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B. TECH
(SEM IV) THEORY EXAMINATION 2017-18
THEORY OF AUTOMATA AND FORMAL LANGUAGES

Time: 3 Hours

Total Marks: 70

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief.

2 x 7 = 14

- Define alphabet, string and language.
- Design a regular expression that accepts all the strings for input alphabet {a,b} containing exactly 2 a's.
- Design a NFA that accepts all the strings for input alphabet {a,b} containing the substring abba.
- Define Chomsky hierarchy.
- Is context free language closed under union? If yes, give an example.
- Convert NFA into equivalent DFA by taking any suitable example.
- Remove useless productions from the given productions: $S \rightarrow AB|ab$, $A \rightarrow aA|B|a$, $B \rightarrow D|E$

SECTION B

2. Attempt any *three* of the following:

7 x 3 = 21

- Define Deterministic Finite Automata (DFA) and design a DFA that accepts the binary number whose equivalent is divisible by 5.
- State recursive definition of regular expression and construct a regular expression corresponding to the state transition diagram as shown in Fig.1

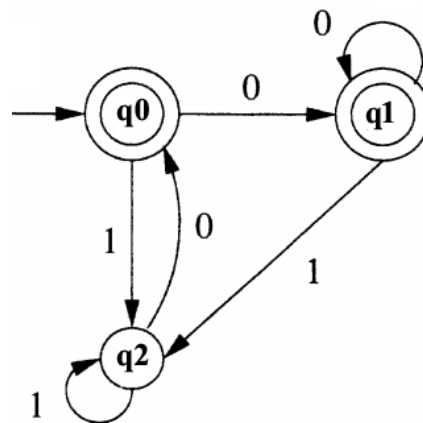


Fig.1

- Reduce the given grammar $G = (\{S, A, B\}, \{a, b\}, P, S)$ to Chomsky Normal Form. Where P is defined as:

$$S \rightarrow bA \mid aB$$

$$A \rightarrow bAA \mid aS \mid a$$

$$B \rightarrow aBB \mid bS \mid b$$
- What is Push Down Automata (PDA)? Design the PDA for the language $L = \{wcw^R \mid w \in \{a, b\}^*\}$
- Define Turing Machine (TM). Construct the TM for the language $L = \{a^n b^n \mid n > 0\}$.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

- (a) Describe Mealy and Moore machines with example. Convert the given Mealy machine as shown in Fig. 2 into Moore Machine.

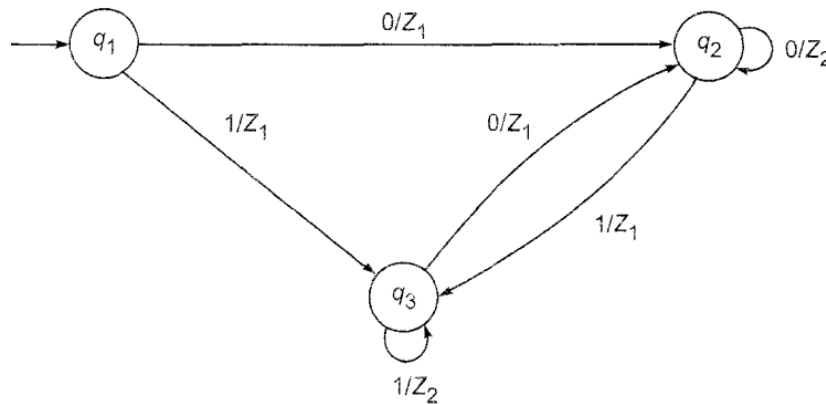


Fig. 2

- (b) Construct the minimum state automata equivalent to DFA described by Fig. 3

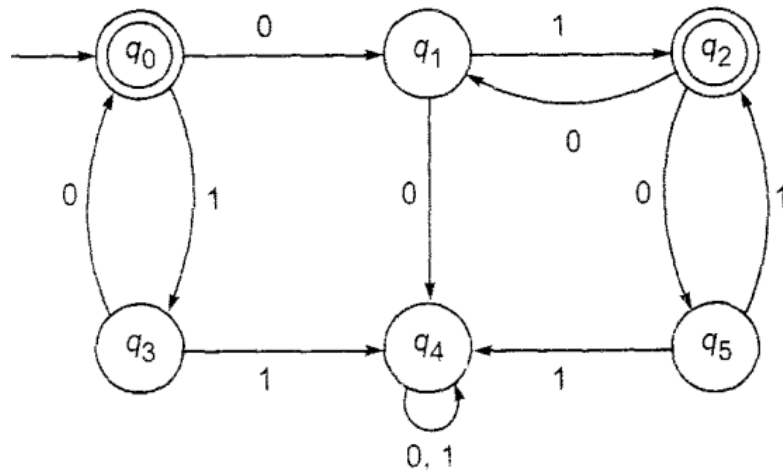


Fig. 3

4. Attempt any *one* part of the following: 7 x 1 = 7

- (a) State Pumping Lemma for regular sets. Show that the set $L = \{a^p \mid p \text{ is a prime}\}$ is not regular.
- (b) Discuss closure properties i.e. concatenation, union, intersection, complement of regular languages.

5. Attempt any *one* part of the following: 7 x 1 = 7

- (a) Discuss inherent ambiguity of context free languages with suitable example. Construct the context free grammar that accepts language $L = \{a^i b^j c^k \mid i = j \text{ or } j = k; i, j, k \text{ are positive integers}\}$.
- (b) Define parse tree. Find parse tree for the string *abcde* considering the productions-
- $S \rightarrow aAcBe$
 $A \rightarrow Ab$
 $A \rightarrow b$
 $B \rightarrow d$
- Is this ambiguous? Justify.

6. Attempt any *one* part of the following: 7 x 1 = 7

- (a) Differentiate between deterministic PDA (DPDA) and non-deterministic PDA (NPDA) with suitable example. Also discuss two stack PDA with example.

- (b) Construct a PDA equivalent to the following CFG productions:

$$S \rightarrow aAA, A \rightarrow aS \mid bS \mid a$$

7. Attempt any *one* part of the following:

7 x 1 = 7

- (a) Write short notes on the following:
- (i) Halting problem of Turing machine
 - (ii) Recursive Language
 - (iii) Variants of Turing Machine
- (b) Define Post's Correspondence Problem (PCP) and Modified PCP with its applications. Find any three PCP solutions of the lists $x=(b, bab^3, ba)$ and $y=(b^3, ba, a)$.