CHAROTAR UNIVERSITY OF SCIENCE & TECHNOLOGY

Six Semester of B. Tech. (CE) Examination

May 2014

CE306 Theory of Computation

Date: 12.05.2014, Monday **Time: 10:00 a.m. To 1:00 p.m.** **Maximum Marks: 70**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.

SECTION – I

Q - 1 (a) State true or false with justification. [04]

1. PDA is more powerful than FA.
2. For any NFA accepting a language L, there is an FA that also accepts L.
3. All Recursive languages are Recursive Enumerable languages.
4. Turing machine can accept every regular language.

(b) A Relation R on the set {1,2,3} is defined as R={(1,3),(3,1),(2,2)}.Find which of the 3 properties- reflexivity, symmetry and transitivity is satisfied by R? Give reasons. [03]

Q - 2 (a) State pumping lemma for regular language. Show that the set $L = \{a^{i^2} | i \geq 1\}$ is not regular. [05]

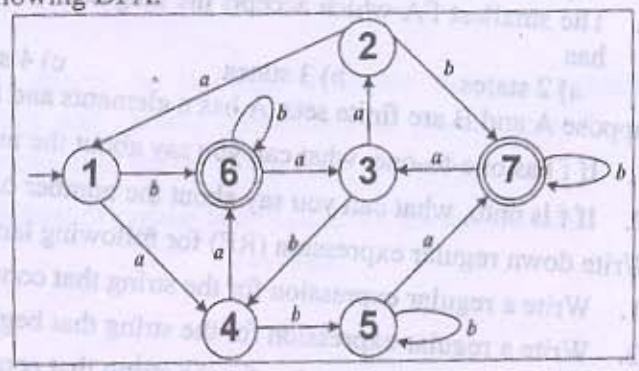
(b) $A = 2^S$ for some set S. An element X of A is related via R to an element Y if there is a bijection from X to Y. Show that R is an Equivalence relation. [04]

OR

Q - 2 (a) Prove with PMI that for every $n \geq 1$, [05]
$7 + 13 + 19 + \ldots\ldots\ldots\ldots + (6n + 1) = n(3n + 4)$

(b) What is an ambiguous grammar? Show that $S \rightarrow a \mid Sa \mid bSS \mid SSb \mid SbS$ is ambiguous. [04]

(c) Minimize the following DFA. [05]



Q - 3 (a) Design a Turing Machine for $L(G) = \{a^n b^n \mid n \geq 1\}$. [06]

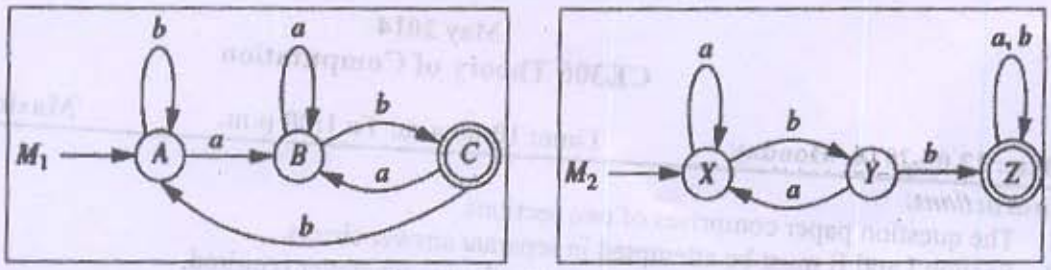
(b) Describe the term: "regular grammar" with an example. [03]

OR

Q - 3 (a) Design a Turing Machine that performs concatenation operation on string of '1'. [06]
Show an ID for $w_1 = 111$ and $w_2 = 1111$.

(b) Define extended transition function δ^* for NFA. [03]

(c) Let M_1 and M_2 are the FA recognizing the languages L_1 and L_2 respectively , shown in following figure: Draw FAs accepting $L_1 \cup L_2$ and $L_1 - L_2$. [



SECTION – II

Q - 4 (a) Choose appropriate answers: [05]

1. The basic limitation of FSM is that
   a) It cannot remember arbitrary large amount of information
   b) It cannot recognize grammars that are regular
   c) It sometimes recognizes grammars that are not regular
   d) All of these
2. The language $\{a^m b^n c^{m+n} \mid m,n \geq 1\}$ is
   a) Type 0 but not context sensitive b) Context Free but not Regular
   c) Context Sensitive but not Context Free d) Regular
3. When does a Turing machine crash?
   a. If the machine traverses all the inputs without traversing some states
   b. If it traverses all its states till the input remains
   c. If the transitional function is not defined for the present state and the input
   d. None of these
4. In the given CFG, S → aSa | bSb | a | b |^ . Which of the following strings is not generated by the grammar?
   a) aaaa b) baba c) abba d) babaaabab
5. The smallest FA which accepts the language {x | length of x is divisible by 3} has
   a) 2 states b) 3 states c) 4 states d) 5 states

(b) Suppose A and B are finite sets, A has n elements and f: A → B. [02]

1. If f has one-to-one, what can you say about the number of elements of B?
2. If f is onto, what can you say about the number of elements of B?

Q - 5 (a) Write down regular expression (RE) for following language. Assume that $\varepsilon \in \{0,1\}^*$. [04]

1. Write a regular expression for the string that contains exactly two 0's.
2. Write a regular expression for the string that begin or end with 00 or 11.
3. Write a regular expression for the string that contains even number of 0's.
4. Write a regular expression for the string in which 0 is immediately followed by 11.

(b) Define DFA. Draw DFA for $0 + 10^* + 01^*0$ [05]

OR

Q - 5 (a) Consider the two regular expressions [04]

$r = 0^* + 1^*$ $s = 01^* + 10^* + 1^*0 + (0^*1)^*$

1. Find a string corresponding to r but not to s.
2. Find a string corresponding to s but not to r.
3. Find a string corresponding to both r and s.
4. Find a string corresponding to neither r nor s.

(b) Define NFA-^. With reference to following transition table for NFA-^, Find $\delta^*(1,ababa)$ [05]

q	$\delta(q, a)$	$\delta(q, b)$	$\delta(q, ^)$
1	∅	∅	{2}
2	{3}	∅	{5}
3	∅	{4}	∅
4	{4}	∅	{1}
5	∅	{6,7}	∅
6	{5}	∅	∅
7	∅	∅	{1}

(c) Using Kleene's Theorem, Convert $(00 + 1)^*(10)^*$ regular expression into NFA- ^. [05]

Q - 6 (a) Simplify the following CFG, whose productions are the following: [06]

$S \rightarrow AaB \mid aaB$ $A \rightarrow D$ $B \rightarrow bbA \mid ^$

$D \rightarrow E$ $E \rightarrow F$ $F \rightarrow aS$

(b) Design a PDA for $L(G) = \{wcw^R | w \in (a, b)^+$ and w^R is the reverse of w} by final state/empty stack. [06]

(c) Prove that CFG is closed under union operation. [02]

OR

Q - 6 (a) Write down CFG [06]

1. The set of odd length string in $\{a, b\}^*$ with middle symbol a.
2. The set of even length string in $\{a, b\}^*$ with two middle symbols equal.
3. The set of odd length string in $\{a, b\}^*$ whose first, middle and last symbols are same.

(b) Design a PDA to accept the language of nested balanced parenthesis (where the number of opening and closing parenthesis is greater than 0) and show an ID (Instantaneous description) for the string (( )). [06]

(c) Prove that every subset of regular language is not always regular. [02]

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