.

(iii) What is the probability that the project will be completed

At least 4 weeks earlier than expected?

Not more than 4 weeks later than expected?

(Given  $\phi(1.33) = 0.4082$ ).

5+7

Q. No. IT 501 /

B. Tech / Odd  
(17-18) / Reg

2017-18

**MICROPROCESSOR**

**IT 501**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

*Answer any five questions.*

1. (a) What is a Machine cycle ? What is its relation to length of the instruction ? 3
- (b) Draw the Memory Write machine cycle. 4
- (c) Specify the contents of registers A,D, and HL after execution of the following instructions: 1 + 1 + 2
- LXI, XX90H;  
SUB A;  
MVI D, 0FH;  
LOOP: MOV M,A;  
INX H; DCR D;  
JNZ LOOP  
HLT
- (d) Specify the memory location and its content after the following instructions are executed: 3
- MVI B, F7H  
MOV A,B

STA XX75H

HLT

2. (a) Draw the diagram to de-multiplex the multiplexed address bus of 8085A 3
- (b) How can the memory address range of a memory chip be changed ? Explain with a diagram. 4
- (c) Draw the block diagram of a microprocessor and explain its parts. 5
- (d) What is the importance of ALE signal ? 2
3. (a) Sort a set of three readings is stored in memory starting at XXXXH. 3
- (b) What are the instructions to clear the (ACC) ? 2
- (c) With diagrams, explain the difference between RAR and RRC. 3
- (d) What is an index register ? Is there any index register in 8085A ? If not, how is a memory location indexed ? 1 + 1 + 1

A data byte 32H is resident in the memory location 2400H. It needs to be added to the (A). How is 2400 location indexed and what shall be the ALP for the addition to proceed ? 3

4. (a) What is importance of LXI SP, XXXX instruction ? 2
- (b) Where is stack initialized and why ? 1 + 2
- (c) Why are instructions PUSH PSW and POP PSW used? 2

- (d) Can a microprocessor be interrupted again once it is interrupted ? Give reasons. 3
- (e) What is difference between RST instruction and Vectored interrupt ? Give significance of SIM instruction. 2 + 2
5. (a) Design a mod- 10 up Counter that resets on encountering 9 and repeats the sequence continuously with 1 second delay between each count. Use Clock speed 2 MHz. Use register pair HL to set up the delay. 7
- (b) Show the sequence of events in Call instruction only through a diagram (No explanation). 7
6. (a) Draw a circuit to implement RST 5 3
- (b) Write a program to generate a square wave with period of 400 microseconds assuming system clock period to be 325 nanoseconds. Use bit  $D_0$  to output square wave. 7
- (c) Name the different vectored interrupts. What is their priority sequence ? If there is a high signal on HOLD and other interrupts which signal is served first and why ? 1 + 1 + 2
7. (a) What is DMA ? Why data transfer in interrupt mode not suitable for DMA ? Explain the master mode and slave mode of DMA execution for 8237A chip. 1.5 + 1.5 + 3
- (b) Draw the block diagram of a 8254 Programmable Interval Timer. 3
- (c) Explain any one mode of the counter in detail. What are its other modes ? 3 + 2

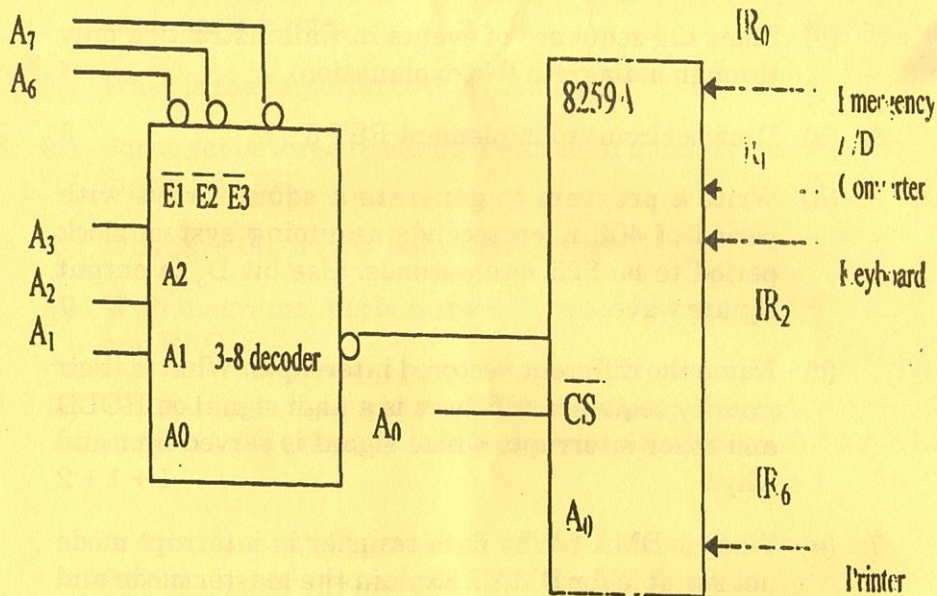
8. (a) What are the functions of 8259A PIC ? 3

(b) Explain the following initialization instructions in reference to the Fig. 1 5

```

DI
MVI A, 76H
OUT 80 H
MVI 20 H
OUT 81 H

```



(c) Draw the block diagram of 8259 A PIC controller. 4

(d) Draw the ICW1 (Initialization Command word-1) format. 2

9. (a) Explain the modes of 8255A PPI. 3

(b) Draw 8255A Mode 1 output configuration and explain the handshake signals. 5

(c) Explain the control word format of 8255A PPI. What shall be the control word for 6b, i.e. Mode 1, output configuration ? 4 + 2

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2017-18

**THEORY OF COMPUTATION**

**IT 502**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

**PART A**

Select the correct alternatives.  $20 \times 1 = 20$

1. The minimum length string generated by the regular expression  $(a+b+c)(a+b)(a)$  over the  $\Sigma = \{a, b, c\}$  is
  - (a) 0
  - (b) 1
  - (c) 3
  - (d) 6
2. Consider the following two grammars over  $\Sigma = \{(,)\}$  for balanced parenthesis

GRAMMAR-1      GRAMMAR-2

$S \rightarrow SS$        $S \rightarrow (S)S$

$S \rightarrow (S)$        $S \rightarrow (S)$

$S \rightarrow \phi$        $S \rightarrow () \mid \phi$

Which of the GRAMMAR is/are ambiguous ?



- (a) Only GRAMMAR-1  
 (b) Only GRAMMAR-2  
 (c) Both of the GRAMMAR  
 (d) None of the above
3. Which are not regular:
- (i)  $L = \{a^n b^n | n > 0\}$   
 (ii)  $L = \{a^n b^m c^n | m, n > 0\}$   
 (iii)  $L = \{a^{n+m} | m, n > 0\}$
- (a) Only i and ii  
 (b) Only ii and iii  
 (c) Only i and iii  
 (d) All are non regular
4. Let  $aAbBc$  be a sentential form where  $a, b, c \in \Sigma$  and  $A, B \in V_N$  (set of nonterminals). Consider the two productions:
- $$aA \rightarrow aa, bB \rightarrow bb$$
- The immediate next sentential form derived as using left-most derivation is:
- (a)  $aabBc$   
 (b)  $aAbbc$   
 (c)  $Aabbc$   
 (d) None of the above
5. The transition function of a deterministic PDA is:  
 (consider  $Q, \Sigma, \Gamma$  be the set of states, input alphabets, and STACK symbols)

- (a)  $Q \times \{\Sigma \cup \Phi\} \times \Gamma \rightarrow Q \times \Sigma$   
 (b)  $Q \times \{\Sigma \cup \Phi\} \times \Gamma \rightarrow Q \times \Sigma^*$   
 (c)  $Q \times \{\Sigma \cup \Phi\} \times \Gamma \rightarrow 2^{Q \times \Sigma^*}$   
 (d)  $Q \times \{\Sigma \cup \Phi\} \times \Gamma \rightarrow Q \times \Gamma^*$
6. Consider the grammar:
- $$S \rightarrow aSa \mid bSb \mid a \mid b$$
- (a) Generates all palindromes over  $\Sigma = \{a, b\}$   
 (b) Generates all palindromes of even length over  $\Sigma = \{a, b\}$   
 (c) Generates all palindromes of odd length over  $\Sigma = \{a, b\}$   
 (d) None of the above
7. Which of the following production is in Chomsky's Normal Form (CNF):
- i.  $A \rightarrow aB$   
 ii.  $A \rightarrow BC$   
 iii.  $A \rightarrow c$
- (a) Only the production i.  
 (b) Production i and ii.  
 (c) Production ii and iii.  
 (d) None of the above.
8. Let  $(10+01)1^*(11+00)$  be the regular expression for the language L. The regular expression of  $L^R$  is:
- (a)  $(01+10)1^*(00+11)$   
 (b)  $(00+10)1^*(11+01)$

- (c)  $(11+00)1^*(10+01)$   
 (d) None of the above

9. The minimum length string generated by the regular expression  $(aaa+aa+a)(bb+b)$  is:

- (a) 0  
 (b) 1  
 (c) 2  
 (d) 3

10. The type of the following production is:

$aA \rightarrow aa$

- (a) Type 0  
 (b) Type 1  
 (c) Type 2  
 (d) Type 3

11. The regular expression of the language  $\Sigma = \{0, 1\}$  where the 3<sup>rd</sup> alphabet from right is 0:

- (a)  $(1+0)^*0(1+0)(1+0)(1+0)$   
 (b)  $(1+0)0^*(1+0)(1+0)(1+0)$   
 (c)  $(0(1+0)(1+0))^*$   
 (d)  $(1+0)^*000$

12. The production

$AB \rightarrow BA$

is a

- (a) Type 0

- (b) Type 1  
 (c) Type 2  
 (d) Type 3

13. Consider the following grammar over  $\Sigma = \{a, b\}$

$S \rightarrow aSb \mid aA \mid Bb$

$A \rightarrow aA$

$B \rightarrow Bb$

The grammar generates the language

- (a)  $L = \{a^n b^m \mid n > m\}$   
 (b)  $L = \{a^n b^m \mid n \neq m\}$   
 (c)  $L = \{a^n b^m \mid n < m\}$   
 (d)  $L = \{a^n b^m \mid n = m\}$

14. Let  $L_1$  and  $L_2$  be two context-free languages, which of the following is correct:

- (a)  $L_1 \cap L_2$  is context-free  
 (b)  $L_1 \cup L_2$  is context-free  
 (c)  $\Sigma^* - L_1$  (complement of  $L_1$ ) is always context-free  
 (d) None of the above is context free.

15. The set  $R$  is called recursively enumerable if

- (a) For which there exists at least one TM (Turing Machine).  
 (b) For which there exists at least one TM that runs on every input  $r \in R$  and either halts or loops for ever.  
 (c) For which there exists an universal TM which always halts on every input  $r \in R$ .

- (d) All the above are correct.
16. Let  $L$  be a regular language over  $\Sigma$ . Then, there exists a constant  $n$  such that for every  $w \in L$  with  $|w| \geq n$  we have  $x, y, z$  substrings of  $w$  (i.e.  $w = xyz$ ) such that
- $|xy| \leq n, |y| \geq n$  and  $xy^iz \in L$  for  $i = 0, 1, \dots$
  - $|xy| \leq n, |y| \geq 1$  and  $xy^iz \in L$  for  $i = 0, 1, \dots$
  - $|xy| \leq n, |y| \geq 1$  and  $xy^iz \in L$  for  $i = 1, 2, \dots$
  - $|xy| \leq n, |y| \geq n$  and  $xy^iz \in L$  for  $i = 1, 2, \dots$
17. The automata for context free language is
- Finite state machine
  - Push down automata
  - Linearly bounded automata
  - Turing machine
18. If  $A$  and  $B$  are two regular sets, then:
- $\overline{A \cap B}$  is not regular.
  - $\overline{A \cap B}$  is regular.
  - Cannot determine  $\overline{A \cap B}$
  - $\overline{A \cap B}$  is NULL
19. Context free language is not closed under
- Union operation
  - Complement operation
  - Reversal Operation
  - Concatenation operation

20. A Turing Machine has the transition function as  
(NOTE:  $Q, \Sigma, \Psi$  be the set of states, input alphabet, set of tape symbol.)
- $Q \times \Sigma \rightarrow Q \times \{\Sigma \cup \Psi\} \times \{\text{left, right, NOmove}\}$
  - $Q \times \Sigma \rightarrow Q \times \{\Sigma \cup \Psi\}^* \times \{\text{left, right, NOmove}\}$
  - $Q \times \Sigma \rightarrow Q \times \Sigma \times \{\text{left, right, NOmove}\}$
  - None of the above

## PART B

Select the correct alternatives.

**Justify your Answer** $10 \times 2 = 20$ 

21. The transition functions of a PDA is as follows:

 $(q_0, a, Z) \rightarrow (q_1, AZ)$  $(q_0, b, Z) \rightarrow (q_1, BZ)$  $(q_1, a, A) \rightarrow (q_1, AA)$  $(q_1, a, B) \rightarrow (q_1, \phi)$  $(q_1, b, B) \rightarrow (q_1, BB)$  $(q_1, b, A) \rightarrow (q_1, \phi)$  $(q_1, a, B) \rightarrow (q_1, \phi)$  $(q_1, \phi, Z) \rightarrow (q_1, \phi)$ 

Which of the following string are accepted by the PDA.  $q_0$  is the initial state,  $Z$  initial Stack Symbol,  $q_1$  final state.

- (FIRST) equal number of  $a$ s and  $b$ s

- (b) (SECOND) even number of as and bs
- (c) Both FIRST and SECOND
- (d) None of the above

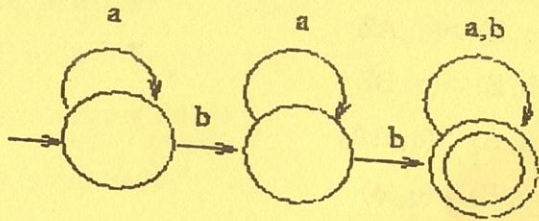
22. Consider the CFG G1 with the production as

$$S \rightarrow aSa \mid bSb \mid c$$

Let G2 be the Chomsky Normal Form of G1. The additional number of nonterminals (minimum) and the total number of productions in the grammar G2 would be

- (a) Additional nonterminals: 4, Number of productions: 7
- (b) Additional nonterminals: 5, Number of productions: 8
- (c) Additional nonterminals: 3, Number of productions: 7
- (d) Additional nonterminals: 2, Number of productions: 9

23. Consider the FSM as below



The number of length-3 strings which are not accepted by the FSM is

- (a) 6
- (b) 4
- (c) 3
- (d) 2

24. Let T be a Turing machine with the transition as follows:

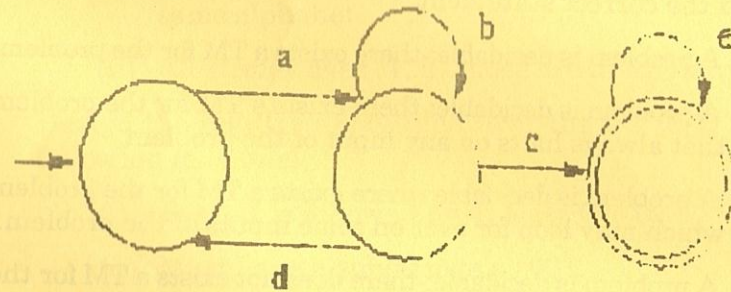
- $(q_0, 0) \rightarrow (q_1, 0, R)$
- $(q_0, 1) \rightarrow (q_2, 1, R)$
- $(q_1, 0) \rightarrow (q_0, 0, L)$
- $(q_2, 1) \rightarrow (q_0, 1, L)$
- $(q_1, 1) \rightarrow (q_2, 1, R)$
- $(q_2, 0) \rightarrow (q_1, 0, R)$
- $(q_1, B) \rightarrow (q_h, B, H)$
- $(q_2, B) \rightarrow (q_2, B, H)$

where  $q_h$  is the halt state. B is the blank symbol, R, L, H denote right, left and NOMove

For what input the TM loops for ever. Let initially TM is at left of the input.

- (a) 1010
- (b) 0101
- (c) 1100
- (d) None of the above

25. The regular expression of the following DFSM is



- (a)  $(ab^*)^*(c+d)e^*$
- (b)  $(ab^*d)^*ab^*ce^*$

- (c)  $ab^*(d+c)^*e^*$   
 (d) None of the above
26. An empty stack PDA accepts the string if  
 (Note:  $q_0$  the initial state,  $w$  input string,  $Z$  initial stack,  $\alpha$  string over stack symbol,  $q_f$  any state,  $q_f$  final state)
- (a)  $ID_0(q_0, w, Z) \rightarrow ID_f(q_i, \phi, \alpha)$   
 (b)  $ID_0(q_0, w, Z) \rightarrow ID_f(q_f, \phi, \phi)$   
 (c)  $ID_0(q_0, w, Z) \rightarrow ID_f(q_i, \phi, \phi)$   
 (d)  $ID_0(q_0, w, Z) \rightarrow ID_f(q_f, \phi, \alpha)$
27. If  $L_1$  and  $L_2$  are regular and context-free respectively. Which of the following statement is correct ?
- (a)  $L_1 \cap L_2$  is regular  
 (b)  $L_1 \cap L_2$  is context free  
 (c)  $L_1 \cap L_2$  is not regular  
 (d)  $L_1 \cap L_2$  is type 1 grammar
28. Find the correct statement.
- (a) A problem is decidable:-there exists a TM for the problem.  
 (b) A problem is decidable:-there exists a TM for the problem that always halts on any input of the problem.  
 (c) A problem is decidable:-there exists a TM for the problem which may loop for ever on some inputs of the problem.  
 (d) A problem is decidable:-there does not exists a TM for the problem.
29. Which of the following is a member of the regular set defined by the regular expression  $(\phi+1)(0+01)^*$

- (a) Equal number of 0s and 1s.  
 (b) Contains substring 01.  
 (c) Number of 0s is more than 1s.  
 (d) No successive 1s.
30. Which of the following statement is true
- (a) For every nondeterministic FSM there exists a deterministic FSM.  
 (b) For every nondeterministic PDA there exists a deterministic PDA.  
 (c) For every nondeterministic TM there exists a deterministic TM.  
 (d) All above are correct.

## PART C

(Marks :  $6 \times 5 = 30$ )

31. (a) Design the Grammar for the following: any one
- (i) All strings over  $\{a, b\}$  those start and end with the same alphabet.  
 (ii) All strings over  $\{1, 0\}$  those are divisible by 3.
- Design the regular expression over the set  $\{0,1\}$  for the following (any one)
- (i) Every 1 is followed by at least two 0s.  
 (ii) Must have a substrings as 001. 3 + 3

Or

- (b) Find the Deterministic FSM for the following (apply the closure property of FSM). any one

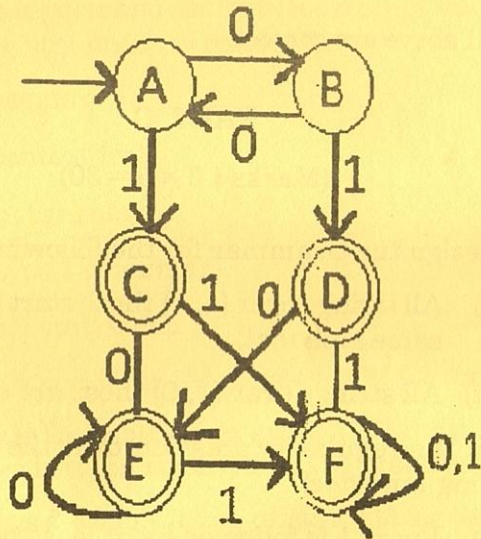
- (i) Accepts binary strings having even length and no successive 0s. 6
- (ii) Accepts binary strings of odd length and divisible by 3. 6

32. (a) Using Pumping lemma show that the following is not regular. any one

- (i) Strings of all palindromes over {a,b}
- (ii)  $L = \{a^p \mid \text{where } p \text{ is prime}\}$  6

Or

(b) Find the minimized FSM for the following machine: 6



33. (a) Design Push Down Automata for the following: any one

- (i) Accepts all palindromes over {a,b}, including odd length.

- (ii) Accepts the strings over {0,1}, with equal number of 0s and 1s. 6

Or

(b) (i) Find the CNF of the given context free grammar:

$$S \rightarrow aB \mid bA$$

$$A \rightarrow aS \mid bAA \mid a$$

$$B \rightarrow bS \mid aBB \mid b$$

(ii) Define the Greibach Normal form (GNF).

(iii) The left recursive production is as follows:

$$A \rightarrow A\alpha$$

$$A \rightarrow \beta$$

How to eliminate the left recursion? 3 + 1 + 2

34. (a) (i) Let  $M_{PDA}$  be an empty stack PDA. Write the procedure to find the equivalent Final State PDA.

(ii) Let  $M_1$  and  $M_2$  be two empty stack PDAs which define the languages  $L_1$  and  $L_2$  respectively. Write the procedure to make a PDA that accepts  $L_1 \cup L_2$ . 3 + 3

Or

(b) Find the nondeterministic PDA for the context free grammar

$$S \rightarrow aSbS \mid bSaS \mid \phi$$

Show the derivation tree for the string aaabbb. 3 + 3

35. (a) Design the Turing Machine for the following: any one

(i)  $L = \{wcw^R \mid \text{where } w \text{ is a string over } \{0,1\}\}$

(ii)  $L = \{a^n b^n c^n \mid n > 0\}$

6

Or

(b) Describe the Universal Turing Machine (UTM) and the halting problem of Turing Machine.

6

2017-18

## COMPUTER NETWORKS

IT 503

Full Marks : 70

Time : 3 hours

*The figures in the margin indicate full marks.*

Answer any five questions.

1. (a) For the network shown in Fig. 1(a), the numbers written around the links show their respective delay (assumed to be same in both directions) and the existing routing table for node A is shown in Fig. 1(b). Now, F measures the delays from its neighbours and sends a new link-state packet, as shown in Fig. 1(c). After A receives the packet, show the changes that must occur in the routing table of A. 2 + 3 = 5

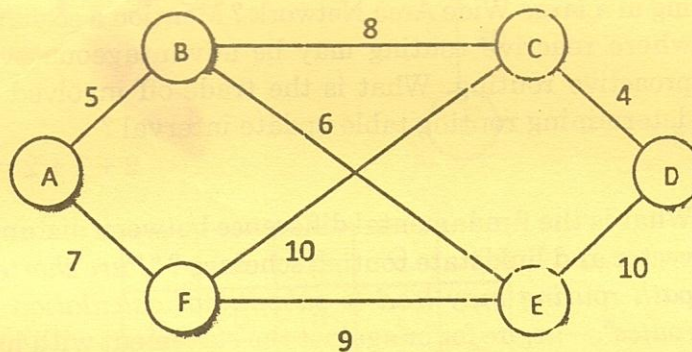


Figure 1(a)



Destination	Next hop	Delay
A	A	0
B	B	5
C	B	13
D	B	17
E	E	7
F	B	11

Fig. 1(b)

Node	Distance
D	7
B	8
E	4

Fig. 1(c)

(b) Why hop-by-hop routing is preferred over source routing in a large Wide Area Network? Mention a scenario where reactive routing may be advantageous over proactive routing. What is the trade-off involved in determining routing table update interval?

$2 + 1 + 2 = 5$

(c) What is the fundamental difference between distance vector and link state routing schemes? "Pure shortest path routing may lead to suboptimal calculation of routes". - argue for or against the statement with justifications.

$2 + 2 = 4$

2. (a) Traffic sources with peak rate of 10 Mbps and average rate of 1 Mbps are to be multiplexed through a link of capacity 100 Mbps. If pure TDM is used, then how many sources can be multiplexed? Also determine the utilization of the output link.

$2 + 1 = 3$

(b) If a buffer of infinite length is available for temporarily buffering the packets and statistical multiplexing scheme is used, then how many sources can be connected? What is the utilization of the output link? Hence find the statistical multiplexing gain. Is there any penalty behind the gain?

$2 + 1 + 1 + 1 = 5$

(c) For the network shown in Fig. 2(a), the numbers around the links show the traffic carrying capacity of the link in packet per second. The average traffic matrix along with the routers to be followed are shown in Figure 2(b). Find the expected delays from A to C. Also find the expected number of packets queued up in the link buffer of BA.

$3 + 3 = 6$

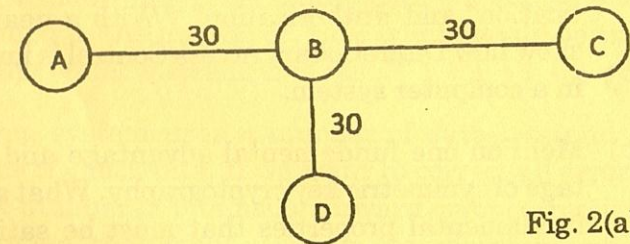


Fig. 2(a)

	A	B	C	D
A	0	5	7	9
B	5	0	6	8
C	7	6	0	10
D	9	8	10	0

Fig. 2(b)

3. (a) Why IP is designed to be connectionless ? How does TCP achieve connection oriented transport over the connectionless IP ? 2 + 2 = 4
- (b) With a schematic diagram show how connection is established by TCP mentioning each message. Mention the use of receiver's window, congestion window and threshold window in TCP. How does TCP update the congestion window after receiving each acknowledgement in slow-start phase and in congestion avoidance phase ? 2 + 3 + 2 = 7
- (c) An image of size 60 kB is to be transferred using simple TCP. The packet size is 1.5kB and current RTT is 10ms. How long will it take for the receiver to receive the complete file if there is no transmission error ? If the 15<sup>th</sup> packet suffers a loss and there is no error thereafter, how long would it take for completion of successful transmission. 3 + 3 = 6
4. (a) What is the fundamental difference between "authentication" and "authorization" ? With a neat diagram, show how Discretionary Access Control is implemented in a computer system. 2 + 2 = 4
- (b) Mention one fundamental advantage and disadvantage of symmetric key cryptography. What are the two fundamental properties that must be satisfied by a private - public key pair ? Explain how message non-repudiation can be implemented by using public key cryptography. 2 + 2 + 1 = 5
- (c) What is hash function ? Which property must be satisfied by a hash function so that it can be effectively utilized for message integrity check ? With a

- neat sketch, show the steps involved in establishing a SSL session between two end users' applications over the Internet. 1 + 1 + 3 = 5
5. (a) A modulation scheme converts 10 kbauds per second to kbits per second. The transmitted signal (digitally modulated analogue carrier) can assume two possible amplitudes only. Show the constellation diagram of the modulation scheme. 3
- (b) Why do fibre-optic links offer higher capacity than ordinary radio frequency media ? Which of the two types of media (mentioned above) offer lower signal propagation time ? 2 + 1 = 3
- (c) A link has capacity of 1Mpbs and its length is 1000km. Packets of size 1kbits are to be transmitted over the link and velocity of signal through the link is  $2 \times 10^5$ km/s. Find packet transmission time, packet propagation time and round trip time over the link. If sliding window based backward error correction is to be applied in the link layer, then what should be the optimum window size in this case ? 1 + 1 + 1 + 2 = 5
- (d) A coding system uses  $n$  number of data bits and  $c$  number of check bits. If we want to correct all errors up to  $k$  number of bits using forward error correction mechanism, then what would be the minimum value of  $c$  ? Mention one advantage and one disadvantage of 'go back  $n$ ' and 'selective repeat' based sliding window protocol. 3 + 2 = 5
6. (a) Why do we need frame delimiters ? If the bit pattern 01111110 is used as the frame delimiter and bit sequence in a transmitted frame is 010111110010-

1011110110, determine the actual data pattern that was required to be transmitted to the receiver.

$$2 + 2 = 4$$

- (b) In a local area network, 4 stations share a common medium. The time is slotted such that each station can transmit only at the beginning of the slot. If the probability of transmission of a station in a slot is 0.1, find the:

$$1 + 1 + 1 = 3$$

(i) Probability of successful transmission ( $P_s$ ).

(ii) Probability that a slot remains idle ( $P_i$ ).

(iii) Probability that collision occurs ( $P_c$ ).

- (c) What are the relative advantages and disadvantages of 1-persistent and non-persistent CSMA ? Explain how in CSMA, dynamic  $p$ -persistence can be achieved in such a way that ' $p$ ' adapts with the existing load.

$$2 + 3 = 5$$

- (d) Why do we observe collision CSMA in spite of accessing channel only when it is sensed free ?

$$2$$

7. (a) What role does a TCP port number play ? Do you need to assign any port number to a client-socket ? If not, how is it assigned ?

$$2 + 1 + 1 = 4$$

- (b) What is the sequence of system call that a TCP client program has to make ?

$$3$$

- (c) Write a TCP server program in a language of your choice (preferred C language) showing clearly how Listen and Accept operations are implemented.

$$4$$

- (d) Write a program in a language of your choice to implement a TCP server which can handle concurrently handle connection requests using multithreading.

$$3$$

2017-18

DESIGN AND ANALYSIS OF  
ALGORITHMS

IT 504

Full Marks : 70

Time : 3 hours

*The figures in the margin indicate full marks.*

Answer any five questions and in order.

1. (a) Find the time complexity of the following algorithms:  
*DFS* and *Bellman-Ford algorithm* for single source  
shortest path problem. 2 + 2
- (b) What is the speciality of *Bellman-Ford algorithm*.  
When will it fail ? 2 + 2
- (c) How can you modify the *Bellman-Ford algorithm* so  
that it can run faster. Write the pseudo code. What is  
the other usage of *Bellman-Ford algorithm* ?  
2 + 3 + 1
2. (a) What is randomized algorithm ? 1
- (b) Write the pseudo code of the randomized version of  
Quick sort. Write the recurrence of this. Solve this  
recurrence. 3 + 3
- (c) Can you recognize the following expression:

$$E[X] = \sum_{i=1}^{n-1} \sum_{j=i+1}^n \frac{2}{j-i+1} ?$$

Solve it.

2 + 5

3. (a) Can you recognize the following expression:

$$E[T(n)] \leq E \left[ \sum_{k=1}^n X_k \cdot T(\max(k-1, n-k)) + O(n) \right]$$

Solve this. 3 + 6

- (b) How can the Quick sort be made to run in  $O(n \lg n)$  time in the worst case? 2
- (c) Suppose that you have a worst case linear time median subroutine. Give a simple, linear time algorithm that solves the selection problem for an arbitrary order statistic. 3
4. (a) Say teachers have given the preferences about the start and finish time of their classes. Each teacher can submit one preference only. Say each class is weighted according to the seniority of a teacher. More is the seniority, better is the priority. Find a maximum weight subset of mutually compatible classes that can be scheduled in a single class. Will the greedy algorithm works for the problem? Justify. If not, which technique will be suitable for this problem? Justify. Write the algorithm and give its time complexity.  $2^{1/2} + 2^{1/2} + 2 + 2$
- (b) Consider a modification of the *Rod-cutting* problem in which, in addition to a price  $p_i$  for each rod, each cut incurs a fixed cost of  $c$ . The revenue associated with a solution is now the sum of the prices minus the costs of making the cuts. Give a dynamic programming algorithm to solve this modified problem. 5
5. Give the correctness of the following algorithms by *loop-invariant* technique:

- (a) Merge Sort.
- (b) Quick Sort Partitioning.
- (c) Dijkstra's shortest path algorithm. 4 + 4 + 6
6. (a) By *amortized analysis* techniques give the time complexity of .
- (i) BFS
- (ii) Topological Sort. 4 + 4
- (b) Given  $N$  distinct integers, how many triples sum to exactly zero? Give an efficient algorithm for this problem. Write the pseudo code for this and analyse the algorithm. Illustrate the idea with an example. 4 + 2
7. (a) By an example illustrate the point of the flow problem. 2
- (b) By using the technique of indicator random variable prove that given an instance of MAX-3CNF satisfiability with  $n$  variables  $x_1, x_2, \dots, x_n$  and  $m$  clauses, the randomized algorithm that independently sets each variables to 1 with probability  $1/2$  and to 0 with probability  $1/2$  is a randomized  $8/7$ -approximation algorithm. 5
- (c) State and formulate the Brewery problem as a linear programming problem. 7
-

2017-18

**OBJECT ORIENTED TECHNOLOGY**

**IT 543**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

Answer all the questions in order.

Answer any *five* questions.

1. Briefly discuss with example: 7 × 2
  - (i) Copy Constructors
  - (ii) Ambiguity that appear in single inheritance and how to overcome that.
  - (iii) Friend Class
  - (iv) Pure virtual function.
  - (v) Function Overloading.
  - (vi) Throw list specification.
  - (vii) Syntax for accessing member variable and member functions through object pointer.
2. (a) Discuss different types of Inheritance. 3
  - (b) In which situations constructor to a deriver class is mandatory? 2

- (c) Write a program to show the use of constructor to a derived class during multilevel inheritance. 6
- (d) With example discuss virtual base class. 3
3. (a) What is the use of catch all statement? Write a program to demonstrate. 4
- (b) Write a program with the following: 4 × 2
- A template function with a proper throw list specification, to read two numbers of any data type from the keyboard.
  - A function to calculate the division of these two numbers.
  - A try block to detect and throw an exception if one of the number is zero or less than 1.0 or the condition "divide-by-zero" occurs
  - Appropriate catch blocks to handle different type of exceptions.
- (c) How to rethrow an exception? Give example. 2
4. (a) What are the different uses of friend function? Give separate examples and discuss. 8
- (b) Write a program to show the use of virtual functions to create runtime polymorphism. 6
5. (a) Write a program to overload pre-increment and post-increment operators. How the compiler differentiates between them? 2 + 2 + 2
- (b) Write a program to overload = operator using member function. 4

- (c) Can the = operator be overloaded using friend function? Justify your answer. 4
6. Short notes : (any two) 7 × 2
- (a) Static member variables and static member functions.
- (b) Destructors and their use.
- (c) Passing and returning objects as argument.

Information Theory and Coding  
IT -701

Full Marks: 70

Time: Three hours

*The figures in the margin indicate full marks.*

Answer all questions in order as given in the question paper

5 + (2 + 2) + 5 = 14

1. (a) State and prove Kraft inequality for the existence of instantaneous code of an  $r$ -ary DMS source.  
 (b) Define self-entropy and average length of code word in a code.  
 (c) Prove that for a source with entropy  $H(S)$  and average length of code words  $L$  bits per symbol,

$$H(S) \leq L \leq H(S) + 1$$

3 + (4 + 3 + 4) = 14

2. (a) Write down the steps of Shannon Fano algorithm for encoding a source.  
 (b) Apply the Shannon Fano coding algorithm to the zero memory source with the following source symbols and given probabilities of occurrence. Calculate efficiency and redundancy of the code.

Source symbols and their probabilities:

$x_i$	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	$x_6$	$x_7$
$P(x_i)$	0.4	0.2	0.12	0.08	0.08	0.06	0.06

Is it possible to construct multiple Shannon Fano codes with different efficiency of the above problem? Explain it.

3 + (4 + 3) + (2 + 2) = 14

3. (a) Prove that  $0 \leq H(S) \leq \log_2 m$ , for a source  $S$  of size  $m$ .  
 (b) Construct Huffman code for the zero memory source with source symbols and their probabilities given in question 2 (b). Calculate efficiency and redundancy of the Huffman code.  
 (c) A zero memory source  $S$  produces four symbols  $s_1, s_2, s_3$  and  $s_4$  with symbol probabilities 0.5, 0.2, 0.2 and 0.1 respectively. Determine the information content of the message  $s_2s_3s_1s_1$ . What is the entropy of the source?

2 + (4 + 4 + 2) + 2 = 14

4. (a) Define mutual information of two discrete random variables  $A$  and  $B$ .

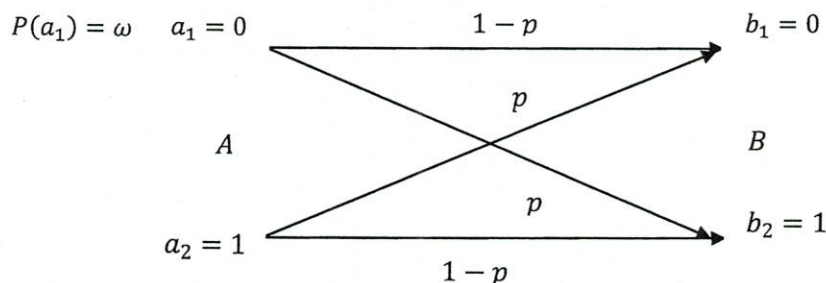


Fig. 1



(b) Consider a binary symmetric channel as shown in Fig. 1 with  $P(a_1) = \omega$ , Prove that the mutual information  $I(A; B)$  is given by,  $I(A; B) = H(B) + p \log_2 p + (1 - p) \log_2 (1 - p)$ .

Compute  $I(A; B)$  for  $\omega = 0.5$  and  $p = 0.1$ . Show that the channel becomes useless for  $p = 0.5$ .

(c) Define channel capacity.

$$10 + 2 + 2 =$$

14

5. (a) For a continuous, band limited, AWGN channel with band width  $B$  and noise spectral density  $\frac{\eta}{2}$ , Prove that, the channel capacity is  $C = B \log_2 \left( 1 + \frac{S}{\eta B} \right)$  bits/sec.

(b) Find out the channel capacity of a telephone channel with band width 3 KHz and signal to noise ratio of 40 dB.

(c) State noisy channel coding theorem.

**N.B.:** All the symbols used in the question paper have their usual meaning.

2017-18

**MULTIMEDIA INFORMATION SYSTEMS**

**IT 702**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

Answer any *five* questions.

1. (a) How is an object animated in raster systems ? If that object rotates, how is that animated object displayed ? Give an example through proper programming steps. 7
- (b) In animation, what is meant by full explicit control ? Is there any animation control methods ? Name and explain any 2 more animation control methods. 2 + 1 + 2
- (c) Explain any one linear list notation. 2
2. (a) In the definition of multimedia, what is meant by
  - (i) perception medium,
  - (ii) Representation medium,
  - (iii) transmission medium ? 3
- (b) What are the main elements of RTF file format or TIFF file format (give a point-wise answer). 3
- (c) What is lossy compression and lossless compression ? Give examples. Where is lossless compression necessary ? In

- which applications lossy compression is the preferred mode ?  $2 + 1 + 1 + 1$
- (d) What is entropy ? What is the formula of entropy calculation ? 3
3. (a) What is significance of code book ? Explain its types. Give example of Huffman Code book.  $2 + 2 + 2$
- (b) Through 2 diagrams, explain source encoding of Vector quantisation with & without error term.  $2 + 2$
- (c) What is differential or predictive encoding ? Where is it used ?  $2 + 2$
4. (a) List and explain the 4 modes of JPEG operation. 4
- (b) Draw the diagram of JPEG compression steps. 2
- (c) What is FDCT ? How many DCT co-efficients are there and what do they represent ? Write the formula of FDCT co-efficient. What is meant by DCT DC co-efficient and what does it represent ?  $1 + 1 + 1 + 2 + 1 + 1$
- (d) What is IDCT and write the formula of its co-efficient. 2
5. (a) MPEG What are the different reference frames used in MPEG compression ? Explain them. Draw one repetitive MPEG frame sequence. Is there any special order of frames in an MPEG frame sequence ? Why ?  $3 + 2 + 1 + 2$
- (b) Explain block matching technique of motion estimation. 6

6. (a) When data is read or written into a disk block, why significant time is needed to read or write data ? Which time is minimised in disk scheduling algorithms ?  $3 + 1$
- (b) Draw and explain SCAN-EDF. If  $D_i$  is deadline of a tssk &  $N_i$  be the track position, how is the deadline deferred ? How is an accurate perturbation of deadline achieved taking into account the actual position of the head (N) ?  $3 + 1 + 2$
- (c) Explain Group Sweeping Schedule. 4
7. (a) What is point synchronization and Stream synchronization ? 2
- (b) Draw the Relative temporal relationships properly (RTRs). 3
- (c) Explain the 3 Absolute time specifications with diagrams wherever necessary. 3
- (d) What are the delay factors for stored MM objects ? What is the latency formula for the same ?  $4 + 2$
8. (a) Discuss through proper diagrams, additive and general shape covers for shape matching of multimedia data objects. When it can be assumed that there is a good match in object shape ?  $2 + 2 + 2$
- (b) What is the storage structure of the multimedia data object with respect to rectangular shape cover ? 4
- (c) What are the different index structures used for retrieving multimedia objects from a MMDB by similarity matching ? 1

- (d) What are the different types of multimedia database queries ? 3
9. (a) What is meant by authentication & non-repudiation in Network Security ? 2
- (b) In encryption methods, discuss transposition encryption and permutational encryption. 2 + 2
- (c) Draw the schematic diagram of DES showing the 19 steps. Show the subkey generation steps in a form of diagram. 3 + 3
- (d) Why is RSA a highly secured algorithm ? 2
-

2017-18

**DISTRIBUTED COMPUTING**

**IT 719**

*Full Marks : 70*

*Time : 3 hours*

*The figures in the margin indicate full marks.*

*Answer any five questions.*

1. (a) What is a single-point-of-failure and how can distribution help here ?  
(b) What are pros and cons of different types of binding ?  
(c) Which set of events is concurrent (all events are concurrent with each other)? Justify your answer.  
(i) (3, 1, 5, 7), (3, 2, 6, 7), (2, 1, 6, 8)  
(ii) (2, 1, 3, 4), (2, 2, 3, 3), (3, 3, 2, 5)  
(iii) (1, 2, 3, 4), (2, 3, 4, 5), (3, 4, 5, 6)  
(iv) (1, 5, 6, 7), (1, 4, 5, 7), (1, 3, 2, 2)      4 + 4 + 6
2. (a) Consider a process  $P$  that requires access to file  $F$  which is locally available on the machine where  $P$  is currently running. When  $P$  moves to another machine, it still requires access to  $F$ . If the file-to-machine binding is fixed, how could the system wide reference to  $F$  be implemented ?

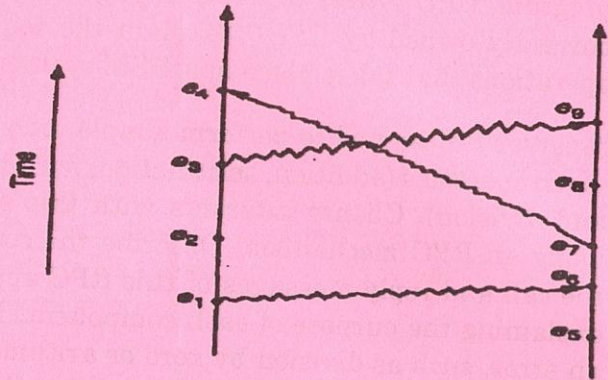
- (b) What do you mean by false deadlock in distributed environment? How do you overcome this problem?
- (c) Consider an OS resource request model and WFG,  $G = \{V, E\}$ , where  $V = \{P1, P2, P3\}$  and  $E = \{<P1, P2>, <P2, P3>, <P3, P1>\}$ . Is the system in deadlock state? Justify. 5 + 4 + 5
3. (a) Give the definition of Middleware and show in a small diagram where it is positioned.
- (b) Give implementation rules of Lamport's logical clock and vector clock. In which type of application vector clocks are more appropriate?
- (c) Consider a bank database which is fully replicated. Give an algorithm/protocol for ordering of transactions in above situations.
- (d) What is the problem behind keeping state for a client on a server? 4 + 5 + 2 + 3
4. (a) What are stub and skeleton and why are they needed in remote procedure calls?
- (b) A client's clock reads 3:20:00. The server's clock reads 3:10:00 when they synchronize using Cristian's algorithm. Assume message delays are negligible. What is the time at the client after synchronization?
- (c) Some networks, such as cable TV Internet service, provide an asymmetric bandwidth. For example, a cable modem may provide 12 Mbps downstream service but only 1 Mbps upstream. Cristian's algorithm assumes symmetric delays to and from the server. Reformulate the algorithm to accommodate asymmetric delays, where  $T_s$  is the server's time,  $T_c$  is the time

the request was sent,  $T_b$  is the time the response was received,  $U$  is the upstream bandwidth, and  $D$  is the downstream bandwidth. 4 + 3 + 7

5. (a) You have several computers cooperating on a parallel program. CPU 1 tries to write to page 302, which is currently owned by CPU 0. Explain the sequence of operations that takes place in a DSM system.
- (b) A server is designed to perform simple integer arithmetic operations (addition, subtraction, multiplication, and division). Clients interact with this server by using an RPC mechanism. Describe the contents of the call and reply messages of this RPC application, explaining the purpose of each component. In case of an error, such as division by zero or arithmetic overflow, the server must suitably inform the client about the type of error.
- (c) A distributed system uses the following IPC primitives:
- (i) send (receiver\_process\_id, sender\_process\_id, message)
- (ii) receive (sender\_process\_id, message)

The primitives are synchronous in the sense that the sender blocks if the receiver is not ready to receive the message and the receiver blocks until a message is received from the sender. What is the minimum number of communicating processes for a communication deadlock to occur in this system? Give reasons for your answer and give an example of a communication deadlock that involves a minimum number of processes. 4 + 4 + 6

6. (a) Add a message-sending event to the space-time diagram of the following Figure that is concurrent to events  $e_5$ ,  $e_6$  and  $e_7$ . Now add a non-message-sending event that is concurrent to events  $e_1$ ,  $e_2$  and  $e_3$ .



- (b) An important issue in clock synchronization in computer systems is that time must never run backward. Give two examples to show why this issue is important. How can a fast clock be readjusted to take care this issue ?
- (c) What will happen in a bully algorithm for electing a coordinator when two or more processes almost simultaneously discover that the coordinator has crashed ?  
4 + 5 + 5
7. (a) There are four processes,  $A, B, C, D$ . Status of their vectors at some instance of time is  $(3, 2, 5, 1), (3, 2, 5, 1), (2, 2, 5, 1), (3, 2, 4, 1)$  respectively. Now if  $B$  wants to send a message to other processes, will they be delivered without delay to other processes ? Justify your answer.

- (b) What is Write Invalid protocol ? How it can be used to maintain the memory coherence ?
- (c) What is Write Invalid protocol ? How it can be used to maintain the memory coherence ?
- (d) What is granularity ? What is the purpose of it in DSM design issue ?  
5 + 3 + 3 + 3

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2017-18

## DIGITAL SIGNAL PROCESSING

IT 720

Full Marks : 70

Time : 3 hours

*The figures in the margin indicate full marks.*Answer *all* questions in order as given in the question paper. $2 \times 15 = 30$ 

1. (A) What is the particular solution of the first order difference equation  $y(n) + ay(n) = x(n)$ , where  $|a| < 1$ , when the input of the system  $x(n) = u(n)$  ?

(i)  $\frac{1}{(1+a)}u(n)$ ,

(ii)  $\frac{1}{(1-a)}u(n)$ ,

(iii)  $\frac{1}{(1+a)}$ ,

(iv)  $\frac{1}{(1-a)}$ .

- (B) If the system is initially relaxed at time  $n=0$  and memory equals to zero, then the response of such state is called as:

- (i) Zero-state response,



- (ii) Zero-input response,
- (iii) Zero-condition response,
- (iv) None of the mentioned.
- (C) What is the form of the FIR system to compute the moving average of the signal  $x(n)$  ?

(i)  $y(n) = \frac{1}{M+1} \sum_{k=0}^M x(n-k),$

(ii)  $y(n) = \frac{1}{M+1} \sum_{k=0}^M x(n+k),$

(iii)  $y(n) = \frac{1}{M+1} \sum_{k=0}^{\infty} x(n-k),$

(iv) None of the mentioned.

- (D) What is the output  $y(n)$  when a signal  $x(n) = nu(n)$  is passed through an accumulator system under the conditions that it is initially relaxed ?

(i)  $\frac{n^2 + n + 1}{2},$

(ii)  $\frac{n(n+1)}{2},$

(iii)  $\frac{n^2 + n + 2}{2},$

(iv) None of the mentioned.

- (E) Let  $x_1(t)$  and  $x_2(t)$  be periodic signals with fundamental periods  $T_1$  and  $T_2$  respectively. Then the fundamental period of  $x(t) = x_1(t) + x_2(t)$  is:

- (i) LCM of  $T_1$  and  $T_2$ ,
- (ii) HCF of  $T_1$  and  $T_2$ ,
- (iii) Product of  $T_1$  and  $T_2$ ,
- (iv) Ratio of  $T_1$  and  $T_2$ .
- (F) If  $X(z)$  is the  $z$ -transform of the signal  $x(n)$  then what is the  $z$ -transform of  $a^n x(n)$  ?
- (i)  $X(az),$
- (ii)  $X(az^{-1}),$
- (iii)  $X(a^{-1}z),$
- (iv) None of the mentioned.
- (G) If  $X(z)$  has  $M$  finite zeros and  $N$  finite poles, then which of the following condition is true ?
- (i)  $|N-M|$  poles at origin (if  $N > M$ ),
- (ii)  $|N+M|$  zeros at origin (if  $N > M$ ),
- (iii)  $|N+M|$  poles at origin (if  $N > M$ ),
- (iv)  $|N-M|$  zeros at origin (if  $N > M$ ).
- (H) What is the system function of the system described by the difference equation  $y(n) = 0.5y(n-1) + 2x(n)$  ?

(i)  $\frac{2}{1+0.5z^{-1}},$

(ii)  $\frac{0.5}{1+2z^{-1}},$

$$(iii) \frac{0.5}{1-2z^{-1}},$$

$$(iv) \frac{2}{1-0.5z^{-1}}.$$

(I) What is the convolution of the sequences of  $x_1(n) = x_2(n) = \{1, 1, 1\}$  ?

(i)  $\{1, 2, 3, 2, 1\},$

(ii)  $\{1, 2, 3, 2, 2\},$

(iii)  $\{1, 1, 2, 1, 1\},$

(iv)  $\{1, 1, 3, 1, 1\}.$

(J) 2. If  $x(n)$  and  $X(k)$  are an  $N$ -point DFT pair, then  $X(k + N) = ?$

(i)  $X(-k),$

(ii)  $-X(k),$

(iii)  $X(k),$

(iv) None of the mentioned.

(K) If  $M$  and  $N$  are the orders of numerator and denominator of rational system function respectively, then how many multiplications are required in direct form-I realization of that IIR filter ?

(i)  $M + N - 1,$

(ii)  $M + N,$

(iii)  $M + N + 1,$

(iv)  $M + N + 2.$

(L) Which of the following is true regarding the number of computations required to compute an  $N$ -point DFT?

(i)  $N^2$  complex multiplications and  $N(N-1)$  complex additions,

(ii)  $N^2$  complex additions and  $N(N-1)$  complex multiplications,

(iii)  $N^2$  complex multiplications and  $N(N+1)$  complex additions

(iv) None of the mentioned.

(M) If the signal to be analyzed is an analog signal, we would pass it through an antialiasing filter with  $B$  as the bandwidth of the filtered signal and then the signal is sampled at a rate:

(i)  $F_s < 2B,$

(ii)  $F_s \leq 2B,$

(iii)  $F_s \geq 2B,$

(iv)  $F_s = 2B.$

(N) The impulse response of a LTI system is  $h(n) = \{1, 1, 1\}$ . What is the response of the signal to the input  $x(n) = \{1, 2, 3\}$ ?

(i)  $\{1, 3, 6, 3, 1\},$

(ii)  $\{1, 2, 3, 2, 1\},$

(iii)  $\{1, 3, 6, 5, 3\},$

(iv)  $\{1, 1, 1, 0, 0\}.$

(O) What is the Nyquist rate of sampling for the signal  $x(t) = 3 \cos(50\pi t) + 10 \sin(300\pi t) - \cos 100\pi t$ ?

- (i) 50Hz,  
(ii) 100Hz,  
(iii) 200Hz,  
(iv) 300Hz.

2. (a) The impulse response of a linear time-invariant system is

$$h(n) = \{1, 2, 1, -1\}.$$

↑

Using convolution summation show the response of the system to the input sequence

$$x(n) = \{1, 2, 3, 1\}$$

↑

6 + 4 = 10

- (b) Determine whether or not each of the following system is shift-invariant:

$$y(n) = x(-n)$$

4 + 6 = 10

3. (a) Test for causality of the system whose input output relation is given by,

$$y(n) = \sum_{k=n}^{\infty} x(n-k)$$

- (b) Determine the response  $y(n)$ ,  $n \geq 0$ , of the system described by the second-order difference equation  $y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$  when the input sequence is  $x(n) = (4)^n u(n)$
- 6 + 4 = 10

4. (a) Determine the spectra of the following signals:

(i)  $x(n) = \cos\left(\frac{\pi n}{3}\right)$

(ii)  $x(n) = \cos(\sqrt{2}\pi n)$

- (b) Determine and sketch the energy density spectrum  $S_{xx}(\omega)$  of the signal.

$$x(n) = a^n u(n), \quad -1 < a < 1 \quad 5 + 5 = 10$$

5. (a) Design a first-order digital low-pass filter with a 3-dB cutoff frequency of  $\omega_c = 0.25\pi$  by applying the bilinear transformation to the analog Butterworth filter

$$H_a(s) = \frac{1}{1 + s/\Omega_c}$$

Write down the difference equation of the designed filter. Realize the filter using direct form I.

- (b) Write down short note on bilinear transformation.

*(All the symbols used in the question paper have their usual meaning)*