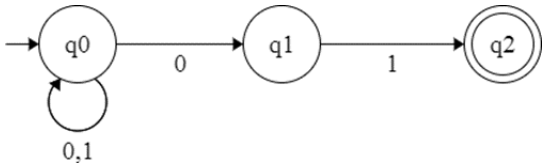
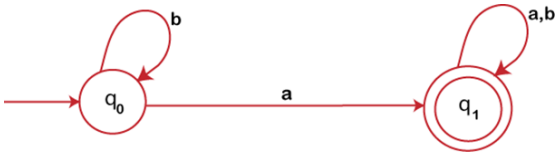
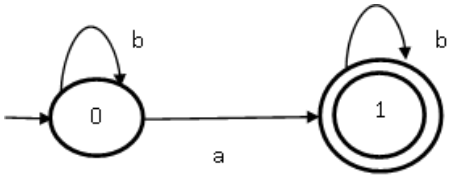
CST301 FORMAL LANGUAGES AND AUTOMATA THEORY

MODULE 1

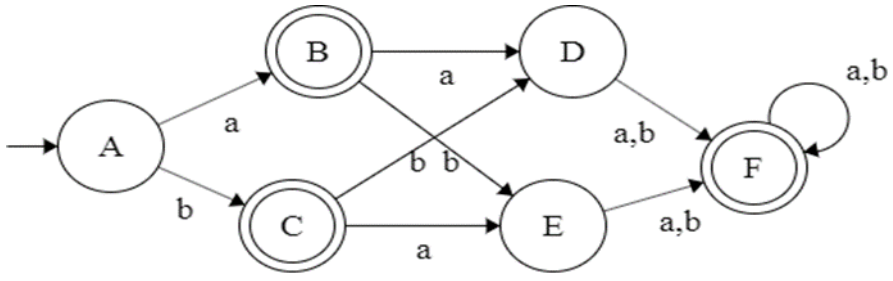
Sl. No	Questions	Marks	KTU/KU Month/Year
1	Define Ɛ-closure of a state? Explain with example.	3	DEC 22
2	Construct a DFA for strings in which first and last letters do not match. ∑ = {a, b}	3	DEC 22
3	Prove that, if L is accepted by an ordinary NFA, there exist an equivalent ϵ-NFA that also accepts L	**7**	DEC 22
4	Design an NFA (without Ɛ-moves) for strings having substring 'bab'. Convert it into equivalent DFA. ∑ = {a, b}	**7**	DEC 22
5	Construct an ϵ-NFA for the language $L= \{ 0^n 1^m 2^p / n, m, p \geq 0 \}$ and convert it into equivalent NFA without ϵ-transitions	**7**	DEC 22
6	Design an NFA (without Ɛ-moves) for strings with either consecutive zeros or consecutive ones. Obtain its corresponding DFA	**7**	DEC 22
7	Draw the state transition diagram showing a DFA for recognizing the language. L over the alphabet set Σ = {a, b}: L = {x | x ∈ Σ* and the number of a in x is divisible by 2 or 3}.	3	DEC 21
8	Write a Regular Grammar G for the language: L = $\{0^n 1^m : n, m >= 1\}$	3	DEC 21
9	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.}	6	DEC 21
10	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	DEC 21

11	Define Regular Grammar and write Regular Grammar G for the following language : L = {x ∈ {a, b} * | x does not ends with 'bb' }	7	DEC 21
12	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	7	DEC 21
13	Formally define extended delta for an NFA. Show the processing of input $w = 0101$ for the following NFA. 	3	SEP 20
14	Differentiate between the transition function in DFA, NFA and ϵ-NFA	3	SEP 20
15	Prove that " A language L is accepted by some ϵ-NFA if and only if L is accepted by some NFA".	4	SEP 20

	MODULE 2		
Sl. No	**Questions**	**Marks**	**KTU/KU Month/Year**
1	Generate regular expression for strings in which number of a's is a multiple of three. ∑ = {a, b}	3	DEC 22
2	Explain any 3 closure properties of regular languages	3	DEC 22
3	Using pumping lemma, show that ***L= { $a^n b^n$ / n > 0 }*** is not regular	7	DEC 22
4	Develop equivalent automata for the Regular Expression ***$(a+b)^* aabb(a^*+bb)^*$***	7	DEC 22
5	Prove that for every Regular Expression ***'R',*** there is an ϵ-NFA ***'M'***	7	DEC 22
6	List out the rules for writing regular expressions. Convert the following DFA to its equivalent Regular Expression 	7	DEC 22
7	Using homomorphism on Regular Languages, Prove that the language L={$a^n b^n c^{2n}$ | n>=0} is not regular. Given that the language {a^n b^n : n >= 1} is not regular.	3	DEC 21
8	Construct an ε-NFA for the regular expression (a+b)*ab(a+b)*	3	DEC 21
9	State and explain any three closure properties of Regular Languages.	6	DEC 21
10	Find the equivalent Regular Expression using Kleene's construction for the language represented by the following DFA. 	8	DEC 21

11	Using pumping lemma for Regular Languages, prove that the language L = $\{0^n \mid n \text{ is a perfect square}\}$ is not Regular.	7	DEC 21
12	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	DEC 21
13	Give a regular expression for the set of all strings not containing 101 as a substring	3	SEP 20
14	State pumping lemma for regular languages. Prove that the language $L = \{a^{n^2} \mid n > 0\}$ is not regular.	5	SEP 20
15	Write regular expression for the language L={1n 0 m |n>=1, m>=0}	3	SEP 20

<table>
<tr><td></td><td>MODULE 3</td><td></td><td></td></tr>
<tr><td>Sl no</td><td>Questions</td><td>Marks</td><td>KTU/KU Month/Year</td></tr>
<tr><td>1</td><td>With suitable example, explain about ambiguous grammar</td><td>3</td><td>DEC 22</td></tr>
<tr><td>2</td><td>State Myhill - Nerode Theorem</td><td>3</td><td>DEC 22</td></tr>
<tr><td>3</td><td>What is Greibach Normal Form (GNF)? Convert the following CFG to GNF
S → AA / a, A → SS / b</td><td>7</td><td>DEC 22</td></tr>
<tr><td>4</td><td>Design CFG for the following languages
(i) Palindromes over {a, b}
(ii) Stings with more than 2 zeros. ∑ = {0, 1}
(iii) (0+1)*(01)*(0+1)*</td><td>7</td><td>DEC 22</td></tr>
<tr><td>5</td><td>Minimize the following DFA using Myhill – Nerode theorem
<table>
<tr><th></th><th>a</th><th>b</th></tr>
<tr><td>→q0</td><td>q1</td><td>q2</td></tr>
<tr><td>q1</td><td>q1</td><td>q3</td></tr>
<tr><td>q2</td><td>q1</td><td>q2</td></tr>
<tr><td>q3</td><td>q1</td><td>*q4</td></tr>
<tr><td>*q4</td><td>q1</td><td>q2</td></tr>
</table></td><td>7</td><td>DEC 22</td></tr>
<tr><td>6</td><td>What is Chomsky Normal Form (CNF)? Convert the following productions to CNF. S → aSa / bSb / SS / Ɛ</td><td>7</td><td>DEC 22</td></tr>
<tr><td>7</td><td>State Myhill-Nerode Theorem.</td><td>3</td><td>DEC 21</td></tr>
</table>

8	Write a Context-Free Grammar for the language L = {wcw^r | w ∈ {a,b}* }, w^r represents the reverse of w.	3	DEC 21
9	Show the equivalence classes of Canonical Myhill-Nerode relation for the language of binary string which starts with 1 and ends with 0.	7	DEC 21
10	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	7	DEC 21
11	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.	7	DEC 21
12	Find the Greibach Normal Form for the following Context Free Grammar S→XA | BB , B → b | SB, X → b, A→ a	7	DEC 21
13	State Myhill-Nerode theorem, Minimize the following DFA. 	5	SEP 20

14	Define context free grammar. Consider the following CFG $S \rightarrow aS \mid Sb \mid a \mid b$ Prove by induction on the string length that no string in L(G) has ba as substring.	3	SEP 20
15	Convert the following grammar into Chomsky normal form $S \rightarrow ASB \mid \in, \quad A \rightarrow aAS \mid a, \quad B \rightarrow SbS \mid A \mid bb$	4	SEP 20

	MODULE 4		
Sl no	**Questions**	**Marks**	**KTU/KU Month/Year**
1	Whether DPDA and NPDA are equivalent? Justify your answer	3	DEC 22
2	Explain how CFGs can be converted to Chomsky Normal Form	3	DEC 22
3	Prove that for every PDA accepted by final state, there exists an equivalent PDA accepted by empty stack.	7	DEC 22
4	Design PDA for set of even length palindromes over {a, b}. Illustrate the working with suitable example	7	DEC 22
5	Design PDA for $L = \{ x \in \{a, b\}^* / \#_a(x) = \#_b(x) \}$. Here $\#_p(x)$ represents the number of occurrences of the symbol p in the string x	7	DEC 22
6	Using pumping lemma for CFLs, show that $L = \{ ww / w \in \{a, b\}^* \}$ is not context free.	7	DEC 22
7	Write the transition functions of PDA with acceptance by Final State for the language $L = \{a^n b^n : n >= 0\}$.	3	DEC 21
8	State Pumping Lemma for Context Free Languages.	3	DEC 21
9	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'.	7	DEC 21
10	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: $\delta(q, 0, Z_0) = (q, XZ_0)$ $\delta(q, 0, X) = (q, XX)$ $\delta(q, 1, X) = (p, \varepsilon)$ $\delta(p, 1, X) = (p, \varepsilon)$ $\delta(p, \varepsilon, X) = (p, \varepsilon)$ $\delta(p, \varepsilon, Z_0) = (p, \varepsilon)$	7	DEC 21

11	Using pumping lemma for Context free languages, prove that the language L = { $a^n b^n c^n$ | n>=1 }.	7	DEC 21
12	Prove that CFLs are closed under Union, Concatenation and Homomorphism.	7	DEC 21
13	Prove the equivalence of acceptance of a PDA by final state and empty stack.	6	SEP 20
14	Define a deterministic PDA. How a DPDA differs from a non-deterministic PDA?	3	SEP 20
15	Write the conditions for a pushdown automaton to be considered as deterministic.	3	DEC 19

	MODULE 5		
Sl no	**Questions**	**Marks**	**KTU/KU Month/Year**
1	Define Turing Machine	3	DEC 22
2	Differentiate between Recursive and Recursively Enumerable languages	3	DEC 22
3	Design TM for **L = {$a^n b^m a^n$ / m, n > 0}.** Illustrate the working with suitable example	7	DEC 22
4	Explain Chomsky hierarchy for formal languages and evaluate various types	7	DEC 22
5	Design a TM to copy a string of a's and b's to the right side, leaving one blank symbol (b) in between**.** Assume that initially the input tape contains **bxb** and TM halts with **bxbxb** as the tape content. **x Є {a, b}***	7	DEC 22
6	Prove that TM halting problem is undecidable	7	DEC 22
7	Write the formal definition of Context Sensitive Grammar and write the CSG for the language L = { $a^n b^n c^n$ | n>=1 }.	3	DEC 21
8	Explain Chomsky hierarchy of languages.	3	DEC 21
9	Design Linear Bounded Automata for the language L = { $a^n b^n c^n$ | n>=1 }.	7	DEC 21
10	Design a Turing Machine for the language L = { $a^n b^{2n}$ | n>=1 }. Illustrate the computation of TM on the input 'aaabbbbbb'.	7	DEC 21
11	Design a Turing Machine to obtain the product of two natural numbers a and b 7 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.	7	DEC 21
12	Prove that 'Turing Machine halting problem' is undecidable.	7	DEC 21
13	Design a TM to compute the 2's complement of a binary string.	5	SEP 20
14	Define formally Type 0, Type 1, Type 2 and Type 3 grammar. Show the corresponding automata for each class	5	SEP 20
15	Define a Universal Turing Machine (UTM). With the help of suitable arguments show the simulation of other Turing machines by a UTM.	6	SEP 20