RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2019

SECOND YEAR (BATCH 2017-20)

Date : 16/05/2019 **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) Assume that 3 processes all with requirements of 1 second of burst time each and no I/O request arrive at the same time.
   i) What will be the average turn around time to completion for the processes under FIFO scheduling?
   ii) What will be the average turn around time if Round Robin scheduling is used assuming a time slice of 0.1 second? [2+3]
   b) What do you mean by a zombie process and an orphan process? [2]
   c) State importance of the Kernel of an operating system. [2]
   d) What is a multitasking operating system? [1]

2. a) What is the significance of the critical section of a process? How is it handled using a hardware lock? [1+2]
   b) Propose a solution of Dining Philosopher's problem using semaphores. Make necessary assumptions. [3]
   c) Consider the following five statements of a subroutine: [4]

$S1: x = a + b$

$S2: d = x + 1$

$S3: e = x + 2$

$S4: \mathrm{t} = d + e + 4$

$S5: r = t + e$

Serialize the process using necessary semaphores.

3. a) Explain the use of Resource-Allocation graph for deadlock avoidance. [3]
   b) Consider the following snapshot of a system with five processes and four resource types: [5]

	Allocation					Max			
Process	X	Y	Z	W		X	Y	Z	W
P_1	0	0	1	2		0	0	1	2
P_2	2	0	0	0		2	7	5	0
P_3	0	0	3	4		6	6	5	6
P_4	2	3	5	4		4	3	5	6
P_5	0	3	3	2		0	6	5	2

Available			
X	Y	Z	W
2	1	0	0

Check whether the system is in safe state or not. If a request from P_3 arrives for (0, 1, 0. 0), show whether the request can be granted immediately or not.

   c) Explain the difference between a deadlock avoidance strategy and a deadlock prevention strategy. [2]

4. a) What is demand paging technique? Explain its differences with pre-paging technique. [2+2]
   b) There are five processes in a job queue:

Process	Memory	Required Time
P_1	600KB	10ms
P_2	1000KB	5 ms
P_3	300KB	20 ms
P_4	700KB	8 ms
P_5	500KB	15ms

   If the size of the memory is 2000KB and contiguous memory allocation is used, after 30 ms which processes are in memory? [3]
   c) What is external fragmentation? How can this be solved? [1+2]

5. a) How is segmentation different from paging? [2]
   b) What are the front-end and back-end phases of a compiler and why they are termed so? [3]
   c) What is the advantage of 2-pass assembler over 1-pass? [2]
   d) How is access control implemented in operating system to ensure file protection? [3]

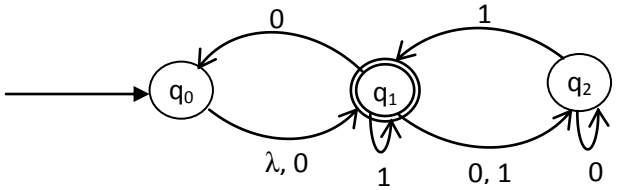
Group - B [20 marks]

(*Answer any two questions*) [2×10]

6. a) Design a P.D.A. to accept the following language $L = \left\{ ww^R \mid w \in (0,1)^* \right\}$. [4]
   b) Draw a DFA which accepts 00 and 11 at the end of a string containing only 0's and 1's in it. [3]
   c) Write the regular expression for $L = \left\{ a^2, a^5, a^8, \ldots \right\}$ [2]
   d) If $L = \{0,11\}$, then what will be L^2? [1]

7. a) Begin with the grammar:
   $S \to aSb \mid \lambda$
   $A \to aAS \mid a$
   $B \to SbS \mid A \mid bb$
   i) Eliminate λ -productions.
   ii) Eliminate any unit productions.
   iii) Put the grammar into Chomsky Normal Form. [1½+1½+3]
   b) For $\Sigma = \{a, b\}$, design a Turing Maching that accepts $L = \left\{ a^n b^n \mid n >= 1 \right\}$. [4]

8. a) Explain the characteristics of a Moore machine. [3]
   b) Convert the following NFA into an equivalent DFA. [3]



   c) Find a grammar equivalent to [2]
   $S \to AB \mid CA$
   $A \to a$
   $B \to BC \mid AB$
   $C \to aB \mid b$
   with no useless symbol.

d) Compare "acceptance by final state" and "acceptance by empty stack". [2]

9. a) What are the different types of grammars according to Chomsky's hierarchy? Explain each type. [4]

b) Define the grammar which produces $L(G) = \{a^m b^n \mid m >= 0 \text{ and } n > 0\}$. [2]

c) State Arden's theorem. [1]

d) Consider the following Context Free Grammars over the alphabet $\{a, b\}$. What is the length of the shortest string which does not belong to $L(X)$ but belongs to $L(Y)$? [1]

$X : S \rightarrow aSa \mid bSb \mid \lambda$

$Y : S \rightarrow aaS \mid bbS \mid \lambda$

e) Consider $L = \{(a^P)^* \mid P \text{ is a prime number}\}$ over the alphabet $\{a\}$, then what is the minimum number of states in N.F.A that accepts the language L? [2]

Group - C [25 marks]

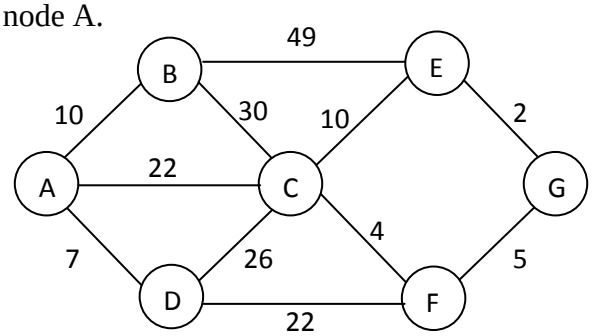
10. Answer **any one** question : [1×5]

a) A message is made up entirely of characters from the set $X = \{P, Q, R, S, T\}$. The table of probabilities for each of the characters is shown below. [5]

Character	Probability
P	0.22
Q	0.34
R	0.17
S	0.19
T	0.08
Total	1.00

If a message of 100 characters over X is encoded using Huffman coding, then find out the expected length of the encoded message in bits.

b) Execute Prim's algorithm on the following undirected graph to construct a minimum spanning tree starting with node A.



Does the following sequence of edges represent a possible order in which the edges would be added to construct the minimum spanning tree? Justify.

$$(A, D), (A, B), (A, C), (C, F), (G, E), (F, G)$$

Answer any two questions from Question Nos. 11 to 13: [2×10]

11. a) Which of the following functions, given by their recurrence, grows asymptotically fastest?

i) $T(n) = 4T\left(\frac{n}{2}\right) + 10n$

ii) $T(n) = 8T\left(\frac{n}{3}\right) + 24n^2$

iii) $T(n) = 16T\left(\frac{n}{4}\right) + 10n^2$

Justify your answer. [5]

b) Using Greedy algorithmic approach, design an algorithm to find the maximum product subset of an array. For example for array A[]={4, –8, 0, 8}, the maximum product of a subset is 32. The subset having maximum product of its element is {4,8}. [5]

12. a) Consider the weights and values of items listed below [6]

Item Number	Weight (in Kgs)	Value (in Rupees)
1	10	60
2	7	28
3	4	20
4	2	24

The task is to pick a subset of these items such that their total weight is no more than 11 Kgs and their total value is maximized. Moreover , no item can be split. The total value of items picked by an optimal algorithm is denoted by V_{opt}. A greedy algorithm sorts the items by their value-to-weight ratios in decreasing order and packs them greedily, starting from the first item in the ordered list. If total value of items picked by the greedy algorithm is denoted by V_{greedy}, then find the value of $(V_{opt} - V_{greedy})$.

b) Mathematically define Θ - notation. [2]

c) What is a dynamic programming approach? [2]

13. a) Using asymptolic notation, find the average case time complexity of merge sort algorithm. [5]

b) Use Strassen's algorithm to compute the product of the following matrices. [5]

$$\begin{pmatrix} 2 & 5 \\ 5 & 2 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

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