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Fifth Semester B.E. Degree Examination, June/July 2019
Formal Languages and Automata Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Briefly discuss why study automata theory. **(06 Marks)**

b. Design a DFA to accepts strings over {a, b} that contain the substring bb or do not contain the substring aa. **(05 Marks)**

c. Design a DFA to accept set of strings over {0, 1} in which the number of 0's is divisible by three and 1's is divisible by two. **(05 Marks)**

d. Explain the procedure subset construction for converting NFA to an equivalent DFA. **(04 Marks)**

2 a. Define ε - NFA. Consider the following ε - NFA :

δ	ε	0	1	2
$\to q_0$	$\{q_1\}$	$\{q_0\}$	ϕ	ϕ
q_1	$\{q_2\}$	ϕ	$\{q_1\}$	ϕ
$*q_2$	ϕ	ϕ	ϕ	$\{q_2\}$

i) Compute the ε - closure of each state.

ii) Convert the automaton to a DFA. **(10 Marks)**

b. Define regular expression. Convert the following DFA to a regular expression, using the state elimination technique:

δ	0	1
$\to *p$	s	p
q	p	s
r	r	q
s	q	r

(10 Marks)

3 a. State and prove pumping lemma for regular languages. **(05 Marks)**

b. Prove that the language $L = \{0^{n!} | n \geq 0\}$ is not regular. **(05 Marks)**

c. Prove the following with examples:

i) If L and M are regular languages, then so is $L \cap M$.

ii) If L is a regular language, so is L^R. **(10 Marks)**

4 a. Define context-free grammar. Design CFG's for the following languages:

i) $L = \{0^i 1^j | i \neq j\}$ ii) $L = \{x | n_0(x) \neq n_1(x)\}$ **(10 Marks)**

b. What is an ambiguous grammar? Show that the following grammar is ambiguous.

$S \to aSb | aAb$

$A \to cAd | B$

$B \to aBb | \varepsilon$ **(05 Marks)**

c. Define inherently ambiguous. With suitable example, show that the CFL is inherently ambiguous. **(05 Marks)**

PART – B

5 a. Define pushdown automata. Define a PDA to accept the language.
$L = \{wxw^R \mid w \text{ is in } \{0,1\}^* \text{ and } x \text{ is in } \{0,1,\varepsilon\}\}$. **(10 Marks)**

b. What conditions are to be met for a PDA to be deterministic? Convert the PDA $P = (\{q_0, q_1\}, \{0,1\}, \{X, Z_0\}, \delta, q_0, Z_0)$ to a CFG, if δ if given by :
i) $\delta(q_0, 0, Z_0) = \{(q_0, XZ_0)\}$
ii) $\delta(q_0, 1, X) = \{(q_0, XX)\}$
iii) $\delta(q_0, 0, X) = \{(q_1, \varepsilon)\}$ **(10 Marks)**

6 a. Consider the grammar:
$S \to aAa \mid bBb \mid \varepsilon$
$A \to C \mid a$
$B \to C \mid b$
$C \to CDE \mid \varepsilon$
$D \to A \mid B \mid ab$
i) Are there any useless symbols? Eliminate them if so.
ii) Eliminate ε - productions
iii) Eliminate unit productions
iv) Put the resulting grammar into CNF. **(10 Marks)**

b. Show that the language $L = \{a^n b^n i \mid n \le i \le 2n\}$ is not context-free. **(05 Marks)**

c. Prove that if L is a CFL and R is a regular language, then $L \cap R$ is a CFL. **(05 Marks)**

7 a. Define Turing machine. Design a Turing machine to accept the language $L = \{ww^R \mid w \text{ is in } \{0,1\}^*\}$. Also show the sequence of moves made by the Turing machine for the string 0110. **(12 Marks)**

b. Prove that if M_N is a nondeterministic Turing machine, then there is a deterministic Turing machine M_D such that $L(M_N) = L(M_D)$. **(08 Marks)**

8 a. Define the following:
i) Recursive and recursively enumerable languages.
ii) Decidable and undecidable problems. **(04 Marks)**

b. Prove that if a language L and its complement are recursively enumerable, then L is recursive. **(06 Marks)**

c. Define Post's Correspondence Problem. With suitable example, briefly explain PCP and its variant Modified PCP. Also comment on how PCP problem is undecidable. **(10 Marks)**

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