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Mahindra University Hyderabad
École Centrale School of Engineering
EndTerm
Program: B. Tech Branch: CSE/ARI/CAM/ECM/ECE Year: II Semester:2
Subject:- Theory of Computation (CS/AI 2204)

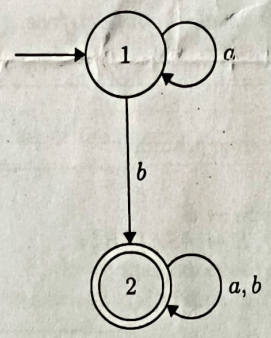
Date: 31/05/2024 **Start Time: 10:00 AM**
Time Duration: 3 h 00 m **Max. Marks: 100**

Instructions:

- Answer all the questions.
- Keep the answers short, meaningful, straight to the point.

A) Answer the following $10 \times 8 = 80$ Marks

1. Convert the following DFA to an equivalent regular expression. *Hint: Convert this to a GNFA with two states.*



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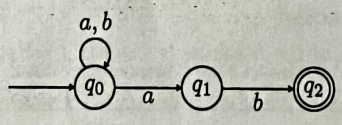
2. Following is an NFA that recognizes the language $L = \{w \in \{a,b\}^* | w \text{ ends with ab}\}$.



The following is transition function for the DFA designed to recognize the complement language $\bar{L}$. Fill the table with appropriate entries and explain your method.

δ	0	1
$\{q_0\}$		
$\{q_0, q_1\}$		
$\{q_0, q_2\}$		

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3. How many DFAs exist with n states over input alphabet $\{0,1\}$? Explain your answer.

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4. Consider the statment:
There exists a DFA which takes as input two integers (of arbitrary size) in binary representation and accepts it if and only if the most significant bit of their sum is 1.
Prove if True, refute otherwise.

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5. Let $D_1 = (Q_1, \Sigma_1, \delta_1, q_1, F_1)$ and $D_2 = (Q_2, \Sigma_2, \delta_2, q_2, F_2)$ be two DFAs each designed to recognize languages L_1 and L_2 respectively. Let $D_{12} = (Q, \Sigma, \delta, q_0, F)$ be a DFA to recognize $L_1 \cup L_2$. Express the 5 components of D_{12} in terms of the components of D_1 and D_2.

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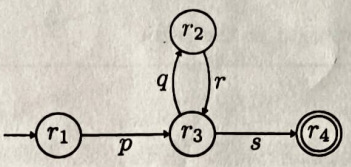
6. Consider the following FSM. For any input string that is accepted by this machine, what is the substring that can be *pumped up* indefinitely? Explain.



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7. Consider this statement:
Complement of a context-free language is also context-free.
Prove it if True, give a counter example otherwise.

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8. Remove ϵ rules from the following context-free grammar.

$$S_0 \to S$$
$$S \to ASA \mid \mathtt{a}B \mid \mathtt{a}$$
$$A \to B \mid S \mid \epsilon$$
$$B \to \mathtt{b} \mid \epsilon$$

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9. Consider the following Turing Machine:

(a) What language does this machine decide?

(b) Supposing the current configuration of the machine is $\sqcup q_5 x 0 x \sqcup$, what would be the next configuration? Explain.

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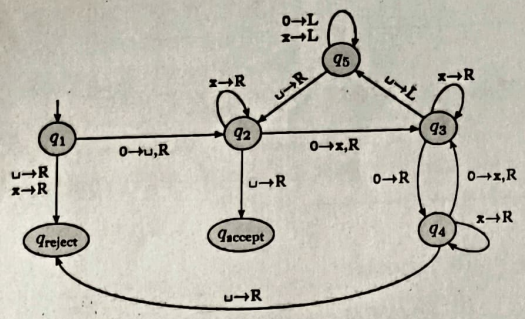
10. Explain the three steps in converting a regular grammar to regular expression. Find the regular expression equivalent to the following grammar.

$$S \to aCb$$
$$C \to a \mid b \mid \epsilon$$



B) Multiple Choice Questions

$10 \times 2 = 20$ Marks

Select all correct answers for full marks.

1. Which of the following is true for a DFA which is equivalent to a given NFA?

Statement 1: The Initial State of NFA is the Initial State of DFA. Statement 2: The final state of DFA will be every combination of final state of NFA.

a) Statement 1 is true and Statement 2 is true b) Statement 1 is true and Statement 2 is false
c) Statement 1 can be true and Statement 2 is true d) Statement 1 is false and Statement 2 is also false

2. Which of the following strings is not generated by the given grammar:

$$S \rightarrow SaSbS \mid \epsilon$$

a) aabb b) abab c) abaabb d) None of the above

3. A DPDA is a PDA in which:

a) No state has two outgoing transitions b) More than one state can have two or more outgoing transitions
c) Atleast one state has more than one transitions d) None of the above

4. Which of the following strings have the pattern $a(a \cup b)^*b$.

a) aabbb b) bbbb c) ab d) aaaabbbb

5. Let $G = (\Sigma, V, S, P$ be a formal grammar. Let $\alpha \rightarrow \beta$ be a typical production rule in P. Then, a) $\alpha \in \Sigma^*$ b) $\alpha \in (\Sigma \cup V)^*$ c) $\alpha \in (\Sigma \cup V)^* V (\Sigma \cup V)^*$ d) $\beta \in (\Sigma \cup V)^* V (\Sigma \cup V)^*$

6. We call a language regular if

a) It can be generated by context-free grammar b) It can be recognized by an NFA c) It can be recognized by an DFA d) It can be represented by a regular expression

7. A language is context free if

a) It is regular. b) It can be recognized by a PDA. c) It is decidable. d) All languages are regular

8. We call a language (L) Turing Recognizable if

a) There exists a Turing machine to answer $x \in L$ and $x \notin L$ b) There exists a Turing machine to answer $x \in L$ c) There exists a Turing machine to answer $x \notin L$ d) If the language has no grammar.

9. Which of the following languages are decidable

a) A_{TM} b) E_{CFG} c) EQ_{CFG} d) EQ_{DFA}

10. How many decidable languages exist?

a) Finite b) Uncountable c) Countable d) As many as the number of problems