U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

October 2023 Semester End Main Examinations

Programme: B.E **Semester: IV**
Branch: Information Science and Engineering **Duration: 3 hrs.**
Course Code: 19IS4PCTFC **Max Marks: 100**
Course: Theoretical Foundations of Computations

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

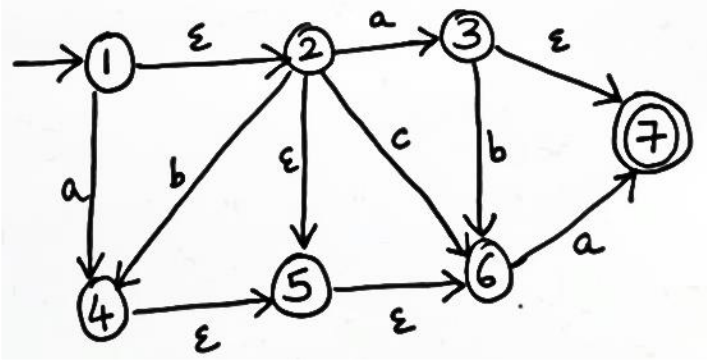
1 a) Design Deterministic Finite Automata for the following languages with ∑ = {0,1} **10**

i) $L_1 = \{0^n10^m \mid n>=2 \text{ and } m>=3\}$

ii) L_2 = {Strings where three consecutive 1's is not allowed}

iii) L_3 = {Strings beginning with a '1', that when interpreted as a binary integer is divisible by 5}

b) Define ε-closure of a state. Convert the following ε-NFA to DFA. **10**



UNIT - II

2 a) Obtain Regular Expressions for the following languages **08**

i) L_1 = { Strings of a's and b's whose length is either even or multiple of 3}

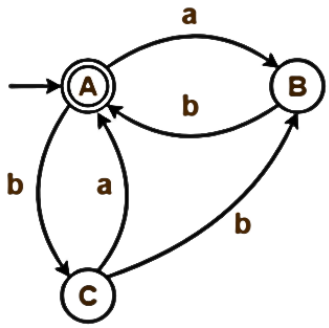
ii) Language L_2 whose ∑ = {0,1}and which includes strings with two or more letters but beginning and ending with same letter

iii) L_3 = { Strings of 0's and 1's with atmost one pair of consecutive 0's }

iv) Language L_4 whose ∑ = {a,b,c} and which includes strings with atleast one a and atleast one b

b) Using pumping lemma, prove that the language L = $\{0^i1^j : i!=j\}$ is not regular. **05**

c) Transform the following DFA to its equivalent regular expression **07**



OR

3 a) Provide English description to identify the language for the following regular expressions: **06**

i) (00)*0(11)*

ii) (1+ε)(01)*(0+ε)

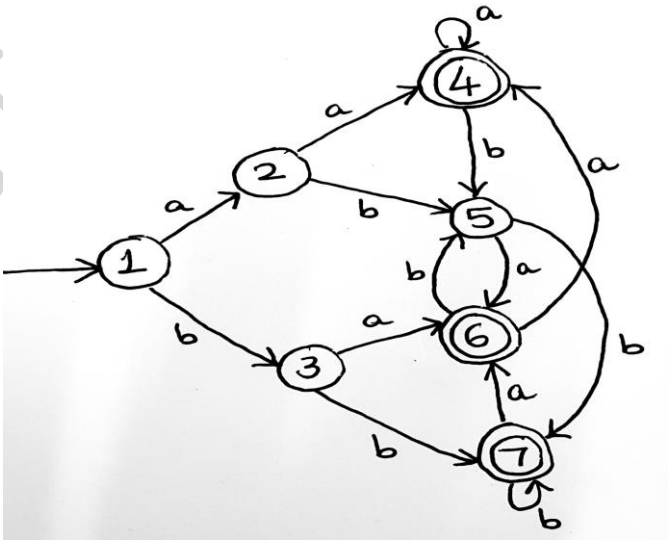
iii) (0+1)*0(0+1)(0+1)

b) Construct ε-NFA for the following regular expressions **06**

i) (0*2*) (10)*

ii) b+a*(b+a)*

c) Minimize the given DFA using table filling algorithm. **08**



UNIT - III

4 a) Design Context-free grammar (CFG) for the following languages **10**

i) L = $\{a^nb^mc^k \mid m>=0, n>=0 \text{ and } n+2m=k\}$

ii) Language with strings of balanced parenthesis. Assume ∑ = { (,), [,], {, } }

iii) L= $\{0^n ww^r1^n \mid n >=1 \text{ and } w = \{0,1\}^*\}$

b) Define Greibach Normal Form (GNF). Convert the grammar, whose productions are given below to GNF **10**

$S \rightarrow XA|BB$

$B \rightarrow b|SB$

$X \rightarrow b$

$A \rightarrow a$

OR

5 a) Define Chomsky Normal Form (CNF). Convert the following grammar to CNF. **10**

$S \rightarrow AACD$, $A \rightarrow aAb \mid \varepsilon$, $C \rightarrow cC \mid a$, $D \rightarrow aDa \mid bDb \mid \varepsilon$

b) Show that the following grammar is ambiguous. **05**

$S \rightarrow a \mid Sa \mid bSS \mid SSb \mid SbS$

c) Explain any two applications of Context Free Grammars. **05**

UNIT - IV

6 a) Design a Push Down Automata (PDA) to recognize the Context free language **08**

$L = \{a^n b^{n+m} c^m \mid n>=1, m>=1\}$

b) Define Deterministic and Non-deterministic PDA. Explain with a suitable example. **05**

c) Obtain CFG for the PDA $M = (\{q0, q1\}, \{a, b\}, \{Z, A, B\}, \delta, q0, Z, \{q0\})$ where δ is defined by: **07**

$\delta(q0, a, Z) = (q1, AZ)$; $\delta(q0, b, Z) = (q1, BZ)$;

$\delta(q1, a, A) = (q1, AA)$; $\delta(q1, b, B) = (q1, BB)$;

$\delta(q1, a, B) = (q1, \varepsilon)$; $\delta(q1, b, A) = (q1, \varepsilon)$; $\delta(q1, \varepsilon, Z) = (q0, \varepsilon)$

UNIT - V

7 a) Design a Turing Machine (TM) for the Language $L = \{0^n 1^n 2^n \mid n>=1\}$ Provide instantaneous description for acceptance of the string "000111222" by the TM. **10**

b) Suppose that a tape contains pair of integers m,k in unary form separated by a single 'x'. Design a Turing Machine to replace its input by the value of the function f(m,k)=m+k. **06**

c) Check whether the following instance of Post Correspondence Problem has a solution. **04**

List A: [ab, bba, a] and List B: [aa, bb, baa]

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