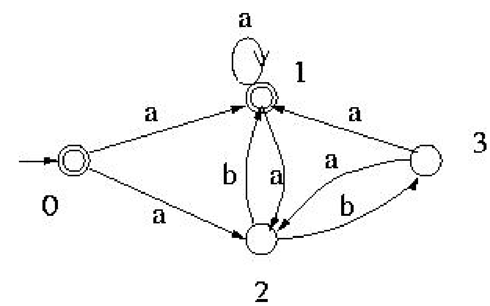
IIIT Chittoor; ToC End-Sem; Max Marks 35; Duration 3 Hours.

Note: Closed book and closed notes exam. Ordinary calculators are allowed. **Answers should be as per the methods discussed in the class. Answers without proper intermediate steps (as per the methods discussed in the class) will not get any marks.**

1 Convert the given NFA to an equivalent DFA having minimum number of states. You should use the methods discussed in the class. {Answers without proper intermediate steps (as per methods discussed in the class) will not give you any marks}.



2 Let R, S be regular expressions, prove or disprove the statements
(a) $(R+S)^* = R^* + S^*$ (b) $(R+S)^*S = (R^*S)^*$

3 Let a PDA $P = (\{q_0, q_1, q_2, q_3, f\}, \{a, b\}, \{Z_0, A, B\}, \delta, q_0, Z_0, \{f\})$ has the following rules defining δ:

$$\begin{array}{lll}
\delta(q_0, a, Z_0) = (q_1, AAZ_0) & \delta(q_0, b, Z_0) = (q_2, BZ_0) & \delta(q_0, \epsilon, Z_0) = (f, \epsilon) \\
\delta(q_1, a, A) = (q_1, AAA) & \delta(q_1, b, A) = (q_1, \epsilon) & \delta(q_1, \epsilon, Z_0) = (q_0, Z_0) \\
\delta(q_2, a, B) = (q_3, \epsilon) & \delta(q_2, b, B) = (q_2, BB) & \delta(q_2, \epsilon, Z_0) = (q_0, Z_0) \\
\delta(q_3, \epsilon, B) = (q_2, \epsilon) & \delta(q_3, \epsilon, Z_0) = (q_1, AZ_0) &
\end{array}$$

Note that, since each of the sets above has only one choice of move, we have omitted the set brackets from each of the rules.

a) Give an execution trace (sequence of ID's) showing that string bab is in $L(P)$.

b) Give an execution trace showing that abb is in $L(P)$.

c) Give the contents of the stack after P has read b^7a^4 from its input.

4 Find out whether each of the following language is a decidable language or not

(a) Let $ALL_{\mathsf{DFA}} = \{\langle A \rangle \mid A \text{ is a DFA and } L(A) = \Sigma^*\}$.

(b) Let $A\varepsilon_{\mathsf{CFG}} = \{\langle G \rangle \mid G \text{ is a CFG that generates } \varepsilon\}$.

5 For the Boolean formula F = $(x \vee \bar{y}) \wedge (\bar{x} \vee y \vee z \vee w)$, $\{\text{note, } \bar{x} \text{ is negation of } x\}$
(a) As per the method given in the class reduce this to a string F1 in 3SAT form, (b) Reduce this F1 to a graph as per the 3SAT to CLIQUE reduction discussed in the class, and thus find whether the given Boolean formula F is satisfiable or not. {Directly giving the answer (i.e., without giving appropriate intermediate stages/steps) will not give you any marks.}

6 Prove or disprove the following statements
(a) ($A \leq_m B$ and B is a regular language) $\Rightarrow A$ is a regular language. (b) The language $\{< M > | M \text{ is a Turing Machine and } L(M) \text{ is a regular language}\}$ is a decidable language.

7 Find whether the polynomial time reduction relation between languages $(i.e., \leq_P)$ is (a) reflexive or not, (b) symmetric or not, and (c) transitive or not. {You should prove your answers mathematically.}