VIT
Vellore Institute of Technology

Course: CBS2002 - Formal Languages and Automata Theory
Class NBR(s): 4089 Slot: G1+TG1
Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAMALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

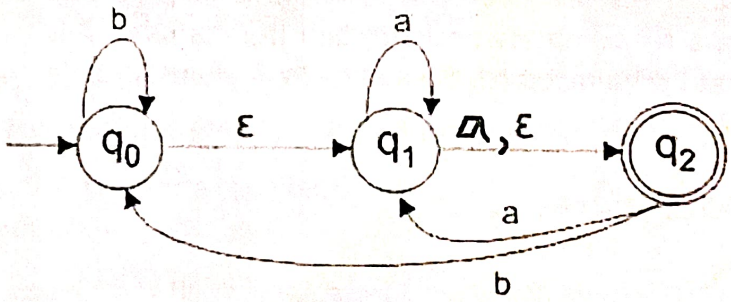
Answer ALL Questions

(10 X 10 = 100 Marks)

1. a. Are there languages for which $L = L^R$, where R is a reversal operator for L. If yes, provide one such language to justify your claim. [2]
   b. Prove that $(uv)^R = v^R u^R$ for any strings $u,v \in \Sigma^*$. [4]
   c. If $L_a = \{a^n b^m : n \geq 0, n > m\}$. What is $L_a{}^3$? [2]
   d. Let $L_1 = \{w \in \{0,1\}^* : |w| \bmod 5 = 0\}$. $L_2 = \{w \in \{0,1\}^* : |w| \bmod 10 = 0\}$. Is $L_1 L_2 = L_1$? Justify. [2]

2. a) Construct a DFA that accepts all strings over {a,b} whose occurrences of a is even and occurrences of b is odd. [5]
   b) Given two regular languages L_1 and L_2, how can you check whether they are equivalent or not? [5]

3. a) Prove or disprove that for all DFA M having k >1 final states, there exists an equivalent NFA M' having only one final state. [3]
   b) Prove that the procedure 'Minimization' applied to a DFA M actually produces 'the' minimized DFA M'. [7]

4. 

Convert the NFA with epsilon transition to an equivalent DFA. Note that $\delta(q_1, a) = \{q_1, q_2\}$, $\delta(q_1, \varepsilon) = \{q_2\}$, $\delta(q_0, \varepsilon) = \{q_1\}$.

5. Show that the power of deterministic PDA and non-deterministic PDA are the same or different with constructive example(s). Defend why the PDA is deterministic / non-deterministic.

6. For the following context-free grammar convert to equivalent grammar in GNF and then using the GNF construct the equivalent PDA.

$S \rightarrow AD$, $A \rightarrow aAb \mid BD$, $B \rightarrow Bd \mid bD$, $D \rightarrow SD \mid d$.

7. Discuss the following variants of TM with possible transition rules/suitable diagram.

a) TM with stay option
b) TM with multihead
c) TM with multitape
d) Universal TM

8. Construct a TM that accepts the language $\{0^n1^n \mid n \geq 1\}$. Given the input strings, $w_1 = 0011$ and $w_2 = 00011$, discuss through ID that how the inputs are processed by TM.

9.a) i. Prove that there are languages over unary alphabet that are not recursively enumerable.

ii. Define PCP with an example.

OR

9.b) i. Show that if S is an infinite set, then 2^S is uncountable.

ii. State Halting problem and Rice theorem.

10.a) (i) Define Class P and Class NP-Complete. (ii) You are given two computational problems A and B with A is known to have a polynomial time solution and the status of B is unknown. How can you show that Problem B is solvable in polynomial time. Explain with diagrammatic representation and suitable notations and write to the point.

OR

10.b) (i) Define class NP and NP-Hard. (ii) You are given two computational problems R and Q with Q is known to be a NP-complete problem and the status of R is unknown. How can you show that Problem R is NP-Complete. Write with suitable notations and write to the point.

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