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

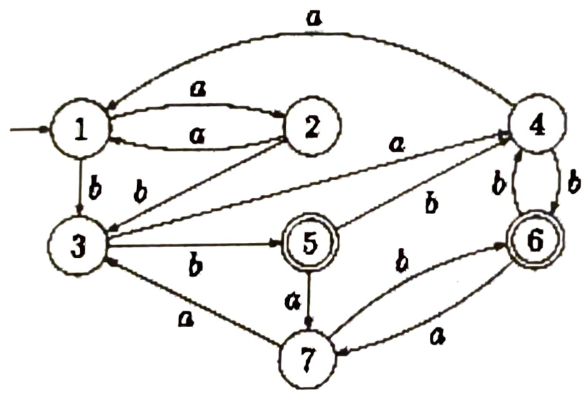
Answer ALL Questions
(10 X 10 = 100 Marks)

1. Can a DFA accept an infinite language? Find the minimal DFA for the following regular languages:

   a) L= $\{\omega_1 ab\omega_2 \mid \omega_1 \in \{a, b\}^*, \omega_2 \in \{a, b\}^*\}$ **[5]**

   b) L=$\{ba^n \mid n>=1, n \neq 5\}$ **[5]**

2. Why do we remove unreachable states before starting the minimization process? Consider the following DFA:



Minimize this DFA and provide the transition table for the minimized DFA.

3. What are the key advantages of Moore machines over Mealy machines? Design a Moore machine that scans a sequence of 0s and 1s and generates output 'A' if the input string terminates in '00', output 'B' if the string terminates in '11', and output 'C' otherwise. For instance, for the input '010011', find the corresponding output string.

4. Construct a Finite Automata that accepts the language described by the given regular expression.

   a) $a(b+c)d^*$ **[2.5]**

   b) $(a+b)(ab+ba)^*$ **[2.5]**

   c) $a(b+a)^*bb$ **[2.5]**

   d) $ab(a+b)^*abb$ **[2.5]**

5. Consider the grammar G over the alphabet {0, 1} with a single nonterminal S and productions given by:

$S \rightarrow 0S \mid 0S1S \mid \epsilon$

a) What is the language generated by G? **[2]**

b) Show that G is ambiguous. **[3]**

c) Given the following strings (Q1, Q2, Q3, Q4, Q5), identify the valid and invalid strings of above grammar. **[5]**

(Q1) 0011 (Q2) 10 (Q3) 00000 (Q4) 010 (Q5) 0010

6. Consider the grammar:

S→Sa | bC | A

A→Aa | c

C→Cb | d

a) Simplify the grammar further by removing epsilon-productions, useless productions and unit productions. Also, ensure the resulting grammar generates the same language. **[5]**

b) Convert the given grammar into Chomsky Normal Form (CNF). After converting to CNF, ensure that the grammar is in the desired form. **[5]**

7. Explain how a PDA can be used to recognize a language L(M) that accepts the language L by M on $\Sigma = \{a, b, c\}$.

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

Design a PDA for this language. Discuss how the PDA uses the stack to compare the number of a's b's and c's. Provide an example to illustrate how the PDA works.

8. Design a Turing machine that accepts the language $L = \{0^n 1^n 0^n \mid n \geq 0\}$. Provide a detailed explanation of the steps of the machine and the transitions. Explain the difficulty of designing a pushdown automaton (PDA) for this language.

9.a) Define the Post Correspondence Problem (PCP). Given the following set of pairs P={(a,ab),(b,ba),(aa,ab)}, determine whether there exists a solution to the Post Correspondence Problem (PCP) for this set of pairs. If so, show the solution; otherwise, justify why no solution exists.

OR

9.b) Explain why unrestricted grammars are considered more powerful than context-sensitive grammars. Illustrate your explanation with an example of a language that can be generated by an unrestricted grammar but not by a context-sensitive grammar.

10.a) Show that the Halting Problem cannot be solved by any algorithm by reducing the Halting Problem to another undecidable problem of your choice. Provide the formal proof for the reduction.

OR

10.b) Compare the power of finite automata (FA), pushdown automata (PDA) and Turing machines (TM) in terms of the languages they can recognize. Provide examples of languages that each machine type can and cannot recognize.

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