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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIRST SEMESTER M. TECH DEGREE EXAMINATION
Computer Science and Engineering
(*Computer Science and Systems Engineering*)

04 CS 6405 - Automata Theory and Computability

Max. Marks: 60 Duration: 03 Hrs

Part A (Answer All, Each Carries 03 Marks)

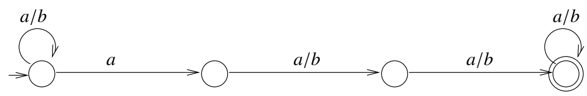
1. Design a DFA for the language $L = \{x \in \{0, 1\}^* \mid x \text{ represents an odd Natural number}\}$
2. Argue that the ultimate periodicity condition is not sufficient for proving regularity.
3. Give a regular expression for the language, $L = \{x \in \{a, b\}^* \mid \text{either } x \text{ starts with an } a \text{ or } x \text{ ends with a } b\}$
4. Let R be the canonical MN relation for a language L in $\{a, b\}^*$ with the set of equivalence classes - $\{[\lambda], [a], [b], [ab]\}$. Suppose $ab \in L$ and $\{\lambda, a, b\} \cap L = \emptyset$. Then, which language is L?
5. Write a Context Free Grammar for the language $L = \{a^n x b^n \mid x \in \{0, 1\}^*\}$
6. Prove or disprove that "Context-Free Languages are closed under intersection"
7. What are unit productions? What is their effect on deciding membership problem (deciding whether a given string is present in a given language or not) of Context-Free Languages?
8. Argue that the following property of Recursively Enumerable languages is non-monotone: "Language is finite"

[08 X 03 = 24 Marks]

Part B (Answer All, Each Carries 06 Marks)

[06 X 06 = 36 Marks]

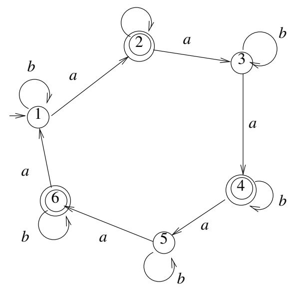
9. Apply subset construction on the following NFA to obtain the equivalent DFA.



nfa

OR

10. Obtain the unique-minimal DFA corresponding to the canonical MN relation representing the language recognised by the following DFA.



11. Prove that the language $\mathcal{L} = \{a^p \text{ where } p \text{ is prime}\}$ is not regular.

OR

12. Using MN Theorem argue that the language $\mathcal{L} = \{a^m b^n \mid m \leq n, m \geq 0\}$ is not regular.

13. Covert the Context Free Grammar with the following set of productions into CNF: $S \rightarrow aSb \mid bSa \mid \epsilon$

OR

14. What is a pump. Give the basic pumps of the Context Free Grammar with the following set of productions:$S \rightarrow aSa \mid bSb \mid a \mid b$

15. Give a PDA (accepts by emptying stack) accepting the language $\mathcal{L} = \{a^m b^n \mid m \geq 0 \text{ and } n > m\}$. (No explanation is required. It is enough to give the set of transitions or transition graph where a transition $\delta(p, a, X) = (q, YX)$ is represented by the edge $\textcircled{p} \xrightarrow{(a,X)/YX} \textcircled{q}$.)

OR

16. Give a PDA (accepts by emptying stack) accepting the language $\mathcal{L} = \{a^m b^n c^{m+n} \mid m \geq 0, n \geq 0\}$. (No explanation is required. It is enough to give the set of transitions or transition graph where a transition $\delta(p, a, X) = (q, YX)$ is represented by the edge $\textcircled{p} \xrightarrow{(a,X)/YX} \textcircled{q}$.)

17. Design a Turing Machine to recongnize the language $L = \{a^n b^{n+2} \mid \text{where } n \geq 0\}$ (No explanation is required. It is enough to give the set of transitions or transition graph where a transition $\delta(p, a) = (q, b, R)$ is represented by the edge $\textcircled{p} \xrightarrow{a/(b,R)} \textcircled{q}$.)

OR

18. Design a Turing Machine for checking whether a natural number m is greater than another natural number n or not. Assume that the tape initially contains the unary representations of m and n separated by the symbol \$. That is the initial tape content will be $\vdash 1^m \$ 1^n \flat^\omega$, where $\flat$ represents the blank symbol. Design the Turing Machine to halt in the state t if $m > n$ and to halt in the state r if $m \leq n$. (No explanation is required. It is enough to give the set of transitions or transition graph where a transition $\delta(p, a) = (q, b, R)$ is represented by the edge $\textcircled{p} \xrightarrow{a/(b,R)} \textcircled{q}$.)

19. Show without using Rice's Theorem that the language $REG = \{M \mid M \text{ accepts a regular language}\}$ is not recursively enumerable.

OR

20. Show without using Rice's Theorem that the language $FULL = \{M \mid \mathcal{L}(M) \text{ accepts all strings}\}$ is not recursive.