VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

QUESTION BANK

SUBJECT : CS8501

SEM / YEAR: V/III

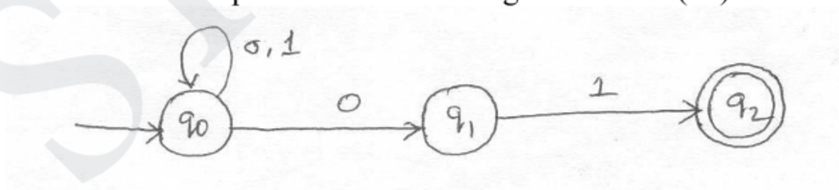
UNIT I AUTOMATA FUNDAMENTALS

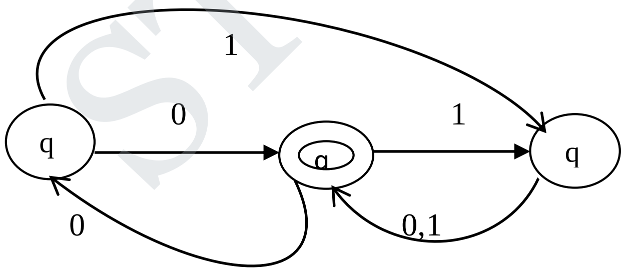
Introduction to formal proof – Additional forms of Proof – Inductive Proofs –Finite Automata – Deterministic Finite Automata – Non-deterministic Finite Automata – Finite Automata with Epsilon Transitions

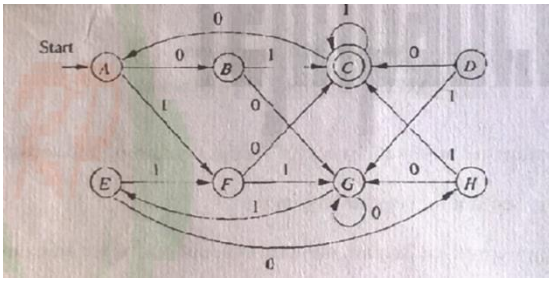
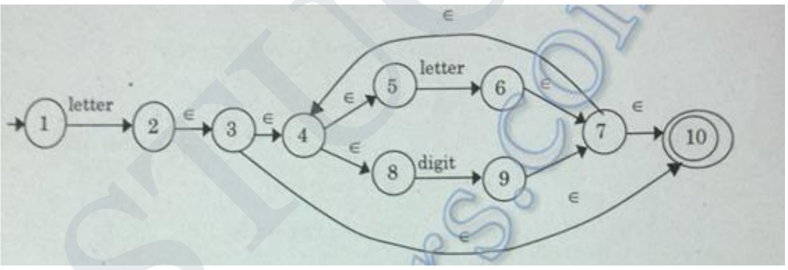
PART – A

Q.No	Questions	BT Level	Competence
1.	**Differentiate** between DFA and NFA.	BTL-2	Understand
2.	**Define** DFA	BTL-1	Remember
3.	**Define** inductive proof.	BTL-1	Remember
4.	**Identify** NFA- ε to represent a*b | c	BTL-1	Remember
5.	**Consider** the String X=110 and y=0110 find i) XY ii) X^2 iii) YX iv) Y^2	BTL-4	Analyze
6.	**Describe** the following language over the input set A={a,b} L={ $a^n b^n$ | n>=1}	BTL-4	Analyze
7.	**Describe** what is non-deterministic finite automata and the applications of automata theory.	BTL-1	Remember
8.	Illustrate the induction principle.?	BTL-3	Apply
9.	What is proof by contradiction ?	BTL-1	Remember
10.	**Describe** an identifier with a transition diagram (automata).	BTL-2	Understand
11.	**Define** ε-NFA	BTL-1	Remember
12.	**Summarize** minimization of DFA	BTL-5	Evaluate
13.	**Give** the non-deterministic automata to accept strings containing the substring 0101	BTL-2	Understand
14.	**Illustrate** if L be a set accepted by an NFA then there exists a DFA that accepts L.	BTL-3	Apply
15.	**Define** the term epsilon transition.	BTL-2	Understand
16.	**Summarize** the extended transition function for a ε-NFA	BTL-5	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>BTL-6</td><td>Create</td></tr>
<tr><td>18.</td><td>Describe a Finite automata and give its types.</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td>19.</td><td>Illustrate deductive proof.</td><td>BTL-3</td><td>Apply</td></tr>
<tr><td>20.</td><td>Create a FA which checks whether the given binary number is even.</td><td>BTL-6</td><td>Create</td></tr>
<tr><td colspan="4">PART - B</td></tr>
<tr><td>1.</td><td>(i)Explainif L is accepted by an NFA with ε-transition then show that L is accepted by an NFA without ε-transition.(6)

(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.(7)
<table>
<tr><td></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>BTL-5</td><td>Evaluate</td></tr>
<tr><td>2.</td><td>Prove for every n>=1 by mathematical induction
$\sum$ (i)={n(n+1)/2}. (13)</td><td>BTL-3</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.(13)</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>4.</td><td>Give the NFA that accepts all strings that end in 01.Give its transition table and the extended transition function for the input string 00101.Also construct a DFA for the above NFA using subset construction method.(13)</td><td>BTL-2</td><td>Understand</td></tr>
<tr><td>5.</td><td>Construct DFA equivalent to the NFA given below: (13)

</td><td>BTL-2</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. (6)
(ii)Consider the following ε–NFA. Compute the ε–closure of each state and find it" s equivalent DFA. (7)
<table>
<tr><th></th><th>ε</th><th>a</th><th>b</th><th>C</th></tr>
<tr><td>→ p</td><td>ф</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>ф</td></tr>
<tr><td>*r</td><td>{q}</td><td>{r}</td><td>ф</td><td>{p}</td></tr>
</table></td><td>BTL-6</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(7)
(ii)Convert the following NFA to its equivalent DFA.(6)
<table>
<tr><th></th><th>0</th><th>1</th></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>ф</td></tr>
<tr><td>*s</td><td>{s}</td><td>{s}</td></tr>
</table></td><td>BTL-3</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 (7)
ii) Construct the DFA over {a,b} which produces not more than 3 a's (6)</td><td>BTL-1</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(7)
<table>
<tr><th>δ</th><th>a</th><th>b</th></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 following to a regular expression.(6)

</td><td>BTL-4</td><td>Analyze</td></tr>
</table>

<table>
<tr><td>10.</td><td>Identify and explain the algorithm for minimization of DFA.Using the above algorithm minimize the following DFA.(13)

</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>11.</td><td>Tabulate the difference between the NFA and DFA .Convert the following ε-NFA to DFA.(13)
<table>
<tr><td>states</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>BTL-1</td><td>Remember</td></tr>
<tr><td>12.</td><td>(i).Describe the extended transition function for NFA ,DFA and – ε-NFA(6)
(ii) Consider the following ε-NFA for an identifier .Consider the ε-closure of each state and give it's equivalent DFA.(7)

</td><td>BTL-2</td><td>Understand</td></tr>
<tr><td>13.</td><td>(i)Given $\sum$ ={a,b} Analyze and construct a DFA which recognize the language L={b^m a b^n: m,n>0} (13)</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td>14.</td><td>(i)Analyze and Prove that if n is a positive integer such that n mod 4 is 2 or 3 then n is not a perfect square.(6)
(ii)Construct a DFA that accept the string {0,1} that always ends with 00 (7)</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td colspan="4">PART – C</td></tr>
</table>

1.	(i) **Draw** and Explain the transition diagram for recognizing the set of all operators in c Language.(8) (ii)**Evaluate** a DFA from the given NFA(7) M=({qo,q1},{a,b},δ,q0,{q1} with the state table diagram for δ given below: δ | a | b qo | {qo,q1} | q1 q1 | Φ | {qo,q1}	BTL-5	Evaluation
2.	Construct the following ε-NFA to DFA.(15) states | ε | a | b | c p | Φ | {p} | {q} | {r} q | {p} | {q} | {r} | {p,q} *r | {q} | {r} | ф | Φ	BTL-6	Create
3.	**Infer** the DFA which is accepting the following language over the alphabet{0,1}.The set of all the strings beginning with a1 that wheninterrupted as a binary integer , is multiple of 5, For example strings 101,1010 and 1111 are in the language 0,100 and 111 are not.(15)	BTL-4	Analyze
4.	**Rewrite** the basic approach to convert from NFA to regular expression. Illustrate with an example(15)	BTL-6	Create

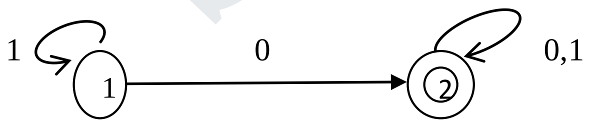
UNIT II REGULAR EXPRESSION AND LANGUAGES

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	BTL-1	Remember
2.	**Differentiate** between regular expression and regular	BTL-1	Remember
3.	**Tabulate** the regular expression for the following L1=set of strings 0 and 1 ending in 00	BTL-4	Analyze
4.	**What** are the closure properties of regular languages?	BTL-2	Understand
5.	**Explain**a finite automaton for the regular expression 0*1*.	BTL-1	Remember
6.	**Illustrate** a regular expression for the set of all the strings	BTL-1	Remember

7.	**Illustrate** a regular expression for the set of all the strings have odd number of 1's R.E=1(0+11)*	BTL-3	Apply
8.	**Compose** the difference between the + closure and * closure	BTL-4	Analyze
9.	**Illustrate** a regular expression for the set of all strings of 0's	BTL-2	Understand
10.	**What** is the Closure property of regular set S.?	BTL-2	Understand
11.		BTL-2	Understand
12.	**Find** out the language generated by the regular expression(0+1)*.	BTL-5	Evaluate
13.	**Name** the four closure properties of RE.	BTL-1	Remember
14.	Is it true the language accepted by any NFA is different from the regular language? **Justify** your answer.	BTL-4	Analyze
15.	**Show** the complement of a regular language is also regular.	BTL-3	Apply
16.	**Construct** a DFA for the regular expression aa*bb*.	BTL-3	Apply
17.	**State** the precedence of RE operator.	BTL-5	Evaluate
18.	**Construct** RE for the language over the set z={a,b} in which total number of a's are divisible by 3.	BTL-6	Create
19.	Define RE.	BTL-1	Remember
20.	**Create** RE to describe an identifier and positive integer.	BTL-6	Create
PART - B			
1.	**Demonstrate** how the set L= {ab^n/n>=1} is not a regular.(13)	BTL5	Evaluate
2.	**Express** that the regular languages are closed under:(13) (a)union (b)intersection(c)Kleene Closure(d)Complement (e)Difference	BTL-1	Remember
3.	**Examine** whether the language L=(0^n1^n| n>=1) is regular or not? Justify your answer (13)	BTL-2	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.(6) (ii)**Construct** Finite Automata equivalent to the regular expression (ab+a)*(7).	BTL1	Remember
5.	(i)**Describe** the closure properties of regular languages.(6) (ii)**Describe** NFA with epsilon for the RE=(a/b)*ab and convert it into DFA and further find the minimized DFA.(7)	BTL1	Remember

6.	**Demonstrate** how the set L= $\{a^n b^n / n>=0\}$ is not a regular.(13)	BTL-3	apply
7.	**Verify** the whether L ={ a 2n | n>=1} regular (13)	BTL-3	Apply
8.	i) Prove The reverse of a regular language is regular (6) ii) A homomorphism of regular language is regular (7)	BTL-4	Analyze
9.	Discuss on regular expressions (13)	BTL-2	Understand
10	**Construct** NDFA for given RE using Thomson rule. (13) i) a.(a+b)* ab ii) (a.b)* iii) (a+b)	BTL-6	Create
11	Explain the DFA Minimization algorithm with an example.(13)	BTL-1	Remember
12	**Demonstrate** how the set L= $\{a^n b^m \mid m,n>=1\}$ is not a regular.(13)	BTL 2	Understand
13	i) **Prove** the L1 and L2 are two languages then L1- L2 is regular (7) ii) **Prove** the L1 and L2 are two languages then L1 . L2 is regular (6)	BTL 4	Analyze
14	i) **Prove** the L1 and L2 are two languages then L1 U L2 is regular (7) ii) Prove the L1 and L2 are two languages then L1 intersection L2 is regular (6)	BTL-4	Analyze
PART – C			
1.	(i)Deduce into regular expression that denotes the language accepted by following DFA.(7)  (ii)**Evaluate** the equalities for the following RE and prove for the same (8) a. b+ab* +aa*b+aa*ab* b. a*(b+ab*). c. a(a+b)*+aa(a+b)*+aaa(a+b)*	BTL-5	Evaluate

2.	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.(15)	BTL-6	Create
3.	**Point out** about the regular exression and regular Language. (15)	BTL-4	Analyze
4.	**Develop** the procedure for minimizing DFA with example (15)	BTL-6	Create

UNIT III CONTEXT FREE GRAMMAR AND LANGUAGES

CFG – Parse Trees – Ambiguity in Grammars and Languages – Definition of the Pushdown Automata – Languages of a Pushdown Automata – Equivalence of Pushdown Automata and CFG, Deterministic Pushdown Automata.

PART - A

Q.No	Questions	BT Level	Competence
1.	**Express** the ways of languages accepted by PDA and define them?	BTL 2	Understand
2.	**Summarize** PDA .Convert the following CFG to PDA S→aAA , A→aS|bS|a.	BTL 2	Understand
3.	**Define** ambiguous grammar and CFG	BTL 1	Remember
4.	**Define** parse tree and derivation.	BTL 1	Remember
5.	**Examine** the context free Grammar representing the set of Palindrome over (0+1)*	BTL 2	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.	BTL 2	Understand
7.	**When** is PDA said to be deterministic?	BTL 1	Remember
8.	**Examine** the string aaabbabbba for the Grammar G with S→aB|bA A →a|aS|bAA B →b|bS|aBB	BTL 5	Evaluate
9.	**Examine** whether a pushdown automata has a memory?	BTL 1	Remember
10.	**Design**equivalence of PDA and CFG.	BTL 6	Create
11.	**Point out** the languages generated by a PDA using final state of the PDA and empty stack of that PDA	BTL 4	Analyze
12.	**Illustrate** the rule for construction of CFG from given PDA	BTL 3	Apply
13.	**Give** a CFG forthe language of palindrome string over {a,b}.Write the CFG for the language ,L=(a^nb^n|≥n).	BTL 5	Evaluate
14.	What is Instantaneous Descriptions (ID)	BTL 1	Remember
15.	**Show** that L={$a^{p/p}$ is prime} is not context free.	BTL 3	Apply

16.	**Infer** the CFG for the set of strings that contains equal number of a's and b's over $\sum=\{a,b\}$	BTL 4	Analyze
17.	**Point out** the various types of grammar with example	BTL 1	Remember
18.	**Illustrate** the rightmost derivation (a+b)*c for using the grammar and also state whether a given grammar is ambiguous one or not. E→E+E/E*E/(E)/id	BTL 3	Apply
19.	**Point out** the additional features a PDA has when compared with NFA.	BTL 4	Analyze
20.	**Convince** your answer of acontext free grammar for the given expression $(a+b)\ (a+b+0+1)^*$	BTL6	Create
	PART - B		
1.	(i)**Discuss** about PDA and CFL Prove the equivalence of PDA and CFL.(6) (ii)If L is Context free language then **prove** that there exists PDA M such that L=N(M). (7)	BTL 2	Understand
2.	**(i)Describe** the different types of acceptance of a PDA. Are they equivalent in sense of language acceptance? Justify your answer. (7) (ii)Design a PDA to accept $\{0^n1^n \mid n>1\}$.Draw the transition diagram for the PDA and **identify** the instantaneous description(ID)of the PDA which accepts the string '0011.(6)	BTL 1	Remember
3.	(i)**Identify that** deterministic PDA is less powerful than non nondeterministic PDA.(7) (ii)Construct a PDA accepting $\{a^nb^ma^n$ / m, n>=1} by empty stack. Also **tell** the corresponding context-free grammar accepting the same set.(6)	BTL 1	Remember
4.	**(i)Describe** and draw the parse tree for the string 1+2*3 Given the grammar G=(V,Σ,R,E)where V={E,D,1,2,3,4,5,6,7,9,0,+,-,*,/,9,)} Σ ={1,2,3,4,5,6,7,8,9,0,+,-,*,/,(,)} where R contains the following rules : E ⟶D|(E)|E+E|E-E|E/E D ⟶0|1|2|…9 (6) (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. (7)	BTL 6	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.(5) (ii)**Convert** PDA to CFG.PDA is given by P=({p,q},{0,1},{X,Y},δ,q,Z}, δ is defined by δ(p,1,z)={(p,XZ)}, δ(p,ε,Z)={p, ε)}, δ(p,1,X)={(p,XX)}, δ(q,1,X)={(q, ε)}, δ(p,0,X)={(q,X0} δ(q,0,Z)={(p,Z)} (8)	BTL 1	Remember
6.	(i)Define PDA. **Give** an Example for a language accepted byPDA by empty stack.(7) (ii)**Convert** the grammar S ->0S1|A A ->1A0|S| εinto PDA that accepts the same language by the empty stack .Check whether 0101 belongs to N(M).(6)	BTL 2	Understand
7.	**(i)Analyze** the theorem: If L is Context free language then prove that there exists PDA M such that L=N (M). (7) (ii) **Prove** that if there is PDA that accepts by the final state then there exists an equivalent PDA that accepts by Null State.(6)	BTL 4	Analyze
8.	**Solve** the following grammar S→aAa | bBb | BB A→ C B→ S | A C → S | ε for the string abaaba .Give i) Left most derivation(3) ii)Right most derivation(3) iii)Derivation Tree(3) iv) For the string abaabbba, find the right most derivation.(4)	BTL 5	Evaluate
9.	(i)**Examine**Construct the grammar for the following PDAM. M=({q0, q1},{0,1},{X,z0},δ,q0,Z0,Φ) and where δis given by δ(q0,0,z0)={(q0,XZ0)}, δ(q0,0,X)={(q0,XX)}, δ(q0,1,X)={(q1, ε)}, δ(q1,1,X)={(q1, ε)}, δ(q1,ε,X)={(q1, ε)}, δ(q1, ε, Z0)= {(q1, ε)}. (7) (ii)Prove that if L is N(M1) for some PDA M1 then L is L(M2) for some PDA M2. (6)	BTL 3	Apply
10.	Construct a PDA that recognizes and **analyzes**the language $\{a^ib^jc^k \mid i,j,k>0 \text{ and } i=j \text{ or } i=k\}$. **Explain** about PDA acceptance i) From empty Stack to final state. (6) ii) From Final state to Empty Stack. (7)	BTL 4	Analyze

11.	**Examine** and construct a CFG G which accepts N(M), where M=({q_0, q_1},{a,b},{z_0,z},δ,q_0,z_0,Φ) and where δis given by δ(q_0,b,z_0)={(q_0,zz_0)} δ(q_0, ε,z_0)={(q_0, ε)} δ(q_0,b,z)={(q_0,zz)} δ(q_0,a,z)={(q_1,z)} δ(q_1,b,z)={(q_1, ε)} δ(q_1,a,z_0)={(q_0,z_0)} Show that $a^nb^nc^n$ is not context free language i.e show that the set of strings of a' s and b's and c's with an equal number of each is not context free(13)	BTL-1	Remember
12.	(i) **Describe** the PDA that accept the given CFG (7) S→xaax X→ax/bx/€ (ii) **Express** a PDA for the language $a^nb^ma^{n+m}$ (6)	BTL-2	Understand
13.	(i) Illustratea PDA for the language {WCWR/W€{0,1}}.(7) (ii) **Illustrate** a CFG for the constructed PDA. (6)	BTL-3	Apply
14.	(i)**Identify** CFG for the language L={$0^i1^j0^k$ | j>i+k} (7) (ii)**Define** derivation tree. Explain its uses with an example.(6)	BTL-4	Analyze
	PART – C		
1.	(i)Design and **Explain**a PDA to accept each of the following language {$a^ib^jc^k$|i=j or j=k}(7) (ii) The set of all string with twice as many 0's and 1's. (8)	BTL-5	Evaluation
2.	(i)Let P be a PDA with empty stack language L=N(P) and suppose that ε is not in L. **Design**how you would modify P so that it accepts L U { ε} by empty stack.(8). (ii) **Design** a DPDA for even length palindrome.(7)	BTL-6	Create
3.	(i) Convert the following CFG to PDA and **analyze** the answer (a+b) and a++. (8) I→a|b|Ia|Ib|I0|I1 E→I|E+E|E*E|(E) (ii) Convert the following CFG to PDA by empty stack.(7) S→0S1/A; A→1A0/S/ ε **Infer** whether 0101 belongs to N(M).	BTL-4	Analyze
4.	(i)If L is a CFL then prove that there exists PDA M, such that L=N(M) , language accepted by empty stack .(7) (ii)**Construct** a PDA empty store , L= {a^mb^n|n<m}.(8)	BTL-6	Create

UNIT IV PROPERTIES OF CONTEXT FREE LANGUAGES			
Normal Forms for CFG – Pumping Lemma for CFL – Closure Properties of CFL – Turing Machines – Programming Techniques for TM.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	**Conclude** the procedure for converting CNF to GNF with an example	BTL 2	Understand
2.	**Illustrate** the Basic Turing Machine model and explain in one move. What are the actions take place in TM?	BTL 3	Apply
3.	**Define** the two normal forms of CFG	BTL 1	Remember
4.	**Point** out the hierarchy summarized in the Chomsky hierarchy..	BTL 4	Analyze
5.	**Define** the pumping Lemma for CFLs	BTL1	Remember
6.	Define Turing Machine.	BTL1	Remember
7.	**Discuss** the applications of Turing machine.	BTL 2	Understand
8.	**Define** Chomskian hierarchy of language.	BTL 1	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**.	BTL 2	Understand
10.	**Show** the following grammar into an equivalent one with no unit productions and no useless symbols $S \rightarrow ABA$ $A \rightarrow aAA \mid aBC \mid bB$ $B \rightarrow A \mid bB \mid Cb$ $C \rightarrow CC \mid cC$	BTL 3	Apply
11.	**Explain** the special features of TM? Define universal TM. Define Instantaneous description of TM	BTL 5	Evaluate
12.	**Define** GNF.	BTL 1	Remember
13.	**Prepare** the difference between finite automata and turing machine.	BTL 6	Create
14.	**List** the three ways to simplify a context free grammar. What are the properties of the CFL generated by a CFG?	BTL 5	Evaluate
15.	Draw a transition diagram for a Turing machine to **identify** n mod 2.	BTL 1	Remember
16.	**Express** the techniques for TM construction.	BTL 2	Understand
17.	**Develop** the short notes on two-way infinite tape TM.	BTL 6	Create
18.	Differentiate TM and PDA.	BTL 4	Analyze
19.	**Point out**the role of checking off symbols in a Turing Machine	BTL 4	Analyze
20.	**Illustrate** Halting Problem.	BTL 3	Apply

PART - B			
1.	**Express** the following grammar G into Greibach Normal Form(GNF) (13) S→XA|BB B→b|SB X→b A→a	BTL 1	Remember
2.	Use the CFL pumping lemma to show **how** each of these languages not to be context-free$\{a^ib^jc^k \mid i<j<k\}$ (13)	BTL 2	Understand
3.	**(i)Discuss**a TM to accept the language LE=$\{1^n\ 2^n\ 3^n \mid n >= 1\}$ (6) (ii)Construct a turing machine that **estimate** unary multiplication (Say 111 X 11 = 11111) (7)	BTL 2	Understand
4.	**(i)Illustrate** the Turing machine for computing f(m, n)=m-n (proper subtraction). (7) (ii)**Demonstrate** a Turing Machine to compute f(m+n)=m+n, m,n>=0 and simulate their action on the input 0100. (6)	BTL 3	Apply
5.	(i)**Examine**the role of checking off symbols in a Turing Machine.(6) (ii)**Describe** a Turing Machine M to implement the function "multiplication" using the subroutine copy(7)	BTL 1	Remember
6.	**(i)Demonstrate** the implications of halting problem.(7) (ii)**Show** that if a language is accepted by a multitapeturing machine ,it is accepted by a single-tape TM .(6)	BTL 3	Apply
7.	(i)**Summarize** in detail about multihead and multitape TM with an example.(7) (ii)Construct a Turing Machine to accept palindromes in an alphabet set ∑={a,b}.Trace the strings "abab" and "baab".(6)	BTL 5	Evaluate
8.	(i)**Explain** the TM as computer of integer function with an example.(7) (ii)Design a TM to implement the function f(x)= x+1. (6)	BTL 4	Analyze
9.	**(i)Design** a TM to accept the set of all strings {0,1} with 010 as substring.(7) (ii)Write shot notes on Two –way infinite tape TM.(6)	BTL 6	Create
10.	(i)**Describe** computing a partial function with a TM.(6) (ii)Design a TM to accept the language LE=$\{a^nb^nc^n \mid n >1\}$.(7)	BTL 1	Remember
11.	(i)**Define** Turing machine for computing f(m, n)=m*n,n€N. (7) (ii) Write notes on Partial solvability.(6)	BTL -1	Remember
12.	(i) **Construct** a TM to reverse the given string {abb}. (6) (ii) **Explain** Multi tape and Multi head Turing machine with suitable example.(7)	BTL 2	Understand

13.	(i)**Analyze** and Construct a TM to compute a function f(w) =W^R where W€{a,b}.(7) (ii)**Construct** Turing machine (TM) that replace all occurence of 111 by 101 from sequence of 0's and 1's.(6)	BTL 4	Analyze
14.	(i)**Infer** the Chomsky grammar classification with necessary example. (6) (ii)**Explain** a TM with no more than three states that accepts the language. a(a+b) *.Assume €={a,b}. (7)	BTL 4	Analyze
PART – C			
1.	(i)**Compose** the limitation of automata for Type 3, Type 2, type 0 languages.(7) (ii) Consider two-tape Turing Machine (TM) and determine whether the TM always writes a nonblank symbol on its second tape during the computation on any input string 'w'. **Formulate** this problem as a language and show it is undecidable.(8)	BTL-6	Create
2.	(i) Define pumping lemma for CFL. Show that L={$a^ib^jc^k$, i<j<k} is not context free and **Judge** your answer.(6) (ii) Construct a TM to move an input string over the alphabet A={a} to the right one cell. **Consider** that the tape head starts somewhere on a blank cell to the left of the input string to the right one cell , leaving all the remaining cell blank.(9)	BTL-5	Evaluate
3.	(i) Design and **explain** a TM to compute f(m,n) = m*n , for all m,n€ N.(6) (ii) **Explain** how a multi track in a TM can be used for testing given positive integer is a prime or not(9).	BTL-4	Analyze
4.	(i)**Prepare** a subroutine to move a TM head from its current position to the right, skipping over all 0's until reaching a 1 or a blank. If the current position does not hold 0, then the TM should halt. You may assume that there are no tape symbol other than 0,1 and B(blank). Then , use this subroutine to design to TM that accepts all strings of 0's and 1's that do not have two 1's in a row.(8) (ii)**Write** short notes on checking off symbols(7)	BTL-6	Create

UNIT V UNDECIDABILITY			
Non Recursive Enumerable (RE) Language – Undecidable Problem with RE – Undecidable Problems about TM – Post's Correspondence Problem, The Class P and NP			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	**Distinguish** between PCP and MPCP? What are the concepts used in UTMs?	BTL 2	Understand
2.	**List** out the features of universal turing machine.	BTL 1	Remember
3.	When a recursively enumerable language is said to be recursive? **Discuss** on it.	BTL 2	Understand
4.	**Compare** and contrast recursive and recursively enumerable languages	BTL 4	Analyze
5.	State **when** a problem is said to be decidable and give an example of an undecidable problem.	BTL 1	Remember
6.	**Define** NP hard and NP completeness problem.	BTL 1	Remember
7.	**Define** a universal language Lu?	BTL 1	Remember
8.	Is it true that the language accepted by a non-deterministic Turing Machine is different from recursively enumerable language? **Judge** your answer.	BTL 5	Evaluate
9.	**Formulate** the two properties of recursively enumerable sets which are undecidable	BTL 6	Create
10.	When a problem is said to be decidable? Give an example of undecidable problem. **Analyze** it.	BTL 4	Analyze
11.	What is (a) recursively enumerable languages (b) recursive sets? **Generalize** your answer.	BTL 6	Create
12.	**Define** the classes of P and NP.	BTL 1	Remember
13.	Is it true that complement of a recursive language is recursive? **Discuss** your answer	BTL 2	Understand
14.	**Describe** an example of an undecidable problem	BTL 1	Remember
15.	**Point out** the properties of recursive and recursive enumerable language.	BTL 4	Analyze
16.	**Illustrate** on Primitive Recursive Function.	BTL 3	Apply
17.	**Show** the Properties of Recursive Languages	BTL 3	Apply
18.	**Explain** about tractable problem.	BTL 5	Evaluate
19.	**Describe** post correspondence problem.	BTL 2	Understand
20.	**Illustrate** about Time and space complexity of TM.	BTL 3	Apply
PART - B			

1.	(i)**Describe** about the tractable and intractable problems.(7) (ii)**Identify** that "MPCP reduce to PCP".(6)	BTL 1	Remember
2.	(i)**Describe** about Recursive and Recursive Enumerable languages with example.(7) (ii)State and **describe** RICE theorem.(6)	BTL 1	Remember
3.	(i)**Summarize** diagonalization language.(6) (ii)**Discuss** the significance of universal turing machine and also construct a turing machine to add two numbers and encode it .(7)	BTL 2	Understand
4.	**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>List A</td><td>List 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?(7) (ii)Prove that the universal language is recursively enumerable.(6)	BTL 2	Understand
5.	(i)**Explain** computable functions with suitable example.(6) (ii)**Explain** in detail notes on Unsolvable Problems.(7)	BTL 4	Apply
6.	(i)**Describe** in detail notes on universal Turing machines with example.(7) (ii)**Collect** and write the short notes on NP-complete problems.(6)	BTL 1	Remember
7.	(i) **Show** that the diagonalization language (L_d) is not a recursively enumerable.(7) (ii)**Illustrate** about unsolvability.(6)	BTL 3	Apply
8.	(i)**Compare** the difference between recursive and recursively enumerable languages.(7) (ii)**Explain** about PCP.(6)	BTL 5	Evaluate
9.	(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.(5)	BTL 6	Create
10.	(i)**Explain** about the recursively Enumerable Language with example.(6) (ii)**Point out** that the following problem is undecidable. Given two CFGs G1 and G2 is $L(G1) \cap L(G2) = \emptyset$.(7)	BTL 4	Analyze
11.	(i)**Show** that the characteristic function of the set of all even number is recursive .(7) (ii)**Illustrate** in detail notes on primitive recursive functions with examples.(6)	BTL-3	Apply

12.	(i)**Point out** the Measuring and Classifying Complexity.(7) (ii)Does PCP with two lists x=(b,b ab^3,ba) and y=(b^3,ba,a) have a solution. **Analyze** your answer.(6)	BTL-4	Analyze
13.	(i)**Discuss** in detail about Time and Space Computing of a Turing Machine(6) (ii)**Express** two languages which are not recursively enumerable.(7)	BTL-2	Understand
14.	(i)**Describe** in detail Polynomial Time reduction and NP-completeness.(7) (ii)**List** out the short notes on NP-Hard Problems.(6)	BTL 1	Remember
	PART – C		
1.	**Consider** and find the languages obtained from the following operations: (i)Union of two recursive languages.(5) (ii)Union of two recursively enumerable languages.(5) (iii)L if L and complement of L are recursively enumerable.(5)	BTL-5	Evaluate
2.	Prove that the universal language is recursively enumerable but not recursive. **Generalize** your answer.(15)	BTL-6	Create
3.	(i) **Plan** and explain on decidable and un-decidable problems with an example(7) (ii) **Design** and prove that for two recursive languages L1 and L2 their union and intersection is recursive.(8)	BTL-6	Create
4.	(i) **Compare** and write about tractable and untractable problems with an example.(10) (ii) **Explain** the language L_u and show that L_u is RE language.(5)	BTL-4	Analyze