RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2018

SECOND YEAR (BATCH 2016-19)

Date : 19/05/2018 **COMPUTER SCIENCE (Honours)**

Time : 11.00 am – 3.00 pm Paper : IV Full Marks : 75

[Use a separate Answer Book for each group]

Group - A [30 marks]

(*Answer any three questions*) [3×10]

1. a) Consider a computer system with 40-bit virtual address and page size of 16 KB. If the computer system has one level page table per process and each page table entry requires 48 bits, then what is the size of per-process page table in megabytes? [3]

   b) What is a parse tree? Explain its role in the compilation process. [2+2]

   c) What is an absolute loader? How does a relocatable loader solve the problem faced by an absolute loader? [1+2]

2. a) In a system, there are three types of resources : E, F and G and four processes execute concurrently. At the outset, the processes have declared their maximum resource requirements using a matrix named Max as given below where Max[P_2,F] is the maximum number of instances of F that P_2 would require. The number of instances of the resources allocated to the various processes at any given state is given by a matrix named Allocation. Consider a state of the system with the Allocation matrix as shown below and in which three instances of E and three instances of F are the only resources available.

	Allocation			Max		
	E	F	G	E	F	G
P0	1	0	1	4	3	1
P1	1	1	2	2	1	4
P2	1	0	3	1	3	3
P3	2	0	0	5	4	1

   From the perspective of deadlock avoidance, check whether the system is in safe state. [6]

   b) What do you mean by orphan process? [2]

   c) State the differences between a multiprogramming operating system and a multitasking operating system. [2]

3. a) Consider a computer system with ten physical page frames. The system is provided with an access sequence (a_1, a_2, ..., a_{20}, a_1, a_2, ..., a_{20}), where each a_i is a distinct virtual page number. Find out the number of page faults considering Last-In-First-Out (LIFO) page replacement policy. [3]

   b) What is the advantage of thread pool? [2]

   c) What is thrashing in memory management? [2]

   d) Differentiate between pre-paging and demand paging. [2]

   e) What is the significance of dirty bit in demand paging? [1]

4. a) Consider the following CPU processes with arrival times (in milliseconds) and length of CPU bursts (in milliseconds) as given below.

Process	Arrival Time	Burst Time
P1	0	7
P2	3	3
P3	5	5
P4	6	2

If shortest remaining time first scheduling algorithm is used to schedule processes, then find out average waiting time across all processes. [4]

b) What do you mean by 'atomic instruction' with respect to hardware instruction of process synchronization? [2]

c) Give a solution to the producer consumer problem using semaphore. [4]

5. a) The following two functions P1 and P2 that share a variable B with an initial value of 2 execute concurrently.

```
P1 ( )              P2 ( )
{                   {
   C = B – 1;          D = 2*B;
   B = 2*C;            B = D –1;
}                   }
```

Find out the distinct values that B can take after the execution. [4]

b) 'Segmentation supports programmer's view of memory' —Justify. [2]

c) What is an interrupt service routine? [2]

d) Why deadlock is called probabilistic event? [2]

Group - B

[20 marks]

(*Answer any two questions*) [2×10]

6. a) Give DFA which accepts the following language over the alphabet {0, 1} :

i) The set of all strings with three consecutive 0's (not necessarily at the end) [2]

ii) The set of strings with 011 as a substring. [2]

b) Find a regular expression for the set $\{a^m b^n : (m+n) \text{ is even}\}$. [3]

c) When are two finite state automata said to be equivalent? [2]

d) What is a right-linear regular grammar? [1]

7. a) Explain the role of Arden's theorem to find a regular expression of a finite automaton. [3]

b) Design an FSM that outputs 1, if K 1's have been input, where K is a multiple of 3 and outputs 0 otherwise. Draw the state diagram. [4]

c) For $\Sigma = \{a, b\}$, design a Turing machine that accepts $L = \{a^n b^n : n \geq 1\}$. [3]

8. a) What is a context free grammar? Explain the leftmost derivation and the rightmost deviation of the same with proper examples. [1+3]

b) Construct a context free grammar G generating all integers upto 999 with sign. Use the grammar to obtain (–35). [3]

c) Find a grammar generating $L = \{a^n b^n c^i \mid n >= 1, i >= 0\}$. [3]

9. a) Consider the following grammar : (S is the starting symbol and other symbols have their usual meanings)

$S \rightarrow AB$

$A \rightarrow A1 \mid 0$

$B \rightarrow 2B \mid 3$

Identify the type of grammar according to Chomsky classification. Justify your answer. [3]

b) Use the pumping lemma to show whether the following set is regular or not : [3]

$\{a^n b^m \mid 0 < n < m\}$

c) Prove that $P + PQ^*Q = a^*bQ^*$ where $P = b + aa^*b$ and Q is any regular expression. [3]

d) Define Mealy machine. [1]

Group - C [25 marks]

10. Answer **any one** question : [1×5]

a) Compare two functions $f_1(n) = n^2$ and $f_2(n) = \frac{2^n}{4}$ for various values of n. Determine when the second one becomes larger than the first.

b) Define the asymptotic notation Big-Omega. Is it less strict than Small-Omega notation? Justify. [2+3]

***Answer any two questions from Question Nos. 11 to 14* :** [2×10]

11. a) Prove that the running time of an algorithm, $T(n) = n^3 + 20n + 1$ is $O(n^3)$, where 'n' is the input size of the algorithm. [4]

b) Define space complexity of an algorithm. [2]

c) Let a problem has two solutions. The first solution uses a recursive approach and the second one uses an iterative approach. Which solution would you choose for optimized time and space utilization? [4]

12. a) What is dynamic programming technique? State its difference with divide-and-conquer technique. [1+2]

b) Solve ${}^5C_3$ using dynamic programming. Show intermediate steps. [3]

c) Find the average case time complexity of linear search implemented on an array. [4]

13. a) What is a minimal spanning tree? Explain with proper diagrams. State Prim's algorithm to find a minimal spanning tree. [1+2+3]

b) What is the general method for solving a problem using greedy approach, Explain a problem in real life where greedy approach can be applied. [3]

c) Which data structure is preferred to implement BFS operation on a graph? [1]

14. a) Explain the steps of Strassen's matrix multiplication method. [3]

b) What is polynomial time reduction? [2]

c) What is a 2-SAT problem? [2]

d) Comment on handling negative cycles for all applicable shortest-path finding algorithms. [3]

———— × ————