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Fifth Semester B.E. Degree Examination, June/July 2023
Formal Languages and Automata Theory

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

PART - A

1. a. Find a deterministic finite automata that recognizes each of the following sets ($\Sigma = \{0, 1\}^*$)
 - i) $\{0\}$ ii) $\{1, 00\}$, iii) $\{1^n \mid n = 2, 3, 4, \dots\}$. (10 Marks)
- b. State the alphabets Σ for the following languages :
 - i) $L = \Sigma^* = \{\epsilon, 0, 1, 00, 01, 11, 000, 001, 010, \dots\}$
 - ii) $L = \Sigma^+ = \{a, aa, aaa, \dots\}$
 - iii) $L = \Sigma^+ = \{\epsilon\}$. (05 Marks)
- c. Design a DFA that recognizes the following language :

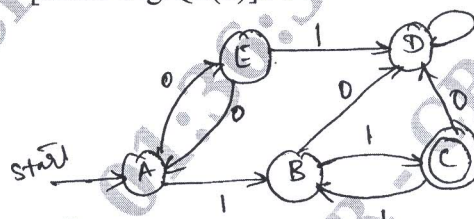
$L = \{W/W \text{ is non-empty \& has 1 on every odd position}\}$. (05 Marks)

2. a. Consider the following ϵ -NFA :

	ϵ	a	b	c
$\rightarrow p$	ϕ	$\{p\}$	$\{q\}$	$\{r\}$
q	$\{p\}$	$\{q\}$	$\{r\}$	ϕ
* r	$\{q\}$	$\{r\}$	ϕ	$\{p\}$

- i) Compute the ϵ -closure of each state ii) Convert the ϵ -NFA to DFA. (08 Marks)
- b. Define Regular expression. Convert the following automation to a regular expression using state elimination technique. [Refer Fig.Q2(b)]. (08 Marks)

Fig. Q2(b)



- c. Convert the regular expression $(0 + 1)^* | (0 + 1)$ to an NFA. (04 Marks)

3. a. State and prove pumping lemma for regular languages. (05 Marks)
- b. Obtain the regular expression from the following finite automation using state elimination method.

Fig. Q3(b)



- c. When two states are equivalent or distinguishable? Minimize the following DFA using table filling algorithm. (05 Marks)

δ	0	1
$\rightarrow q_1$	q_2	q_3
q_2	q_3	q_5
* q_3	q_4	q_3
q_4	q_3	q_5
* q_5	q_2	q_5

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.

- 4 a. Give a Context Free Grammar (CFG) for each of the following language over the alphabet $\Sigma = \{a, b\}$.
- All strings in the language $L = \{a^n b^m a^{2n} / n, m \geq 0\}$.
 - All non empty strings that start and end with the same symbol.
 - All strings with more a's than b's. (07 Marks)
- b. Is the following language L is regular? Justify your answer. (07 Marks)
 $L = \{a^n / n \text{ is prime}\}$
- c. State and prove the pumping Lemma for Regular language. (06 Marks)

PART - B

- 5 a. Define PDA. Construct PDA that accepts the language $L = \{ww^R \mid w \in (a+b)^*\}$ and w^R is the reversal of w . Write IDs for the string aabbaa. (10 Marks)
- b. Convert the following CFG to PDA and give the procedure for the same. (10 Marks)
- $$S \rightarrow aABB \mid aAA$$
- $$A \rightarrow aBB \mid a$$
- $$B \rightarrow bBB \mid A$$
- $$C \rightarrow a$$
- 6 a. What are useless productions? Eliminate ϵ , unit and useless productions from the following grammar : (10 Marks)
- $$A \rightarrow bA/Bba/aa$$
- $$B \rightarrow aBa/b/D$$
- $$C \rightarrow CA/AC/B$$
- $$D \rightarrow a/\epsilon.$$
- b. Define Chomsky normal form. Convert the following CFG to CNF : (06 Marks)
- $$S \rightarrow aSb/ab/Aa$$
- $$A \rightarrow aab.$$
- c. Prove that the context free languages are closed under union. (04 Marks)
- 7 a. For the CFG with productions : (10 Marks)
- $$S \rightarrow a/aAB \mid aCb, \quad A \rightarrow aB \mid \epsilon, \quad B \rightarrow Ba/A \mid \epsilon,$$
- $$C \rightarrow B \mid bCb \mid S, \quad D \rightarrow dd \mid cC$$
- Eliminate ϵ productions
 - Eliminate the unit productions
 - Eliminate the useless symbols.
- b. Prove that the context free Languages are closed under Union concatenation and Kleen closure. (10 Marks)
- 8 Write short notes on : (20 Marks)
- Multitape turing machine
 - Post's correspondence problem.
 - Pumping Lemma for CFL.
 - Recursive languages.

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