OBE

REFNO48594

M.Sc. Semester I Examination 2021-22

Computer Science

CS-202 : Theory of Computation

Time : 4:30 hours **Max. Marks : 70**

Instructions

1. The Question Paper contains **08** questions out of which you are required to answer any **04** questions. The question paper is of **70 marks** with each question carrying **17.5 marks.**

   प्रश्नपत्र में 08 प्रश्न पूँछे गये हैं जिनमें से 04 प्रश्नों का उत्तर देना है। प्रश्नपत्र 70 अंकों का है, जिसमें प्रत्येक प्रश्न 17.5 अंक का है।

2. The total duration of the examination will be **4.30 hours** (Four hours and Thirty Minutes) which includes the time for downloading the question paper from the Portal, writing the answers by hand and uploading the hand-written answer sheets on the portal.

   परीक्षा का कुल समय 4.30 घंटे का है जिसमें प्रश्नपत्र को पोर्टल से डाउनलोड करके पुनः हस्तलिखित प्रश्नों का उत्तर पोर्टल पर अपलोड करना है।

3. For the students with benchmark disability as per Persons with Disability Act, the total duration of examination shall be **6 hours** (six hours) to complete the examination process, which includes the time for downloading the question paper from the Portal, writing the answers by hand and uploading the hand-written answer sheets on the portal.

   दिव्यांग छात्रों के लिये परीक्षा का समय 6 घंटे निर्धारित हैं जिसमें प्रश्नपत्र को पोर्टल से डाउनलोड करना एवं हस्तलिखित उत्तर को पोर्टल पर अपलोड करना है।

4. Answers should be hand-written on a plain white A4 size paper using black or blue pen. Each question can be answered in upto 350 words on 3 (Three) plain A4 size paper (only one side is to be used).

   हस्तलिखित प्रश्नों का उत्तर सादे सफेद A4 साइज के पन्ने पर काले अथवा नीले कलम से लिखा होना चाहिये। प्रत्येक प्रश्न का उत्तर 350 शब्दों तक तीन सादे पृष्ठ A4 साइज में होना चाहिये। प्रश्नों के उत्तर के लिए केवल एक तरफ के पृष्ठ का ही उपयोग किया जाना चाहिए।

5. Answers to each question should start from a fresh page. All pages are required to be numbered. You should write your Course Name, Semester, Examination Roll Number, Paper Code, Paper title, Date and Time of Examination on the first sheet used for answers.

   प्रत्येक प्रश्न का उत्तर नये पृष्ठ से शुरू करना है। सभी पृष्ठों को पृष्ठांकित करना है। छात्र को प्रथम पृष्ठ पर प्रश्नपत्र का विषय, सेमेस्टर, परीक्षा अनुक्रमांक, प्रश्नपत्र कोड, प्रश्नपत्र का शीर्षक, दिनांक एवं समय लिखना है।

Questions

P.T.O.

1 (a) Construct a finite automaton M which can recognize substring "DFA" in a given string over the alphabet {A, B, ..., Z}. For example, M has to recognize DFA in the string TAXDFAMN. [7]

(b) $M = (\{q_1, q_2, q_3\}, \{0, 1\}, \delta, q_1 \{q_3\})$ is a nondeterministic finite automaton. where δ is given by [7]

$\delta(q_1, 0) = \{q_2, q_3\}$, $\delta(q_1, 1) = \{q_1\}$

$\delta(q_2, 0) = \{q_1, q_2\}$, $\delta(q_2, 1) = \Phi$

$\delta(q_3, 0) = \{q_2\}$, $\delta(q_3, 1) = \{q_1, q_2\}$

Construct an equivalent DFA.

(c) Find a regular expression for the set $\{a^n b^m: (n + m) \text{ is even}\}$. [3.5]

2 (a) Let L = {ab, aa, baa}. Which of the following strings are in L*: abaabaaabaa, aaaabaaaa, baaaaabaaaab, baaaaabaa? Which strings are in L^4? Explain. [4.5]

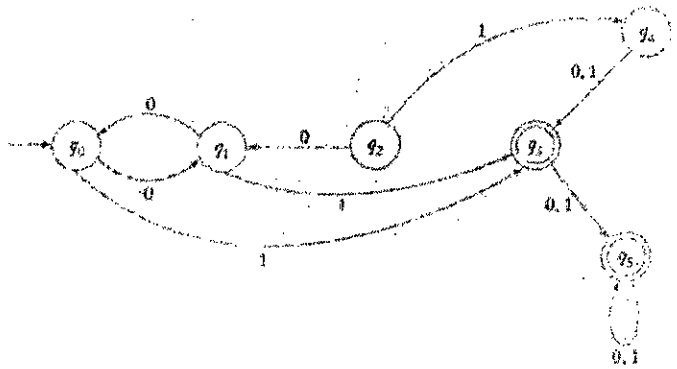
(b) Check that the Grammars [4.5]

$S \rightarrow aSb|bSa|SS|a$

and

$S \rightarrow aSb|bSa|a$ are equivalent or not.

(c) Minimize the number of states in the following DFA: [8.5]



Take an input string, which is accepted by the given DFA and check that the minimized DFA will accept it or not.

3 (a) Construct a Mealy machine which can output EVEN, ODD according as the total number of 1's encountered is even or odd. The input symbols are 0 and 1. Convert the resultant Mealy machine to Moore machine. [6.5]

(b) Take $\Sigma = \{a, b\}$ and $\Gamma = \{a, b, c\}$. Define h by h(a)=bcca, h(b)= bb. If L is a Regular language denoted by r= (a+b*)ab then find homomorphic image of L. [4.5]

(c) Is the halting problem solvable for deterministic push down automata (PDA); that is given a PDA, can we always predict whether or not the automaton will halt on input w? [6.5]

4 (a) Prove or disprove the following conjecture. If $M = (Q, \Sigma, \delta, q_0, F)$ is a minimal DFA for a regular language L, then $N = (Q, \Sigma, \delta, q_0, Q - F)$ is a minimal DFA for L'. [6.5]

(b) Find a regular expression that denotes all bit strings whose value, when interpreted as a binary integer, is greater than or equal to 40. [4.5]

(c) Check that the language $L = \{vwv: v, w \in \{a,b\}^*, |v| = 2\}$ is regular or not. [6.5]

5 (a) Construct NPDA that accepts the following language on $\Sigma = \{a, b, c\}$. [7.5]

$L = \{w: n_a(w) + n_b(w) = n_c(w)$

write transition steps and test the acceptance of an input string using the NPDA.

P.T.O.

(b) Find Linear Bounded Automata (LBA) for the following language: [7.5]

$L=\{ww: w \in \{a, b\}^+\}$

Draw transition table and test the acceptance of an input string using the LBA.

(c) Which language is accepted by Linear Bounded Automata? Does it contain empty string? [2.5]

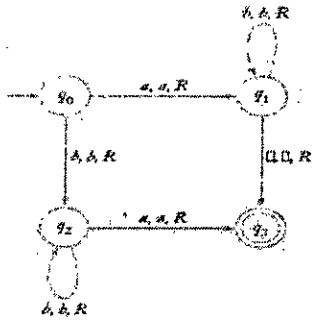
6 (a) Is it possible for a context free grammar to be ambiguous? Explain. [4.5]

(b) Show that the grammar $S \rightarrow a|abSb|aAb$, $A \rightarrow bS|aAAb$ is ambiguous. [4]

(c) Construct the grammar in Chomsky normal form generating the language $\{a^n b^m c^n | m, n \geq 0\}$. [4.5]

(d) Remove all unit-productions, all useless productions, and all λ-productions from the grammar $S \rightarrow aA|aBB$, $A \rightarrow aaA|\lambda$, $B \rightarrow bB|bbC$, $C \rightarrow B$. What language does the grammar generates? [4.5]

7 (a) What language is accepted by the Turing machine whose transition graph is in the figure below? [5]



(b) Design a Turing machine that can compute proper subtraction. i.e. $m \dot{-} n$, where m and n are positive integers. $m \dot{-} n$ is defined as $m - n$, if $m > n$ and 0 if $m \leq n$. Also, draw transition table for the machine. [8.5]

(c) What are Recursive and Recursive Enumerable languages? [4]

8 (a) Find at least three solutions to PCP defined by the dominoes: [5]

1
111

10
0

10111
10

(b) What are P, NP, NP Hard and NP Complete problems? Explain each with the help of suitable example. [6.5]

(c) Explain Church-Turing Thesis and Cook's Theorem. [6]

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