SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur–603203

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

QUESTION BANK

IV SEMESTER

CS3461-Theory of Computation

Regulation–2023

Academic Year 2024–25(Even Sem)

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SUBJECT: CS3461-Theory of Computation

SEM/ YEAR: IV/ II

UNIT I

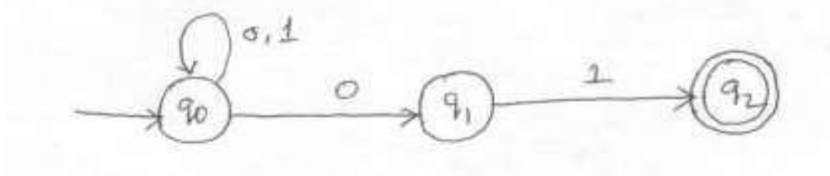
AUTOMATA FUNDAMENTALS

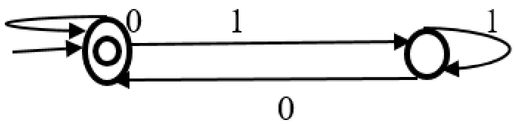
Introduction - Languages: Alphabets and Strings - Finite Automata - Deterministic Finite Automata - Non-deterministic Finite Automata – Equivalence of NFA and DFA – Finite Automata with Epsilon Transitions.

PART– A

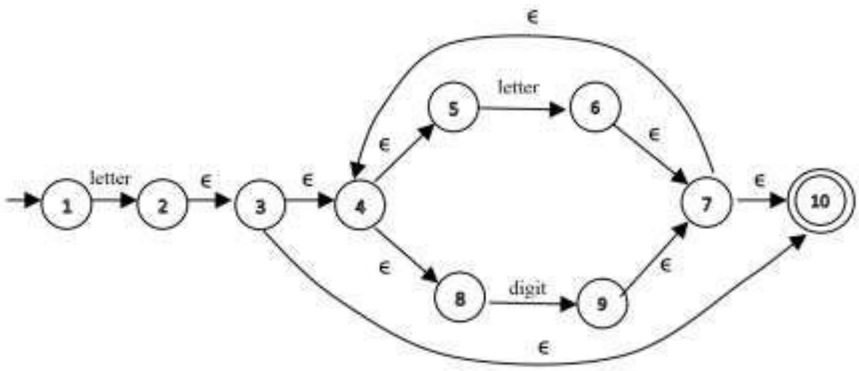
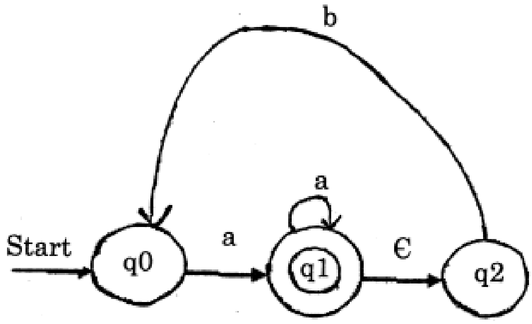
Q.No	Questions	BT Level	Competence
1.	Differentiate between DFA and NFA.	BTL2	Understand
2.	Define DFA.	BTL1	Remember
3.	Write the notations of DFA.	BTL1	Remember
4.	Identify NFA- store present a*b |c.	BTL1	Remember
5.	Consider the String X=110 and y=0110.Find i) XY ii) X^2 iii) YX iv)Y^2	BTL4	Analyze
6.	Describe the following language over the input set ∑={a,b}, L={$a^n b^m$| n,m>=0}.	BTL4	Analyze
7.	Describe what is non-deterministic finite automata and the applications of automata theory.	BTL1	Remember
8.	Design a NFA which accepts the set of all strings that start with zero.	BTL3	Apply
9.	What are the applications of automata theory?	BTL1	Remember
10.	Describe an identified with a transition diagram (automata).	BTL2	Understand
11.	Define ε-NFA.	BTL1	Remember
12.	Summarize the significance of DFA.	BTL5	Evaluate
13.	Give the Non-deterministic automata to accept strings containing the substring 0101.	BTL2	Understand
14.	Illustrate if L be a set accepted by an NFA then there exists a DFA that accepts L.	BTL3	Apply
15.	Define the term epsilon transition.	BTL2	Understand
16.	Summarize the extended transition function for a ε-NFA.	BTL5	Evaluate

<table>
<tr><td>17.</td><td>Create a FA which accepts the only input 101 over the input set: Z={0,1}</td><td>BTL6</td><td>Create</td></tr>
<tr><td>18.</td><td>Describe a Finite automaton and give its types.</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>19.</td><td>Construct a DFA of strings which accepts string either 01 or 10 over {0, 1}.</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>20.</td><td>Create a FA which checks whether the given binary number is even.</td><td>BTL6</td><td>Create</td></tr>
<tr><td>21.</td><td>Give the NFA which accepts the set of all strings that end with zero.</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>22.</td><td>Solve the deterministic finite automata to accept strings over ∑= {0,1} containing three consecutive zeros.</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>23.</td><td>Analyze a NFA which accepts all strings which accepts all strings starts with “10”.</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>24.</td><td>Explain on Alphabets and Strings.</td><td>BTL5</td><td>Evaluate</td></tr>
<tr><td colspan="4">PART-B</td></tr>
<tr><td>1.</td><td>(i)Explain if L is accepted by an NFA with ε-transition hen show that L is accepted by an NFA without ε-transition. (8)

(ii)Construct a DFA equivalent to the NFA.M=({p, q, r},{0,1}, δ, p,{q, s}) Where δ is defined in the following table.(8)
<table>
<tr><td>δ</td><td>0</td><td>1</td></tr>
<tr><td>p</td><td>{q,s}</td><td>{q}</td></tr>
<tr><td>q</td><td>{r}</td><td>{q,r}</td></tr>
<tr><td>r</td><td>{s}</td><td>{p}</td></tr>
<tr><td>s</td><td>-</td><td>{p}</td></tr>
</table></td><td>BTL5</td><td>Evaluate</td></tr>
<tr><td>2.</td><td>(i)Design a DFA that recognizes the set of all strings on ∑={a,b} starting with the ‘prefix ab’ and test using the input string. (8)
(ii) Draw a transition diagram for a DFA that accepts the string abaa and no other strings and test using the input string. (8)</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>3.</td><td>Let L be a set accepted by a NFA then show that there exists a DFA that accepts L. (16)</td><td>BTL1</td><td>Remember</td></tr>
<tr><td>4.</td><td>Give non-deterministic finite automata accepting the set of strings in (0+1)* such that two 0’s are separated by a string whose length is 4i, for some i ≥0. (16)</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>5.</td><td>Construct DFA equivalent to the NFA given below: (16)

</td><td>BTL2</td><td>Understand</td></tr>
</table>

<table>
<tr><td>6.</td><td>(i) Compose that a language L is accepted by some ε–NFA if and only if L is accepted by some DFA. (8)
(ii) Consider the following ε–NFA. Compute the ε–closure of each state and find it's equivalent DFA. (8)
<table><tr><td>δ</td><td>ε</td><td>a</td><td>b</td><td>C</td></tr><tr><td>→ p</td><td>ϕ</td><td>{p}</td><td>{q}</td><td>{r}</td></tr><tr><td>q</td><td>{p}</td><td>{q}</td><td>{r}</td><td>Φ</td></tr><tr><td>*r</td><td>{q}</td><td>{r}</td><td>ϕ</td><td>{p}</td></tr></table></td><td>BTL6</td><td>Create</td></tr>
<tr><td>7.</td><td>(i)Classify how a language L is accepted by some DFA if L is accepted by some NFA. (8)
(ii)Convert the following NFA to its equivalent DFA (8)
<table><tr><td>δ</td><td>0</td><td>1</td></tr><tr><td>→p</td><td>{p, q}</td><td>{p}</td></tr><tr><td>q</td><td>{r}</td><td>{r}</td></tr><tr><td>r</td><td>{s}</td><td>Φ</td></tr><tr><td>*s</td><td>{s}</td><td>{s}</td></tr></table></td><td>BTL3</td><td>Apply</td></tr>
<tr><td>8.</td><td>(i)Construct the DFA to recognize odd number of 1's and even number 0's. (8)
(ii)Construct the DFA over {a,b}which produces not more than 3 a's. (8)</td><td>BTL1</td><td>Remember</td></tr>
<tr><td>9.</td><td>(i) Point out the steps in conversion of NFA to DFA and for the following convert NFA to a DFA: (8)
<table><tr><td>δ</td><td>a</td><td>b</td></tr><tr><td>p</td><td>{p}</td><td>{p,q}</td></tr><tr><td>q</td><td>{r}</td><td>{r}</td></tr><tr><td>r</td><td>{ϕ}</td><td>{ϕ}</td></tr></table>(ii) Infer the language for the following (8)

</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>10.</td><td>Design a DFA from the given NFA. (16)
$M = (\{q_0, q_1\}, \{0, 1\}, \delta, q_0, \{q_1\})$ where δ is given by
$\delta(q_0, 0) = \{q_0, q_1\}$, $\delta(q_0, 1) = \{q_1\}$, $\delta(q_1, 0) = \varphi$, $\delta(q_1, 1) = \{q_0, q_1\}$</td><td>BTL6</td><td>Create</td></tr>
</table>

<table>
<tr><td>11.</td><td>Tabulate the difference between the NFA and DFA. Deduce the following ε-NFA to DFA. (16)
<table>
<tr><td>states</td><td>ε</td><td>a</td><td>b</td><td>C</td></tr>
<tr><td>→p</td><td>{q,r}</td><td>ϕ</td><td>{q}</td><td>{q,r}</td></tr>
<tr><td>q</td><td>ϕ</td><td>{p}</td><td>{r}</td><td>{q}</td></tr>
<tr><td>*r</td><td>ϕ</td><td>ϕ</td><td>ϕ</td><td>{r}</td></tr>
</table></td><td>BTL5</td><td>Evaluate</td></tr>
<tr><td>12.</td><td>(i).Describe the extended transition function for NFA,DFA and –ε-NFA. (8)

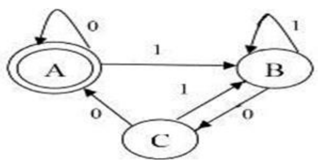
(ii) Consider the following ε-NFA for an identifier .Consider the ε-closure of each state and give its equivalent DFA. (8)

</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>13.</td><td>Given ∑ = {a, b} Analyze and construct a DFA which recognize the language L= {b^m a b^n: m, n>0}. (16)</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>14.</td><td>Tabulate the difference between the NFA and DFA. Convert the following ε-NFA to DFA. (16)</td><td>BTL1</td><td>Remember</td></tr>
<tr><td>15.</td><td>Express the following ε-NFA to DFA and list the difference between NFA and DFA. (16)

</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>16.</td><td>Solve the NFA that accepts all strings that ends in 01. Give its transition table and the extended transition function for the input string 0101. Also construct a DFA for the above NFA using subset construction method. (16)</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>17.</td><td>(i) Point out a DFA which accepts the substring 1010 and prove with the input string. (8)

(ii) Analyze a DFA that accept the string {0, 1} that always ends with 00. (8)</td><td>BTL4</td><td>Analyze</td></tr>
</table>

UNIT II
REGULAR EXPRESSION AND LANGUAGES

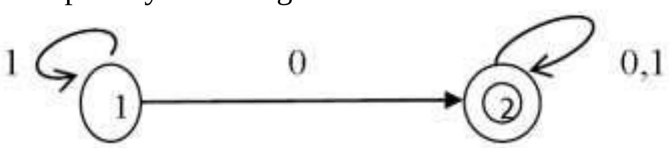
Regular Expressions – FA and Regular Expressions – Proving Languages not to be regular – Closure Properties of Regular Languages–Equivalence and Minimization of Automata.

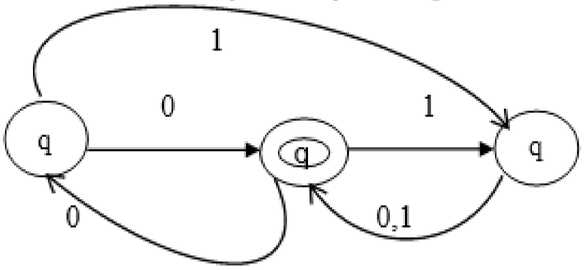
PART-A

Q.No	Questions	BT Level	Competence
1.	List the operators of Regular Expressions.	BTL1	Remember
2.	Differentiate between regular expression and regular.	BTL1	Remember
3.	Tabulate the regular expression for the following L1=set of strings 0 and 1ending in 00.	BTL4	Analyze
4.	What are the closure properties of regular languages?	BTL2	Understand
5.	Explain a finite automaton for the regular expression 0*1*.	BTL1	Remember
6.	Identify a regular expression for the set of all the strings.	BTL1	Remember
7.	Construct a regular expression for the set of all the strings have odd number of 1'sR.E=1(0+11)*.	BTL3	Apply
8.	Compose the difference between the + closure and*closure.	BTL4	Analyze
9.	Illustrate a regular expression for the set of all strings of 0's.	BTL2	Understand
10.	What is the Closure property of regular set S.?	BTL2	Understand
11.	Construct regular expression corresponding to the state diagram: 	BTL2	Understand
12.	Find out the language generated by the regular expression (0+1)*.	BTL5	Evaluate
13.	Name the four closure properties of RE.	BTL1	Remember
14.	Is it true the language accepted by any NFA is different from the regular language? Justify your answer.	BTL4	Analyze
15.	Show the complement of a regular language is also regular.	BTL3	Apply
16.	Construct a DFA for the regular expression aa*bb*.	BTL3	Apply
17.	State the precedence of RE operator.	BTL5	Evaluate
18.	Construct RE for the language over the set z= {a, b} in which total number of a's are divisible by3.	BTL6	Create
19.	Define RE.	BTL1	Remember
20.	Create RE to describe an identifier and positive integer.	BTL6	Create
21.	Express a RE for the language containing of all the strings of any number of a's and b's.	BTL2	Understand
22.	Illustrate arden's theorem.	BTL3	Apply
23.	Explain about the equivalence of two automata?	BTL4	Analyze
24.	Conclude the operations on regular language.	BTL5	Evaluate

PART-B

1.	Demonstrate how the set L= {ab^n/n>=1}is not a regular. (16)	BTL5	Evaluate

2.	Express the RE "a(a+b)*a" into ε-NFA and find the minimal state DFA. (16)	BTL1	Remember
3.	Examine whether the language $L=\{0^n1^n \mid n>=1\}$is regular or not? Justify your answer. (16)	BTL2	Understand
4.	(i)Describe a Regular Expression. Write a regular Expression for the set of strings that consists of alternating 0's and 1's. (8) (ii)Construct Finite Automata equivalent to the regular expression (ab+a)*. (8)	BTL1	Remember
5.	(i)Describe the closure properties of regular languages. (8) (ii)Describe NFA with epsilon for the RE= (a/b)*ab and convert it in to DFA and further find the minimized DFA. (8)	BTL1	Remember
6.	Show that the following languages are not regular. (i) $\{w \in \{a,b\}^* \text{ such that } w=ww^R\}$. (8) (ii) Set of strings of 0's and 1's, beginning with a 1, whose value treated as a binary number is a prime. (8)	BTL3	Apply
7.	Verify whether $L= \{a^{2n} \mid n>=1\}$ is regular or not. (16)	BTL3	Apply
8.	(i)Prove the reverse of a regular language is regular. (8) (ii)A homomorphism of regular language is regular. (8)	BTL4	Analyze
9.	Set the algorithm for minimization of a DFA. Develop a minimized DFA for the RE (a+b)(a+b)* and trace for the string baaaab. (16)	BTL6	Create
10	i) Prove that any language accepted by a DFA can be represented by a regular expression. (8) ii) Construct a finite automata for the regular expression10+(0+11)0*1. (8)	BTL6	Create
11	Explain the DFA Minimization algorithm with an Example (16)	BTL1	Remember
12	Demonstrate how the set $L=\{a^nb^m \mid m,n>=1\}$is not a regular. (16)	BTL2	Understand
13.	(i)Deduce into regular expression that denotes the language accepted by following DFA. (16) 	BTL5	Evaluate
14	(i) Analyze and prove that the L1 and L2 are two languages then L1 U L2 is regular. (8) (ii) Analyze and prove that the L1 and L2 are two languages then L1intersection L2 is regular (8)	BTL4	Analyze
15.	(i)Discuss on regular expression. (8) (ii)Discuss in detail about the closure properties of regular language. (8)	BTL2	Understand

16.	Solve the following to a regular expression. (16) 	BTL-3	Apply
17.	Evaluate a minimized DFA for the RE 10+(0+11)0*1 (16)	BTL5	Evaluate

UNIT III

CONTEXT FREE GRAMMAR AND LANGUAGES

CFG - Parse Trees - Ambiguity in Grammars and Languages - Normal Forms for CFG - Definition of the Pushdown Automata – Languages of a Pushdown Automata - Equivalence of Pushdown Automata and CFG - Pumping Lemma for CFL

PART-A

Q.No	Questions	BT Level	Competence
1.	Express the ways of languages accepted by PDA and define them?	BTL2	Understand
2.	Summarize PDA .Convert the following CFG to PDA S→aAA, A→aS|bS|a.	BTL2	Understand
3.	Define ambiguous grammar and CFG.	BTL1	Remember
4.	Define parse tree and derivation.	BTL1	Remember
5.	Examine the context free Grammar representing the set of Palindrome over (0+1)*	BTL2	Understand
6.	Compare Deterministic and Non deterministic PDA. Is it true that non deterministic PDA is more powerful than that of deterministic PDA? Justify your answer.	BTL2	Understand
7.	When PDA is said to be deterministic?	BTL1	Remember
8.	Examine the language L(G) generated by the grammar G with variables S,A,B terminals a,b and productions. S→aB, B→b, B→bA, A→aB.	BTL5	Evaluate
9.	Conclude the procedure for converting CNF to GNF with an example.	BTL1	Remember
10.	Design equivalence of PDA and CFG.	BTL6	Create
11.	Point out the languages generated by a PDA using final state of the PDA and empty stack of that PDA.	BTL4	Analyze
12.	Illustrate the rule for construction of CFG from given PDA.	BTL3	Apply
13.	Give a CFG for the language of palindrome string over {a,b}.Write the CFG for the language, $L=(a^nb^n\|\geq n)$.	BTL5	Evaluate
14.	Define GNF.	BTL1	Remember

15.	Show that $L=\{a^p \mid P \text{ is prime}\}$ is not context free.	BTL3	Apply
16.	Infer the CFG for the set of strings that contains equal number of a's and b's over $\Sigma=\{a,b\}$.	BTL4	Analyze
17.	Define the pumping Lemma for CFLs.	BTL1	Remember
18.	Illustrate the right most derivation (id+id*id) for using the grammar and also state whether a given grammar is ambiguous one or not. $E \rightarrow E+E/E*E/(E)/id$	BTL3	Apply
19.	Point out the additional features a PDA has when compared with NFA.	BTL4	Analyze
20.	Design parse tree for the grammar $S \rightarrow aS \mid aSbS \mid \varepsilon$. This grammar is ambiguous. Show that the string aab has two parse trees.	BTL6	Create
21.	Describe the unit and null production detail.	BTL2	Understand
22.	Show the Instantaneous Description (ID) for PDA.	BTL3	Apply
23.	Consider the grammar G with the following production. $S \rightarrow Aa$, $S \rightarrow B$, $B \rightarrow A$, $B \rightarrow bb$, $A \rightarrow a$, $A \rightarrow bc$, $A \rightarrow B$ Eliminate all unit production and get an equivalent grammar G_1.	BTL4	Analyze
24.	Conclude the two different ways to define PDA acceptability.	BTL5	Evaluate
	PART-B		
1.	(i)Express a PDA accepting $L= \{a^n b^{3n} \mid n >=1 \}$ by empty store. (8) (ii)Express a PDA that accepts $L = \{ a^n b^m c^n \mid n,m >=1\}$. (8)	BTL2	Understand
2.	Design and Explain the following grammar into equivalent one with no unit production and no useless symbols and convert into CNF. (16) $S \rightarrow A \mid CB$ $A \rightarrow C \mid D$ $B \rightarrow 1B \mid 1$ $C \rightarrow 0C \mid 0$ $D \rightarrow 2D \mid 2$	BTL5	Evaluate
3.	(i)Identify that deterministic PDA is less powerful than non-deterministic PDA. (8) (ii)Construct a PDA accepting $\{a^n b^m a^n / m, n>=1\}$ by empty stack. Also tell the corresponding context-free grammar accepting the same set. (8)	BTL1	Remember

4.	(i) Construct a parse tree for the following grammar (8) G=({S,A},{a,b},P,S) where P Consists of $S \rightarrow aAS \mid b$ $A \rightarrow SbA \mid ba$ Draw the derivation tree for the string w=abbbab. (ii)Let G=(V,T,P,S) be a Context Free Grammar then prove that if the recursive inference procedure call tells us that terminal string W is in the language of variable A, then there is a parse tree with a root A and yield w. (8)	BTL6	Create
5.	(i)Define Non Deterministic Push Down Automata. Is it true that DPDA and NDPDA are equivalent in the sense of language acceptance is concern? Justify your answer. (8) (ii)Let $M=(\{q_0,q_1\},\{0,1\},\{X,z_0\}, \delta, q_0, z_0, \Phi)$ where δ is given by: $\delta(q_0,0,z_0)=\{(q_0, Xz_0)\}$ $\delta(q_0,0, X)=\{(q_0, XX)\}$ $\delta(q_0,1,X)= \{(q_1, \varepsilon)\}$ $\delta(q_1,1,X)= \{(q_1, \varepsilon)\}$ $\delta(q_1, \varepsilon, X)=\{(q_1, \varepsilon)\}$ $\delta(q_1, \varepsilon, z_0)=\{(q_1, \varepsilon)\}$ Construct a CFG G =(V,T,P,S) generating N(M). (8)	BTL1	Remember
6.	(i) Define PDA. Give an Example for a language accepted by PDA by empty stack. (8) (ii) Convert the grammar S->0S1|A A->1A0|S|ε into PDA that accepts the same language by the empty stack .Check whether 0101 belongs to N(M). (8)	BTL2	Understand
7.	**(i)**Analyze the theorem: If L is Context free language then prove that there exists PDA M such that L=N(M). (8) **(ii)** Prove that if there is PDA that accepts by the final state then there exists an equivalent PDA that accepts by Null State. (8)	BTL4	Analyze
8.	Solve the following grammar $S \rightarrow aB \mid bA$ $A \rightarrow a \mid aS \mid bAA$ $B \rightarrow b \mid bS \mid aBB$ for the string "baaabbabba" Give i) Leftmost derivation (4) ii)Rightmost derivation (4) iii)Derivation Tree (8)	BTL5	Evaluate
9.	Express the following grammar G into Greibach Normal Form(GNF) (16) $S \rightarrow AB$ $A \rightarrow BS \mid b$ $B \rightarrow SA \mid a$	BTL3	Apply
10.	Construct a PDA that recognizes and analyzes the language $\{a^i b^j c^k \mid i,j,k>0$ and $i=j$ or $i=k\}$ and also explain about PDA acceptance		

	(i) From empty Stack to final state. (8) (ii) From Final state to Empty Stack. (8)	BTL4	Analyze
11.	Suppose L=L(G) for some CFG G=(V,T,P,S),then prove that L-{ ϵ} is L(G’) for a CFG G’ with no useless symbols or ϵ-productions. (16)	BTL1	Remember
12.	(i) Describe the PDA that accept the given CFG (8) S→ xaax X→ ax/bx/€ (ii) Express a PDA for the language $a^nb^ma^{n+m}$ (8)	BTL2	Understand
13.	(i) Illustrate a PDA for the language {WCWR/W€{0,1}}. (8) (ii) Illustrate a CFG for the constructed PDA. (8)	BTL3	Apply
14.	(i)Consider the grammar (8) S→ASB| ε A→aAS | a B→SbS | A |bb Are there any useless symbols, ε-production and unit production? Eliminate if so. (ii)Define derivation tree. Explain its uses with an example(8)	BTL4	Analyze
15.	Express the following grammar G into Greibach Normal Form(GNF) S → XB | AA A → a | SA B → b X → a (16)	BTL2	Understand
16.	(i) Solve a PDA for accepting a language $\{a^nb^{2n} \mid n>=1\}$. (8) (ii) Solve a PDA for accepting a language $\{0^n1^m0^n \mid m, n>=1\}$. (8)	BTL3	Apply
17.	Deduce PDA for the given CFG, and test whether 010^4 is acceptable by this PDA. S → 0BB B → 0S | 1S | 0 (16)	BTL5	Evaluate
UNIT IV **TURING MACHINES**			
Turing Machines – Introduction – Formal definition of Turing machines – Instantaneous descriptions – Turing machines as Acceptors – Turing machine as Transducers computable languages and functions - Deterministic TM, Multi-track and Multitape Turing Machine- Programming Techniques for TM.			
PART-A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Discuss on checking off symbols.	BTL2	Understand
2.	Illustrate the Basic Turing Machine model and explain in one move. What are the actions take place in TM?	BTL3	Apply
3.	When do you say a turing machine is an algorithm?	BTL1	Remember
4.	Define universal TM.	BTL4	Analyze
5.	Write a note on Turing machine as Transducers.	BTL1	Remember
6.	Define Turing Machine.	BTL1	Remember

7.	Discuss the applications of Turing machine.	BTL2	Understand
8.	Narrate on Turing machines as Acceptors	BTL1	Remember
9.	What is the class of language for which the TM has both accepting and rejecting configuration? Can this be called a Context free Language? Discuss.	BTL2	Understand
10.	Define Instantaneous description of TM.	BTL3	Apply
11.	Explain the special features of TM.	BTL5	Evaluate
12.	Write the difference between finite automata and Turing machine.	BTL1	Remember
13.	Give a note Deterministic TM	BTL6	Create
14.	List the Programming Techniques for TM	BTL5	Evaluate
15.	Draw a transition diagram for a turing machine to identify n mod 2.	BTL1	Remember
16.	Express the techniques for TM construction.	BTL2	Understand
17.	Develop the short notes on two-way infinite tape TM.	BTL6	Create
18.	Differentiate TM and PDA.	BTL4	Analyze
19.	Point out the role of checking off symbols in a Turing Machine.	BTL4	Analyze
20.	Illustrate the basic difference between 2-way FA and TM.	BTL3	Apply
21.	Describe the language accepted by TM.	BTL2	Understand
22.	Show the various representation of TM.	BTL3	Apply
23.	Explain the situation before and after the move caused by the transition of TM.	BTL4	Analyze
24.	Evaluate a TM for a successor function for a given unary number f(n)=n+1.	BTL5	Evaluate
	PART-B		
1.	Illustrate the Turing machine for computing f (m, n) = m - n (proper subtraction). (16)	BTL1	Remember
2.	Construct a turing machine that estimate unary multiplication (Say 000 X 00 = 000000). (16)	BTL2	Understand
3.	Discuss a TM to accept the language L= $\{1^n 2^n 3^n \mid n >= 1\}$.(16)	BTL2	Understand
4.	Demonstrate a Turing Machine to compute, f(m+n)=m+n | m,n>=0 and simulate their action on the input 0100. (16)	BTL3	Apply
5.	(i)Examine the role of checking off symbols in a Turing Machine. (8) (ii)Describe a Turing Machine M to implement the function “multiplication” using the subroutine copy. (8)	BTL1	Remember

6.	(i)Solve the turing machine to accept the language L={0^n1^n | n >=1}. (8) (ii)Show that if a language is accepted by a multi tape turing machine, it is accepted by a single-tape TM. (8)	BTL3	Apply
7.	(i)Summarize in detail about multi head and multi tape TM with an example. (8) (ii) Construct a Turing Machine to accept palindromes of even length in an alphabet set∑={a,b}.Trace the strings "abab"and"baab" (8)	BTL5	Evaluate
8.	(i)Explain the TM as computer of integer function with an example. (8) (ii)Design a TM to implement the function f(x)=x+1. (8)	BTL4	Analyze
9.	(i)Design a TM to accept these to all strings{0,1}with 010 as substring. (8) (ii)Write short notes on Two–way infinite tape TM. (8)	BTL6	Create
10.	(i)Draw a Turing machine to find 1's complement of a binary number. (8) (ii)Draw a Turing machine to find 2's complement of a binary number. (8)	BTL5	Evaluate
11.	(i)Define Turing machine for computing f(m,n)=m*n, n€N.(8) (ii)Write notes on partial solvability. (8)	BTL1	Remember
12.	(i)Construct a TM to reverse the given string {abb}. (8) (ii)Explain Multitape and Multihead Turing machine with suitable example. (8)	BTL2	Understand
13.	Design the various programming techniques of turing machine construction in detail. (16)	BTL6	Create
14.	Explain a TM with no more than three states that accepts the language.a(a+b)*. Assume W €={a,b}. (16)	BTL4	Analyze
15.	Construct a Turing Machine to accept palindromes of odd length in an alphabet set ∑={a,b}.Trace the strings "ababa"(16)	BTL2	Understand
16.	Demonstrate a TM for the language which recognizes the language L=01*0. (16)	BTL3	Apply
17.	Compare and explain the deterministic and non-deterministic TM with an example. (16)	BTL5	Evaluate

UNIT V

COMPUTATIONAL COMPLEXITY

Undecidability- Basic definitions- Decidable and undecidable problems - Properties of Recursive and Recursively enumerable languages –-Post's Correspondence Problem– complexity classes – introduction to NP-Hardness and NP-Completeness.

PART-A

Q.No	Questions	BT Level	Competence
1.	Distinguish between PCP and MPCP? What are the concepts used in UTMs?	BTL2	Understand
2.	List out the features of universal turing machine.	BTL1	Remember

3.	When a recursively enumerable language is said to be recursive? Discussion it.	BTL2	Understand
4.	Compare and contrast recursive and recursively enumerable languages	BTL4	Analyze
5.	State when a problem is said to be decidable?	BTL1	Remember
6.	Define NP hard and NP completeness problem.	BTL1	Remember
7.	Define a universal language L_u?	BTL1	Remember
8.	Is it true that the language accepted by a non-deterministic Turing Machine is different from recursively enumerable language? Judge your answer.	BTL5	Evaluate
9.	Formulate the two properties of recursively Enumerable sets which are undecidable	BTL6	Create
10.	When a problem is said to be undecidable? Give an example of undecidable problem. Analyze it.	BTL4	Analyze
11.	What is a recursively enumerable language and recursive sets? Generalize your answer.	BTL6	Create
12.	Define the classes of P and NP.	BTL1	Remember
13.	Is it true that complement of a recursive language is recursive? Discuss your answer.	BTL2	Understand
14.	Describe about reduction in TM.	BTL1	Remember
15.	Point out the properties of recursive and recursive enumerable language.	BTL4	Analyze
16.	Illustrate on halting problem.	BTL3	Apply
17.	Show the Properties of Recursive Languages.	BTL3	Apply
18.	Explain about tractable problem.	BTL5	Evaluate
19.	Describe post correspondence problem.	BTL2	Understand
20.	Illustrate about time and space complexity of TM.	BTL3	Apply
21.	Describe the encoding of UTM.	BTL2	Understand
22.	Illustrate about the undecidability of PCP.	BTL3	Apply
23.	Does PCP with two lists x= (b, a, ca, abc) and y= (ca, ab, a, c) have a solution? Explain.	BTL4	Analyze
24.	Compare between recursive and recursive enumerable language.	BTL5	Evaluate
	PART-B		
1.	(i)Describe about the tractable and intractable problems. (8) (ii)Identify that “MPCP reduce to PCP”. (8)	BTL1	Remember
2.	(i)Describe about Recursive and Recursive Enumerable languages with example. (8) (ii)State and describe RICE theorem. (8)	BTL1	Remember

<table>
<tr><td>3.</td><td>(i)Summarize diagonalization language. (8)
Discuss the significance of universal turing machine and also construct a turing machine to add two numbers and encode it. (8)</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>4.</td><td>Discuss post correspondence problem. Let∑={0,1}.Let A and B be the lists of three strings each, defined as
<table><tr><td></td><td>A</td><td>B</td></tr><tr><td>i</td><td>wi</td><td>xi</td></tr><tr><td>1</td><td>1</td><td>111</td></tr><tr><td>2</td><td>10111</td><td>10</td></tr><tr><td>3</td><td>10</td><td>0</td></tr></table>(i) Does the PCP have a solution? (8)
(ii) Prove that the universal language is recursively enumerable. (8)</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>5.</td><td>(i)Explain computable functions with suitable example.
(ii)Explain in detail notes on Unsolvable Problems. (8)</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>6.</td><td>(i) Describe in detail notes on universal Turing machines with example. (8)
(ii) Collect and write the short notes on NP-complete problems. (8)</td><td>BTL1</td><td>Remember</td></tr>
<tr><td>7.</td><td>(i)Show that the diagonalization language (L_d) is not a recursively enumerable. (8)
(ii)Illustrate about un solvability. (8)</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>8.</td><td>Prove that Post Correspondence Problem is undecidable. (16)</td><td>BTL5</td><td>Evaluate</td></tr>
<tr><td>9.</td><td>(i)Explain about Universal Turing machine and show that the universal language (L_u) is recursively enumerable but not recursive. Generalize your answer. (8)
(ii)Design and explain how to measure and classify complexity. (8)</td><td>BTL6</td><td>Create</td></tr>
<tr><td>10.</td><td>Prove and explain that the halting problem is undecidable. (16)</td><td>BTL5</td><td>Evaluate</td></tr>
<tr><td>11.</td><td>(i)Show that the characteristic functions of the set of all even numbers is recursive. (8)
Illustrate in detail notes on primitive recursive functions with examples. (8)</td><td>BTL3</td><td>Apply</td></tr>
<tr><td>12.</td><td>(i)Point out the Measuring and Classifying Complexity. (8)
(ii)Does PCP with two lists x=(b,b ab^3,ba) and y=(b^3,ba,a) Have a solution. Analyze your answer. (8)</td><td>BTL4</td><td>Analyze</td></tr>
<tr><td>13.</td><td>(i)Discuss in detail about time and space computing of a turing machine. (8)
(ii)Express two languages which are not recursively enumerable. (8)</td><td>BTL2</td><td>Understand</td></tr>
<tr><td>14.</td><td>(i)Describe in detail Polynomial Time reduction and NP-completeness. (8)
(ii)List out the short notes on NP-hard problems. (8)</td><td>BTL1</td><td>Remember</td></tr>
<tr><td>15.</td><td>Discuss in detail about decidable problems. (16)</td><td>BTL2</td><td>Understand</td></tr>
</table>

16.	Illustrate the various complexity classes with an example. (16)	BTL3	Apply
17.	(i)Plan and explain on decidable and un-decidable problems with an example. (8) (ii)Design and prove that for two recursive languages L1 and L2 their union and intersection is recursive. (8)	BTL6	Create