



107

Computer Science / Information Technology

TIME : 3 HOURS

MAXIMUM MARKS : 300

INSTRUCTIONS :

1. *All questions are compulsory.*
 2. *Question Paper may be divided into 4 (four) Sections from Section-A to Section-D and carry marks as under :*
 - a. *Section - A - Total 3 Questions having two parts, i.e. (a) and (b) each questions carries 12 marks × 3 Questions = Total 36 Marks.*
 - b. *Section - B - Total 3 Questions having two parts, i.e. (a) and (b) each questions carries 20 marks × 3 Questions = Total 60 Marks.*
 - c. *Section - C - Total 3 Questions having two parts, i.e. (a) and (b) each questions carries 28 marks × 3 Questions = Total 84 Marks.*
 - d. *Section - D - Total 3 Questions having two parts, i.e. (a) and (b) each questions carries 40 marks × 3 Questions = Total 120 Marks.*
-

SECTION - A

(Each question is of 12 marks and each sub part (a) and (b) are of 6 marks each)

- 1 (a) Describe the worst case running time of the following pseudocode functions in Big-Oh notation in terms of the variable n.

```
void silly(int n){  
    if (n <= 0) return;  
    System.out.println("n = "+n);  
    silly(n/2);  
}
```
- (b) Suppose a web server has 10 ongoing TCP connections. How many server-side sockets are used? How many server-side port numbers are used?

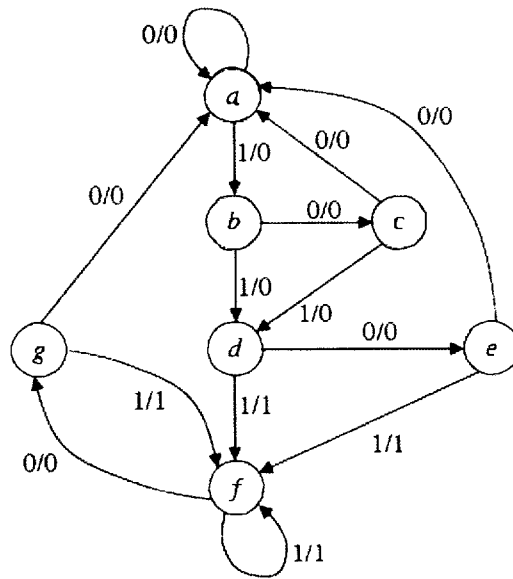
- 2 (a) To successfully prevent user programs from causing damage to other programs or the OS, hardware support is required. Name two hardware mechanisms in modern CPU's that supports this goal, and for each one, describe what specific kind(s) of damage it prevents.
- (b) What is the size, of a TCP header? What is the size of a UDP header? What fields exist in both TCP header and UDP header?
- 3 (a) Describe one advantage and one disadvantage circuit-switched networks have over a packet-switched networks.
- (b) What is the minimum and maximum number of nodes in a perfect binary tree of height h .

SECTION - B

(Each question is of 20 marks and each sub part (a) and (b) are of 10 marks each)

- 4 (a) Draw the binary min heap that results from inserting 9, 3, 2, 6, 8, 4, 1 in that order into an initially empty binary min heap.
- (b) Describe the mechanism of priority inheritance and give an example of the kind of problem; it's intended to solve.
- 5 (a) Find the language generated by the following grammar :
- $$S \rightarrow a.S|b.S|a|b|\epsilon$$
- (b) A 20 mbps satellite link has a propagation delay of $400 \mu s$ The transmitter employs the 'go-back-n ARQ' scheme with n set to 10. Assuming each frame is 100 bytes long, what is the maximum data rate possible?

- 6 (a) Suppose a user has two browser applications active at the same time, and suppose that the two applications are accessing the same server to retrieve HTTP documents at the same time. How does the server tell the difference between the two applications?
- (b) The state diagram of a sequential circuit is given as below. Tabulate the related state table and then reduce the state table to a minimum number of states



SECTION - C

(Each question is of **28** marks and each sub part (a) and (b) are of **14** marks each)

- 7 (a) In the schedules given below, the label $R_i(X)$ indicates a read of element X by transaction T_i , and $W_i(X)$ indicates a write of element X by transaction T_i . Draw the precedence graph for the schedule shown below.
- $R_2(A) R_1(C) R_2(B) R_3(B) W_2(B) R_1(A) R_3(C) W_3(C) W_1(A)$
- Is the schedule conflict-serializable? If so, what order of the three transactions defines a conflict-equivalent serial schedule?
- (b) Draw the Binary Search tree that results from inserting the keys: 3, 9, 1, 7, 4, 5, 8, 2 in that order into an initially empty tree.

- 8 (a) You run program A using kernel threads. You then re-run it using user-level threads. How could these two runs behave differently with respect to load and store instructions?
- (b) Construct a minimal DFA that accepts all binary numbers where each binary number is divisible by 3.
- 9 (a) A microprocessor has a 24-bit address line. We connect a memory chip to the microprocessor. The memory chip addresses are assigned the range 0×800000 to $0 \times BFFFFFF$. What is the minimum number of bits required to represent addresses in that individual memory chip? Explain your procedure.
- (b) Solve the recurrence without using the Masters Theorem.
- $$T(n) = 2T(n/2) + n^2$$

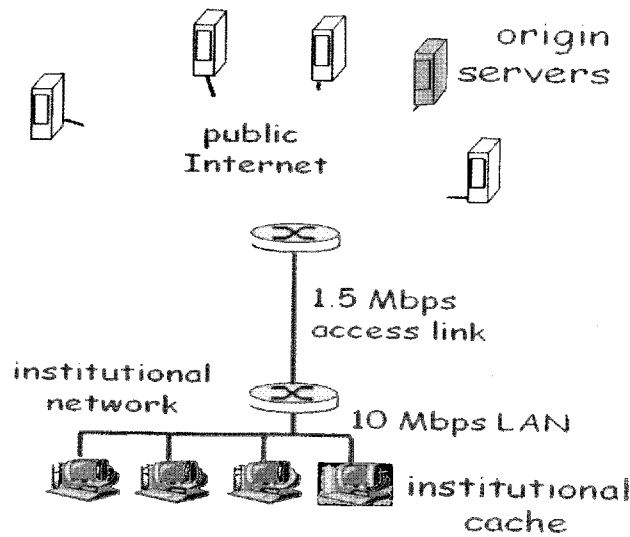
SECTION - D

(Each question is of 40 marks and each sub part (a) and (b) are of 20 marks each)

- 10 (a) You are developing a large program and need a subroutine to solve an optimization problem. You have two options at hand :
- (i) Solve the Integer Linear Programming formulation of the problem to obtain the optimal solution
- (ii) Use a greedy algorithm that provides near-optimal solutions for most cases. Which option would you use in your implementation, under what circumstances, and why?.
- (b) You must keep track of some data. Your options are:
- a binary search tree of records (assume it is well balanced)
 - a linked-list of records stored in order of insertion
 - an array-based list of records maintained in sorted order
- Suppose that you must first build a data structure holding 2^{10} given elements, and then you must perform 2^{20} searches on that

data structure. For each option, use the average case big Θ time complexity results of each data structure to determine the costs associated with that data structure in this situation. Since you know exactly how many elements are stored, and how many searches must be performed, the cost values should be numbers, not expressed in terms of N . Based on your analysis, which of the data structures would be the worst choice in the given situation?

- 11 (a) A Majority operation on an odd number n of Boolean inputs w_1, w_2, \dots, w_n results in 1 if more of the w_i elements evaluate to 1s, and in 0 otherwise. It is written as $\langle w_1, w_2, \dots, w_n \rangle$ and is called a Majority-term. Further A Majority expression is a Majority-term, the individual elements of which may be Majority-terms or Majority-expressions. Example : $\langle ab\langle xyz \rangle c\langle pq \rangle rst \rangle$. Can a Majority-term be expressed as a regular expression? If so, how? If not, prove. Also, does Majority Expression form a context-free language? If so, how? If not, prove.
- (b) Consider the networks shown in the figure below. Assume computers in the institution send out 14 requests per second. Each object average size is 100,000 bits. Also assume the internet side delay of a request is 2 seconds. Using M/M/1 queue to model the access delay in the 1.5 Mbps access link. The formula for the average response time is $E[T] = 1/(\mu - \lambda)$ where λ is the arrival rate of objects to the access link and μ is the service rate of the access link.



Find the total average response time when no institutional cache is used assuming the M/M/1 queue formula to calculate the delay. If the hit rate for the cache is 0.8, find the total average response time assuming the institutional cache is used.

- 12 (a) Suppose that you have an array of length N consisting of replications of the string BBBA. For example, below is the array for $N = 16$: four replications of BBBA.
- (i) How many compares does selection sort make to sort the array as a function of N ?
 - (ii) How many compares does insertion sort make to sort the array as a function of N ?
 - (iii) How many compares does mergesort make to sort the array as a function of N ?

- (b) The following questions deal with CRC error detecting code.
- (i) Given a message $M = 1010001101$, determine the CRC using the polynomial $P = x^5 + x^4 + x^2 + 1$. Show your work.
 - (ii) What is the transmitted message?
 - (iii) How does the receiver check whether the message T was transmitted without any errors?
-

