Code : 051611

B.Tech 6th Semester Exam., 2016

FORMAL LANGUAGES AND AUTOMATA THEORY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

1. Choose the correct answer for any *seven* of the following : 2×7=14

(a) The output of the Moore Machine depends

(i) only on present state

(ii) only on current input symbol

(iii) both on present state and current input symbol

(iv) None of the above

(b) The logic of pumping lemma is a good example of

(i) the pigeon-hole principle

(ii) the divide-and-conquer technique

(iii) recursion

(iv) iteration

(c) Regular languages are closed under
(i) union
(ii) intersection
(iii) complementation
(iv) All of the above

(d) The language $L = \{a^n b a^n$ where $n = 1, 2, 3, ...\}$ is a
(i) regular language
(ii) context-free language
(iii) non context-free language
(iv) None of the above

(e) A language L is denoted by a regular expression $L = (ab \mid ba)\, abb$. Which of the following is not a legal string within L?
(i) *ababb*
(ii) *abbaabb*
(iii) *baabb*
(iv) None of the above

(f) Context-free languages are not closed under
(i) union
(ii) intersection
(iii) concatenation

(Continued)

(g) Context-free languages are
(i) a proper superset of regular languages
(ii) recognizable by PDA
(iii) also called type 2 languages
(iv) All of the above

(h) Choose the incorrect statements :
(i) Every subset of a countable set is countable.
(ii) The class of DPDA is not countable.
(iii) The class of TMs is countable.
(iv) The class of LBA is countable.

(i) Which of the following statements is true?
(i) The language $\{a^n \mid n$ is prime$\}$ is regular language.
(ii) The union of 2 recursive languages is recursive.
(iii) Recursive enumerable languages are closed under complementation.
(iv) Recursive languages are not closed under complementation.

(j) In case of TM, in which of the following cases a string will be accepted?

(i) Entire string has been consumed and TM halts in the final state

(ii) Entire string has been consumed and TM halts is the non-final state

(iii) Entire string has not been consumed and TM halts is in any state

2. (a) Obtain the regular expression for the following sets : 2½×4=10

(i) Set of strings over $\Sigma = \{a, b\}$ with exactly two a

(ii) Set of strings over $\Sigma = \{a, b, c\}$ where all runs of a's have lengths that are multiples of three

(iii) Set of strings over $\Sigma = \{a, b, c\}$ such that every string contains a substring ccc

(iv) $L = \{a^x \mid x \text{ is divisible by 3 or 5}\}$

(b) Show that $(ab)^* \neq a^* b^*$.

3. (a) Construct NFA equivalent to the following regular expression : 4

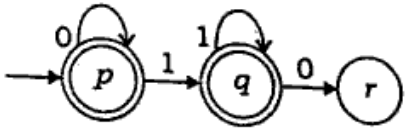
$$r = (ab \mid ba)^* \; aa(ab \mid ba)^*$$

(b) Construct an NFA with ϵ moves for the regular expression $r = a(a + b)^*$. 5

(c) Construct an NFA for the set of all strings over $\Sigma = \{a, b\}$ with exactly two a

4. (a) Construct a DFA for the regular expression $r = 0^*1^*2^*$.

(b) Find out the regular expression for the following transition diagram :



5. (a) Prove the following two properties : 3×2=6

(i) Regular sets are closed over the concatenation operation

(ii) Regular sets are closed over the complement operation

(b) Show with the help of pumping lemma that following language is not regular : 4

$$L = \{ww \mid w \in (0, 1)^*\}$$

(c) Represent the language that contains strings over $\Sigma = \{0, 1\}$ and has even number of 0's. 4

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6. (a) Give the CFG for each of the languages defined by the following regular expressions : 3×3=9

(i) a^*b

(ii) $(ab)^*$

(iii) $(baa+abb)^*$

(b) Construct a CFG for the set of non-negative odd integers. 5

7. (a) For the grammar G, which is defined as

$$S \to aB \mid bA$$
$$A \to a \mid aS \mid bAA$$
$$B \to b \mid bS \mid aBB$$

where S is the starting symbol, show the leftmost derivation, rightmost derivation and parse tree for the string 'abbbaa'. 9

(b) Determine a CFG without unit production equivalent to the CFG given below : 5

$$S \to a \mid Xb \mid aYa \mid b \mid aa$$
$$X \to Y$$
$$Y \to b \mid X$$

8. (a) Find the CNF (Chomsky Normal Form) for the the following CFG : 5

$$S \to ABA$$
$$A \to aA \mid \in$$
$$B \to bB \mid \in$$

(b) Eliminate null productions from the following CFG : 4

$$S \to Xa$$
$$X \to aX \mid bX \mid \in$$

(c) Convert the following grammar to GNF : 5

$$A_1 \to A_2A_3$$
$$A_2 \to A_3A_1 \mid b$$
$$A_3 \to A_1A_2 \mid a$$

9. (a) Design a PDA that accepts the language $L = \{wcw^R \mid w \in (0|1)^*\}$. 4

(b) Design a PDA that accepts the language $L = \{a^n b^m a^n \mid m, n > 0\}$. 4

(c) Design a TM that recognizes strings containing equal number of 0's and 1's. 6

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