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

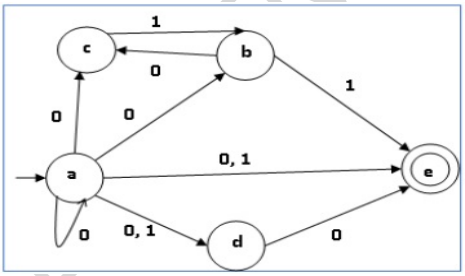
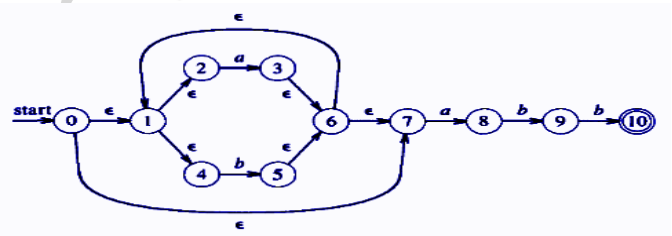
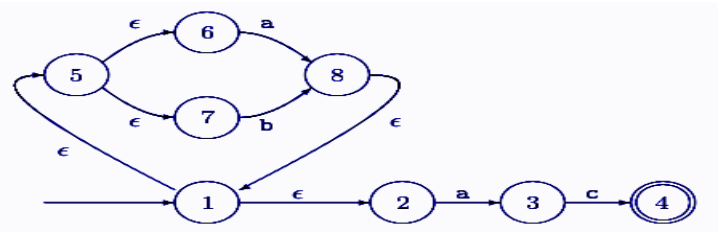
**Autonomous Institute Affiliated to VTU**

## June 2025 Semester End Main Examinations

**Programme: B.E.** **Semester: IV**
**Branch: Information Science and Engineering** **Duration: 3 hrs.**
**Course Code: 23IS4ESTFC /22IS4PCTFC /19IS4PCTFC** **Max Marks: 100**
**Course: Theoretical Foundations and 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 | CO | PO | Marks |
|---|---|---|---|---|---|
| 1 | a) | Construct DFAs for the following:<br>i. To accept the strings starting and ending with different symbols for the $\sum = \{a,b\}$.<br>ii. To accepts binary strings divisible by 3. | CO1 | | 6 |
| | b) | Obtain an equivalent DFA for the given NFA.<br>  | CO2 | PO1 | 9 |
| | c) | Write ε -closures for all states in the ε-NFA given below:<br>  | CO1 | | 5 |
| | | **OR** | | | |
| 2 | a) | Obtain an equivalent DFA for the given ε-NFA.<br>  | CO2 | PO1 | 7 |

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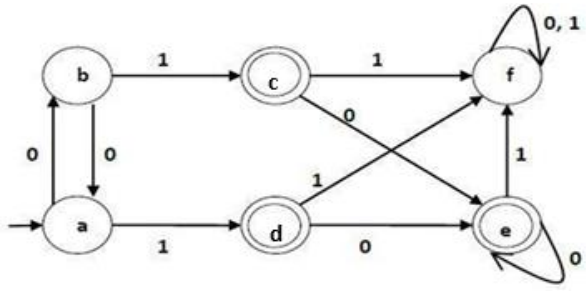
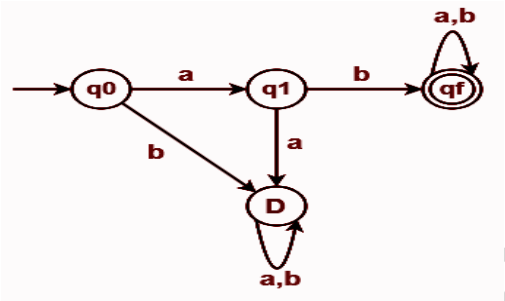
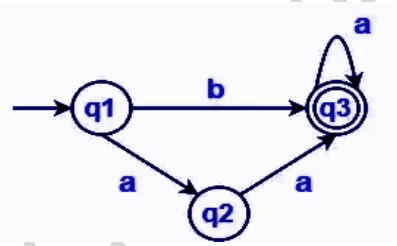
| | | b) | Minimize the given DFA using table-filling method.<br>  | CO2 | PO1 | 10 |
| | | c) | Identify and describe the language accepted by the following DFA. Also write any two sample strings in the language.<br>  | CO2 | PO2 | 3 |
| | | | **UNIT - II** | | | |
| 3 | a) | | Obtain a regular expression for the following finite automata using the state elimination method.<br>  | CO2 | PO1 | 5 |
| | b) | | Obtain **ε**- NFAs for the following regular expressions.<br>i. (0+1)*(00+10+11)<br>ii. (a+b)*ab + ba(a+b)* | CO3 | PO1 | 10 |
| | c) | | Prove the language L={$0^n1^n$ } is not regular using pumping lemma. | CO2 | PO1 | 5 |
| | | | **OR** | | | |
| 4 | a) | | Provide English description to identify the language for the following:<br>i. (a+b)*(aa+bb)<br>ii. (**ε**+a+b) (**ε**+a+b) (**ε**+a+b)<br>iii. 0(10+0)*1<br>iv.(a+b)*b(a+b)(a+b) | CO2 | PO1 | 6 |
| | b) | | State and prove the pumping lemma theorem for regular languages. | CO1 | | 8 |

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| | | c) | Determine regular expressions for the following languages.<br>i. L = { 1w22 \| where w ∈ ∑ = {1,2} }.<br>ii. All strings starting not ending with "bb" except empty string for ∑ = {a,b} .<br>iii. String contains at least two 0's but not consecutive 0's for ∑ = {0,1}. | *CO2* | *PO2* | **6** |
| | | | **UNIT - III** | | | |
| | 5 | a) | Write Grammars for the following languages<br>i.) L (G) = $\{a^m b^n \mid m \geq 0$ and $n > 0\}$<br>ii.) L(G) = $\{ww^R \in \{0, 1\}^*$ and \|w\| is even } | *CO3* | *PO2* | **6** |
| | | b) | Simplify the following grammars:<br>i.) Eliminate ε productions<br>S → XYX<br>X → 0X \| ε<br>Y → 1Y \| ε<br>ii.) Eliminate Unit Productions:<br>S → 0A \| 1B \| C<br>A → 0S \| 00<br>B → 1 \| A<br>C → 01<br>iii.) Eliminate Useless symbols:<br>S → AB \| AC<br>A → aAb \| bAa \| a<br>B → bbA \| aaB \| AB<br>C → abCA \| aDb<br>D → bD \| aC | *CO2* | *PO1* | **10** |
| | | c) | Consider the following grammar.<br>S → aB \| bA<br>A → aS \| bAA \| a<br>B → bS \| aBB \| b<br>For the string **"aabbab", w**rite leftmost and rightmost derivations with respective parse trees. | *CO2* | *PO1* | **4** |
| | | | **OR** | | | |
| | 6 | a) | Briefly explain the different types of grammar. | *CO1* | | **5** |
| | | b) | For the given grammar:<br>S → ABC \| BaB<br>A → aA \| BaC \|aaa<br>B → bBb \| a \|D<br>C → CA \|AC<br>D → ε<br>(i) Eliminate ε-productions.<br>(ii) Eliminate any unit productions in the resulting grammar.<br>(iii) Eliminate any useless symbols in the resulting grammar.<br>(iv) Convert the resulting grammar into Chomsky Normal Form. | *CO2* | *PO1* | **10** |

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| | | c) | Determine if the following grammar is ambiguous or not. Write derivations and parse trees for the same.<br>S → iCtS \| iCtSeS \| a<br>C → b | *CO2* | *PO1* | **5** |
| | | | **UNIT - IV** | | | |
| | 7 | a) | Construct PDA for the language L={$a^n b^m c^n$} and write the instantaneous description for the string "aaabbccc". | *CO3* | *PO1* | **10** |
| | | b) | Convert CFG to PDA.<br>S → aSB \| bAC \| bC<br>A → bAC \| bC<br>B → b<br>C → a | *CO2* | *PO1* | **5** |
| | | c) | How do you determine if a PDA is deterministic or not? | *CO1* | | **5** |
| | | | **OR** | | | |
| | 8 | a) | Design a PDA to accept the language L = {$a^n b^{2n}$ \| n≥1} by final state. Write the sequence of moves using an instantaneous description for acceptance of any string of length 6 in the language. | *CO3* | *PO1* | **10** |
| | | b) | Convert PDA to CFG.<br>δ(q0, a, Z) → (q0, AZ)<br>δ(q0, a, A) → (q0, AA)<br>δ(q0, b, A) → (q1, ε)<br>δ(q1, b, A) → (q1, ε) | *CO2* | *PO1* | **5** |
| | | c) | Determine if the given PDA is deterministic or not.<br>δ(q0, a, z) = (q0, az)<br>δ(q0, a, a) = (q0, aa)<br>δ(q0, b, z) = (q0, bz)<br>δ(q0, b, b) = (q0, bb)<br>δ(q0, a, b) = (q0, ab)<br>δ(q0, b, a) = (q0, ba)<br>δ(q0, a, a) = (q1, ε)<br>δ(q0, b, b) = (q1, ε)<br>δ(q1, a, a) = (q1, ε)<br>δ(q1, b, b) = (q1, ε)<br>δ(q1, ε , z) = (qf, z) | *CO2* | *PO1* | **5** |
| | | | **UNIT - V** | | | |
| | 9 | a) | Construct Turing Machine for the language L = {$0^n 1^n 2^n$ }for n>=1. Provide instantaneous description for acceptance of a string "001122" | *CO3* | *PO1* | **12** |
| | | b) | Construct Turing Machine for simple adder "x+y" sample input 2+3 as "00c000". | *CO3* | *PO2* | **8** |
| | | | **OR** | | | |
| | 10 | a) | Construct Turing Machine for the language L = {$ww^R$} for strings of a's and b's. | *CO3* | *PO1* | **10** |
| | | b) | Illustrate the working of Universal Turing machine for the L={$a^n b^n$ \|n>=1} with transition diagram, transition table and instantaneous description for the string "aaabbb". | *CO3* | *PO2* | **10** |

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