IMPORTANT TOPICS

MODULE 1

1 Draw the state transition diagram showing a DFA for recognizing the language L over the alphabet set $\Sigma = \{a, b\}$:

$L = \{x \mid x \in \Sigma^* \text{ and the number of a in x is divisible by 2 or 3}\}$.

2 Design a DFA for the language $L = \{x \in \{a,b\}^* | aba \text{ is not a substring in } x\}$.

3 Write a Regular Grammar G for the language: $L = \{0^n 1^m : n, m >= 1\}$

4 Write a Regular Grammar for the language: $L = \{axb | x \in \{a,b\}^*\}$

5 (a) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFA D equivalent to N by applying the subset construction algorithm.

$$L = \{x \in \{a,b\}^* | \text{the second last symbol in } x \text{ is } b\}$$

(b) Draw the state-transition diagram showing a DFA for recognizing the following language:

$$L = \{x \in \{0,1\}^* | x \text{ is a binary representation of a natural number which is a multiple of } 5\}$$

6 (a) Write a Regular grammar G for the following language L defined as: $L = \{x \in \{a,b\}^* | x \text{ does not conatin consecutive } b\text{'s}\}$.

(b) Obtain the DFA A_G over the alphabet set $\Sigma = \{a,b\}$, equivalent to the regular grammar G with start symbol S and productions: $S \to aA$ and $A \to aA|bA|b$.

7 a) Draw the state-transition diagram showing a DFA for recognizing the language: L = {x ∈ {a,b}* | every block of five consecutive symbols in x contains two consecutive a's.}

b) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFA D equivalent to N by applying the subset construction algorithm. L = {x ∈ {a, b} * | x contains 'bab' as a substring}

8 a) Define Regular Grammar and write Regular Grammar G for the following language : L = {x ∈ {a, b} * | x does not ends with 'bb' }

b) Obtain the DFA over the alphabet set Σ = {a, b}, equivalent to the regular grammar G with start symbol S and productions: S → aA | bS , A → aB | bS | a *and*

B → aB | bS | a

MODULE 2

1 Construct an ε-NFA for the regular expression (a+b)*ab(a+b)*

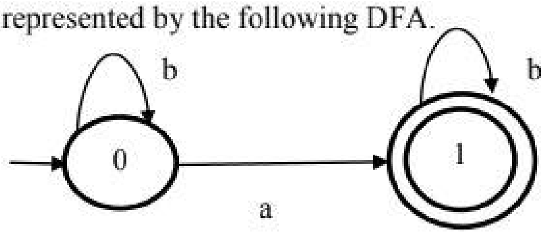
2 Write a Regular Expression for the language:
$L = \{x \in \{0,1\}^* | there\ are\ no\ consecutive\ 1's\ in\ x\}$

3 Using homomorphism on Regular Languages, Prove that the language $L=\{a^n b^n c^{2n} \mid n>=0\}$ is not regular. Given that the language $\{a^n\ b^n : n >= 1\}$ is not regular.

4 4. Prove that the language $L_1 = \{a^{n!} | n \in N\}$ is not regular.

5 a) State and explain any three closure properties of Regular Languages.

b) Find the equivalent Regular Expression using Kleene's construction for the language represented by the following DFA.



6 a) Using pumping lemma for Regular Languages, prove that the language $L = \{0^n \mid n \text{ is a perfect square}\}$ is not Regular.

b) Obtain the minimum state DFA for the following DFA.

	a	b
→0	1	2
1	4	5
2	0	3
3	5	2
4	1	0
5	4	3

7 (a) Draw the state-transition diagram showing an NFA N for the following language L. Obtain the DFA D equivalent to N by applying the subset construction algorithm.

$$L = \{x \in \{a,b\}^* \mid \textit{the second last symbol in } x \textit{ is } b\}$$

(b) Draw the state-transition diagram showing a DFA for recognizing the following language:

$$L = \{x \in \{0,1\}^* \mid x \textit{ is a binary representation of a natural number which is } a \text{multiple of } 5\}$$

8 (a) Write a Regular grammar G for the following language L defined as: $L = \{x \in \{a,b\}^* \mid x \textit{ does not conatin consecutive } b's\}$.

(b) Obtain the DFA A_G over the alphabet set $\Sigma = \{a,b\}$, equivalent to the regular grammar G with start symbol S and productions: $S \rightarrow aA$ and $A \rightarrow aA|bA|b$.

MODULE 3

1 Using homomorphism on Regular Languages, Prove that the language $L=\{a^nb^nc^{2n} \mid n>=0\}$ is not regular. Given that the language $\{a^n b^n : n >= 1\}$ is not regular.

2 State Myhill-Nerode Theorem.

3 Write a Context-Free Grammar for the language $L = \{wcw^r \mid w \in \{a,b\}^* \}$, w^r represents the reverse of w.

4 List out the applications of Myhill-Nerode Theorem.

5 Write a Context-Free Grammar for the language: $L = \{x \in \{a,b\}^* | \#_a(x) = \#_b(x)\}$. Here, the notation $\#_1(w)$ represents the number of occurrences of the symbol 1 in the string w.

6 (a) Show the equivalence classes of the canonical Myhill-Nerode relation for the language of binary strings with odd number of 1's and even number of 0s.

(b) With an example, explain ambiguity in Context Free Grammar

7 (a) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSb|\epsilon\}$ into Greibach Normal form.

(b) Convert the Context-Free Grammar with productions: $\{S \rightarrow aSa|bSb|SS|\epsilon\}$ into Chomsky Normal form.

8 a) Show the equivalence classes of Canonical Myhill-Nerode relation for the language of binary string which starts with 1 and ends with 0.

b) Consider the following productions:

S → aB | bA

A → aS | bAA | a

B → bS | aBB | b

For the string 'baaabbba' find

i) The leftmost derivation

ii) The rightmost derivation

iii) The parse tree

9 a) Construct the Grammars in Chomsky Normal Form generating the set of all strings over {a,b} consisting of equal number of a's and b's.

b) Find the Greibach Normal Form for the following Context Free Grammar S→XA | BB , B → b | SB, X → b, A→ a

MODULE 4

1 Write the transition functions of PDA with acceptance by Final State for the language $L = \{a^n b^n : n >= 0\}$.

2 State Pumping Lemma for Context Free Languages.

3 Design a PDA for the language of odd length binary palindromes (no explanation is required, just list the transitions in the PDA).

4 Prove that Context Free Languages are closed under set union.

5 (a) Using pumping lemma for context-free languages, prove that the language: $L = \{ww | w \in \{a, b\}^*\}$ is not a context-free language.

(b) With an example illustrate how a CFG can be converted to a single-state PDA

6 (a) Design a PDA for the language $L = \{a^m b^n c^{m+n} | n \geq 0, m \geq 0\}$. Also illustrate the computation of the PDA on a string in the language

(b) With an example illustrate how a multi-state PDA can be transformed into an equivalent single-state PDA.

7 a) Design a PDA for the language $L = \{ww^r \mid w \in \{a,b\}^* \}$. Also illustrate the computation of the PDA on the string 'aabbaa'.

b) Construct a CFG to generate L(M) where $M = (\{p, q\}, \{0, 1\}, \{X, Z_0\}, \delta, q, Z_0, \emptyset)$ where δ is defined as follows:

$\delta(q, 0, Z_0) = (q, XZ_0)$

$\delta(q, 0, X) = (q, XX)$

$\delta(q, 1, X) = (p, \varepsilon)$

$\delta(p, 1, X) = (p, \varepsilon)$

$\delta(p, \varepsilon, X) = (p, \varepsilon)$

$\delta(p, \varepsilon, Z_0) = (p, \varepsilon)$

8 a) Using pumping lemma for Context free languages, prove that the language $L = \{ a^n b^n c^n \mid n >= 1 \}$.

b) Prove that CFLs are closed under Union, Concatenation and Homomorphism.

MODULE 5

1 Write the formal definition of Context Sensitive Grammar and write the CSG for the language $L = \{ a^n b^n c^n \mid n >= 1 \}$.

2 Explain Chomsky hierarchy of languages.

3 Write a Context Sensitive Grammar for the language $L = \{a^n b^n c^n | n \geq 0\}$ (no explanation is required, just write the set of productions in the grammar).

4 Differentiate between Recursive and Recursively Enumerable Languages.

5 (a) Design a Turing machine to obtain the sum of two natural numbers $a$and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 0 1^b \not{b}^{\omega}$. The Turing Machine should halt with $\vdash 1^{a+b} \not{b}^{\omega}$ as the tape content. Also, illustrate the computation of your Turing Machine on the input $a = 3$and $b = 2$.

(b) Write a context sensitive grammar for the language $L = \{a^n b^n c^n | n \geq 0\}$. Also illustrate how the the string $a^2 b^2 c^2$ can be derived from the start symbol of the proposed grammar.

6 (a) Design a Turing machine to obtain the sum of two natural numbers a and b, both represented in unary on the alphabet set $\{1\}$. Assume that initially the tape contains $\vdash 1^a 0 1^b \not{b}^{\omega}$. The Turing Machine should halt with $\vdash 1^{a+b} \not{b}^{\omega}$ as the tape content. Also, illustrate the computation of your Turing Machine on the input $a = 3$and $b = 2$.

(b) With an example illustrate how a CFG can be converted to a single-state PDA.

7 a) Design Linear Bounded Automata for the language L = { $a^n b^n c^n$ | n>=1 }.

b) Design a Turing Machine for the language L = { $a^n b^{2n}$ | n>=1 }. Illustrate the computation of TM on the input ‘aaabbbbbb’.

8 a) Design a Turing Machine to obtain the product of two natural numbers a and b both represented in unary on the alphabet 0. For example, number 5 is represented as 00000 ie 0^5. Assume that initially the input tape contains 0^a10^b and Turing machine should halt with 0^{a*b} as the tape content.

b) Prove that ‘Turing Machine halting problem’ is undecidable.