

Signature and Name of Invigilator

1. (Signature) _____

(Name) _____

2. (Signature) _____

(Name) _____

Roll No.

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(In figures as per admission card)

Roll No. _____

(In words)

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Test Booklet No.

Time : 2 1/2 hours]

PAPER-III

[Maximum Marks : 200

COMPUTER SCIENCE & APPLICATIONS

Number of Pages in this Booklet : 24

Number of Questions in this Booklet : 26

Instructions for the Candidates

- Write your roll number in the space provided on the top of this page.
- Answer to short answer/essay type questions are to be given in the space provided below each question or after the questions in the Test Booklet itself.

No Additional Sheets are to be used.

- At the commencement of examination, the question booklet will be given to you. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as below :

(i) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal and do not accept an open booklet.

(ii) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to pages/questions missing or duplicate or not in serial order or any other discrepancy should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given.**

- Read instructions given inside carefully.
- One page is attached for Rough Work at the end of the booklet before the Evaluation Sheet.
- If you write your name or put any mark on any part of the Answer Sheet, except for the space allotted for the relevant entries, which may disclose your identity, you will render yourself liable to disqualification.
- You have to return the test booklet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall.
- Use only Blue/Black Ball point pen.
- Use of any calculator or log table etc., is prohibited.

परीक्षार्थियों के लिए निर्देश

- पहले पृष्ठ के ऊपर नियत स्थान पर अपना रोल नम्बर लिखिए ।
- लघु प्रश्न तथा निबंध प्रकार के प्रश्नों के उत्तर, प्रत्येक प्रश्न के नीचे या प्रश्नों के बाद में दिये हुए रिक्त स्थान पर ही लिखिये ।

इसके लिए कोई अतिरिक्त कागज का उपयोग नहीं करना है ।

- परीक्षा प्रारम्भ होने पर, प्रश्न-पुस्तिका आपको दे दी जायेगी । पहले पाँच मिनट आपको प्रश्न-पुस्तिका खोलने तथा उसकी निम्नलिखित जाँच के लिए दिये जायेंगे जिसकी जाँच आपको अवश्य करनी है :

(i) प्रश्न-पुस्तिका खोलने के लिए उसके कवर पेज पर लगी कागज की सील को फाड़ लें । खुली हुई या बिना स्टीकर-सील की पुस्तिका स्वीकार न करें ।

(ii) **कवर पृष्ठ पर छपे निर्देशानुसार प्रश्न-पुस्तिका के पृष्ठ तथा प्रश्नों की संख्या को अच्छी तरह चैक कर लें कि ये पूरे हैं । दोषपूर्ण पुस्तिका जिनमें पृष्ठ/प्रश्न कम हों या दुबारा आ गये हों या सीरियल में न हों अर्थात् किसी भी प्रकार की त्रुटिपूर्ण पुस्तिका स्वीकार न करें तथा उसी समय उसे लौटाकर उसके स्थान पर दूसरी सही प्रश्न-पुस्तिका ले लें । इसके लिए आपको पाँच मिनट दिये जायेंगे । उसके बाद न तो आपकी प्रश्न-पुस्तिका वापस ली जायेगी और न ही आपको अतिरिक्त समय दिया जायेगा ।**

- अन्दर दिये गये निर्देशों को ध्यानपूर्वक पढ़ें ।
- उत्तर-पुस्तिका के अन्त में कच्चा काम (Rough Work) करने के लिए मूल्यांकन शीट से पहले एक पृष्ठ दिया हुआ है ।
- यदि आप उत्तर-पुस्तिका पर अपना नाम या ऐसा कोई भी निशान जिससे आपकी पहचान हो सके, किसी भी भाग पर दर्शाते या अंकित करते हैं तो परीक्षा के लिये अयोग्य घोषित कर दिये जायेंगे ।
- आपको परीक्षा समाप्त होने पर उत्तर-पुस्तिका निरीक्षक महोदय को लौटाना आवश्यक है और इसे परीक्षा समाप्ति के बाद अपने साथ परीक्षा भवन से बाहर न लेकर जायें ।
- केवल नीले/काले बाल प्वाइंट पेन का ही इस्तेमाल करें ।
- किसी भी प्रकार का संगणक (कैलकुलेटर) या लाग टेबल आदि का प्रयोग वर्जित है ।

J-8710**P.T.O.**

COMPUTER SCIENCE AND APPLICATIONS

PAPER – III

Note : This paper is of **two hundred (200)** marks containing **four (4)** sections. Candidates are required to attempt the questions contained in these sections according to the detailed instructions given therein.

SECTION – I

Note : This section consists of **two** essay type questions of **twenty (20)** marks, each to be answered in about **five hundred (500)** words each. **(2 × 20 = 40 marks)**

Elective – I

1. (a) Design NFA with the specified number of states recognizing each of the following languages. The alphabet is {0, 1}.
- (i) {W | W = x 01ⁿ where x has exactly one 1 and any number of 0s} (4 states) **(4)**
 - (ii) {W | every odd position of W is a 1} (2 states) **(2)**
 - (iii) {W | W contains either the substring 000 or substring 010} (4 states) **(4)**
- (b) Design a Turing Machine for accepting the language {aⁿ bⁿ cⁿ | n ≥ 1} **(10)**

OR

Elective – II

1. (a) For each of the following generating matrices encode the given messages. If G is given as
- $$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 \end{bmatrix}$$
- (i) u = 100
 - (ii) u = 010
 - (iii) u = 111 **(10)**
- (b) Find a generator matrix in standard form for a Hamming code of length 15, then encode the message '11111100000'. **(10)**

OR

Elective – III

1. For a Network flow problem prove max flow = Minimum Cut. **(20)**

OR

Elective – IV

- (a) Compare the functionality of soft computing tools namely ANNs and fuzzy sets with that of expert system. In particular you may comment on the traceability and knowledge representation aspects. **(10)**
- (b) Discuss application of Fuzzy and Neuro systems in providing the solutions to the classical problem of categorization. (You may select text document categorization, categorization of students or categorization of experts etc. as a specific domain to deal with the queries). **(10)**

OR

Elective – V

1. (a) What are the two types of pipes in Unix O.S. supports ? How they differ from each other ? **(10)**
- (b) What is asynchronous socket ? How does it support synchronization ? **(10)**

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2. (a) Given the relation scheme $R[\text{Truck}(T), \text{Capacity}(C), \text{Data}(Y), \text{Cargo}(G), \text{Destination}(D), \text{Value}(V)]$ with the following FO's $\{T \rightarrow C, TY \rightarrow G, TY \rightarrow D, CG \rightarrow V\}$. Is the decomposition of R into $R_1(TCD)$ and $R_2(TGDVY)$ dependency preserving? Justify. Is this decomposition lossless? Justify. Find lossless join and dependency preserving decomposition of R in 3 NF. (10)
- (b) Different memory partition of 100 K, 500 K, 200 K, 300 K and 600 K in order are given. How would each of the First-fit, Worst-fit and Best-fit algorithm places process of 212 K? (10)

OR

2. (a) Explain the difference between bit rate and baud rate. What baud rate is required to realize a 10 mbps data rate using Manchester encoding ? **(10)**
- (b) Given a complete binary tree with 7 nodes. The inorder traversal is GDEABCF. Find preorder and postorder traversals of the tree. **(10)**

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SECTION – II

Note : This section contains **three (3)** questions from each of the electives/specializations. The candidate has to choose only one elective/specialization and answer all the three questions from it. Each question carries **fifteen (15)** marks and is to be answered in about **three hundred (300)** words. **(3 × 15 = 45 marks)**

Elective – I

3. A 'square' is a string of the form xx , such as the English word hotshots. If w is a (finite or infinite) string containing no nonempty sub-word of this form, then it is said to be squarefree. A string producing function F_n ($n \geq 1$), is defined as follows :
- $$F_1 = 0; F_2 = 1; F_n = F_{n-1} F_{n-2} \text{ for } n \geq 3$$
- i.e. $F_3 = 10; F_4 = 101$; and so on
- (i) Develop an algorithm to check if the strings produced by F_n are squarefree. (Checking squarefreeness is important. Say for example, in chess game, if sequence of moves occurs twice in succession and is immediately followed by the first move of a third repetition, it indicates that no progress is to happen and hence draw.)
- (ii) Prove that no F_i contains either 00 or 111 as a substring. What could be an application of this check ?
- (iii) Guess the relationship between $F_i F_{i+1}$ and $F_{i+1} F_i$, prove your guess by induction.
4. (i) Define the operation perm on strings as follows :
perm(x) is the set of all permutations of the letters of x . For example,
Perm(0121) = {0112, 0121, 0211, 1012, 1021, 1102, 1120, 1201, 1210, 2011, 2101, 2110}
Extend perm to languages as follows :
perm(L) = $\bigcup_{x \in L} \text{perm}(x)$.
If L is regular, need perm(L) be regular ? Justify your answer.
- (ii) What are the applications of theory of formal languages to the study of Natural Languages ? Discuss at least one.
5. (a) Parsing is an essential feature of compiler. Parsing is also a feature of Natural Language Recognition system. If the grammar G is in Chomsky Normal Form (CNF), can we parse an arbitrary string $w \in L(G)$ of length n in $O(n^3)$ time ? Prove.
Alternatively, for a given G, as follows (which is in CNF)
 $S \rightarrow AB \mid b$
 $A \rightarrow CB \mid AA \mid a$
 $B \rightarrow AS \mid b$
 $C \rightarrow BS \mid c$
Generate parse table and hence the parse tree for the input $c a b a b$.
- (b) What would be the time complexity if G is an unambiguous grammar ?
- (c) What if G is LR(I) grammar ?

OR

Elective – II

3. What is Lempel-ZIV encoding ? Both the Lempel-ZIV and Huffman algorithm are similar in that they take the advantages of repetitions then how do, they differ ?
4. (a) State and prove Channel Capacity theorem.
(b) Compute weight and distance between each pair of the following words :
10010101, 11011000, 11000011, 00110101

5. Justify DCT form of coding is lossy. Illustrate with an example, why zigzag sequence of run length encoding is associated with it during the compression.

OR

Elective – III

3. Use the revised simplex method to solve the following Linear Programming Problem.

$$\begin{aligned} \text{Maximize} \quad & Z = 2x_1 + x_2 \\ \text{Subject to the constraints} \quad & 3x_1 + 4x_2 \leq 6 \\ & 6x_1 + x_2 \leq 3 \\ & x_1, x_2 \geq 0 \end{aligned}$$

4. Solve the following convex programming to get the optimal solution.

$$\begin{aligned} \text{Maximize} \quad & Z = 2x_1 + x_2 - x_1^2 \\ \text{Subject to the constraints} \quad & 2x_1 + 3x_2 \leq 6 \\ & 2x_1 + x_2 \leq 4 \\ & x_1, x_2 \geq 0 \end{aligned}$$

5. Write down the necessary and sufficient Kuhn-Tucker conditions to get an optimal solution to the problem of maximizing the given quadratic objective function subject to the linear constraints.

$$\text{Max } f(X) = \sum_{j=1}^n C_j X_j - 1/2 \sum_{j=1}^n \sum_{k=1}^n x_j d_{jk} x_k$$

Subject to the constraints

$$\begin{aligned} \sum_{j=1}^n a_{ij} x_j &\leq b_i & i = 1 - m \\ x_j &\geq 0 & j = 1 - n \end{aligned}$$

OR

Elective – IV

3. If $S_x = \{S_1, S_2, S_3, S_4\}$ indicates the severity level of the symptoms S_i for the patient x , A matrix D_i gives the upper and lower bounds of the normal range of severity of each of the four symptoms that can be expected in a patient with the disease i . A matrix W is to provide information about the weight of symptom S_i for disease d_j ; construct a model that uses the matrices. W and D_i s and helps diagnosis of a patient x when provided with S_n . Use following data to illustrate the logic of your system to come to the conclusion of the most likely disease for a given patient. State explicitly your assumptions if any.

Data : We have 3 diseases D_1, D_2 and D_3 for which D_i s are given below.

$$\begin{aligned} D_1 &= \begin{array}{l} \text{lower} \\ \text{upper} \end{array} \begin{bmatrix} 0 & .6 & .5 & 0 \\ .2 & 1 & .7 & 0 \end{bmatrix} \\ D_2 &= \begin{array}{l} \text{lower} \\ \text{upper} \end{array} \begin{bmatrix} 0 & .9 & .3 & .2 \\ 0 & 1 & 1 & .4 \end{bmatrix} \end{aligned}$$

$$D_3 = \begin{matrix} \text{lower} \\ \text{upper} \end{matrix} \begin{bmatrix} 0 & 0 & .7 & 0 \\ .3 & 0 & .9 & 0 \end{bmatrix}$$

Weight matrix W is given below.

$$W = \begin{matrix} & d_1 & d_2 & d_3 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \end{matrix} \begin{bmatrix} .4 & .8 & 1 \\ .5 & .6 & .3 \\ .7 & .1 & .9 \\ .9 & .6 & .3 \end{bmatrix}$$

In a specific case of patient, S_x is given as $S_x = \{(S_1, .1), (S_2, .7), (S_3, .4), (S_4, .6)\}$

4. It is argued that ANNs can effectively be used for learning membership function, fuzzy inference rules and other content dependent patterns. On the other hand, fuzzification of ANNs extends their capabilities and applicability. Assessment of students based upon their responses in the written tests is an intelligent activity. The growing number of students and the scarcity of teachers has called for a computer assisted evaluation system for the students responses in the written tests. Assuming that the most part of the students' responses is text; occasionally there are drawings and formulae. Design a model hybrid system comprising of neuro-fuzzy and fuzzy-neuro approaches.
5. What are the supervised, unsupervised and reinforced learnings in the content of ANNs ? Explain, how would you employ them in a typical facial expression recognition system. Discuss the real time models that you would be using in the system. Justify your choice.
[Hint : Vector quantization, self organizing maps, cognition, simulated annealing etc., are the examples of real time models in ANNs]

OR

Elective – V

3. (a) Explain when a process incurs a protection fault, how Kernal handles it.
(b) What are three different ways in which a process can respond to 'death of child' signal ?
4. (a) Explain the concept of demand paging in Unix.
(b) What is syntax of "Creat" system call ? Write an algorithm for creating a file.
5. (a) What do you mean by Object library and Dynamic link library in Windows environment ?
(b) Describe briefly six Window functions usually called while creating a Window.

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SECTION - III

Note : This section contains **nine (9)** questions of **ten (10)** marks, each to be answered in about **fifty (50)** words. **(9 × 10 = 90 marks)**

6. Realize the function of four variables using 8 : 1 multiplexer for
 $F = \sum M (0, 3, 5, 6, 9, 10, 12, 15)$

7. How does Cohen-Sutherland algorithm decide whether the following lines are to be displayed, clipped or rejected totally for two different lines having their two ends points respectively [(10, 15) and (15, 30)] and [(150, 100) and (250, 100)] for the window having lower left corner at (20, 40) and the top higher corner at (200, 200) ?

8. Draw the equivalent DFA and Regular expression for CFG
 $S \rightarrow xS_y/Z$

9. Consider following sequence of memory reference from a 460 word program :
10, 11, 104, 170, 73, 309, 185, 245, 246, 434, 458, 364
Give the reference string, assume a page size of 100 words.

10. Attendance of students is taken on a blank sheet. Suggest a data structure that would be storage and retrieval efficient. Will your choice vary in the following cases ? Justify your answer by providing efficiency analysis. Remember, there is a connection between the data structures and algorithm and therefore the efficiency of the system.
- Case 1 : Number of students appearing for the exam are 10 to 100 and the exam is conducted centrally.
- Case 2 : Number of students appearing for the exam would range from 5,000 to 50,000 and the exam is conducted centrally.
- Case 3 : Number of students appearing for the exam would range from 5,000 to 50,000 and the exam is conducted at distributed places and attendance record is maintained centrally.
- You may consider insertion (one time deletion rarely) and search (frequently) as the operations to be provided to handle this data.

11. Explain the role of entities play in XML DTD's and documents. Describe the different type of entities and how they are used in DTD's and documents.

12. Explain with example, why Quicksort is called a "Divide and Conquer" algorithm.

13. Give conceptual dependency diagram for the following :
"Since Smoking Can Kill You, I Stopped"

16. The class diagram.

17. Sequence diagram.

18. Activity diagram.

19. State chart diagram.

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Marks Obtained	
Question Number	Marks Obtained
1	
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Total Marks Obtained (in words)

(in figures)

Signature & Name of the Coordinator

(Evaluation)

Date