INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

INFORMATION TECHNOLOGY

QUESTION BANK

Department	**INFORMATION TECHNOLOGY**				
Course Title	**THEORY OF COMPUTATION**				
Course Code	AITC04				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr.U Sivaji, Associate Professor				

COURSE OBJECTIVES:

The students will try to learn:

I	The fundamental knowledge of automata theory which is used to solve computational problems.
II	TThe reorganization of context free language for processing infinite information using push down automata..
III	The computer based algorithms with the help of an abstract machine to solve recursively Enumerable problems.

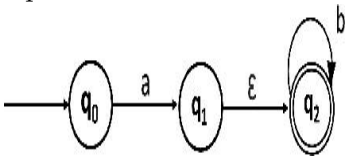
COURSE OUTCOMES:

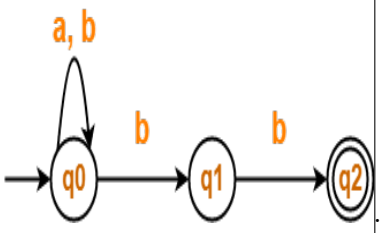
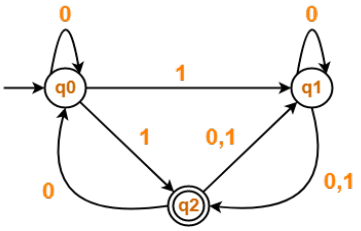
After successful completion of the course, students should be able to:

CO 1	**Make use of** deterministic finite automata and non deterministic finite automata for modeling lexical analysis and text editors.	Apply
CO 2	**Extend** regular expressions and regular grammars for parsing and designing programming languages.	Understand
CO 3	**Illusrate** the pumping lemma on regular and context free languages for perform negative test .	Understand

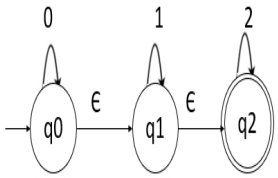
CO 4	**Demonstarte** context free grammars, normal forms for generating patterns of strings and minimize the ambiguity in parsing the given strings.	Understand
CO 5	**Construct** push down automata for context free languages for developing parsing phase of a compiler.	Apply
CO 6	**Apply** Turing machines and Linear bounded automata for recognizing the languages,complex problems.	Apply

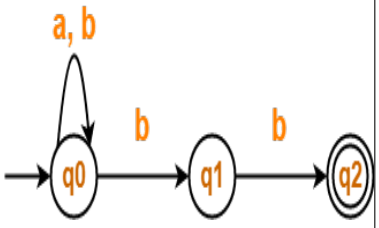
QUESTION BANK:

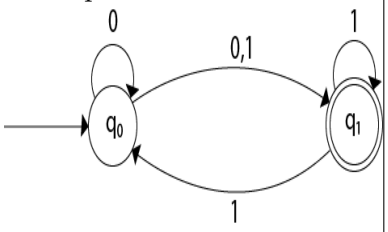
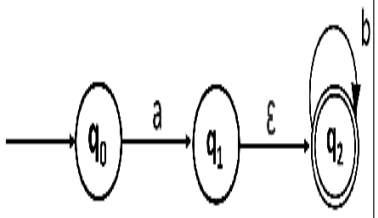
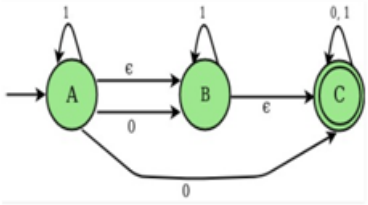
Q.No	QUESTION	Taxonomy	How does this subsume the level	CO's
MODULE I				
FINITE AUTOMATA				
PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	Describe NFA for accepting any binary string that contains 11 as a substring and Convert to DFA.	Understand	This would require the learner to **recall** the Non Deterministic finite automata and **discuss** the steps for the construction of NFA and the conversion of NFA to DFA.	CO 1
2	Convert NFA with ϵ to equivalent DFA 	Understand	This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA with ϵ to DFA.	CO 1
3	Describe a DFA that any given decimal number is divisible by 5	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA.	CO 1
4	Describe a DFA for the followinglanguage L={w/ |w| mod 5=0,w belongs to (a,b)*} L={w/ |w| mod 5=1,w belongs to (a,b)*}	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA.	CO 1

5	Convert NFA with ϵ to equivalent NFA M=({q0,q1,q2},{0,1,2}, δ, q0, {q2}) where δ is given by [δ (q0,0)={q0}, δ (q0,1)=ϕ, δ (q0,2)=ϕ, δ(q0, ϵ)=q1] [δ (q1,0)=ϕ, δ (q1,1)=q1 , δ (q1,2)=ϕ ,δ (q1, ϵ)=q2] [δ (q2,0)=ϕ, δ (q2,1)= ϕ , δ (q2,2)= {q2},δ (q2, ϵ)= ϕ] .	Understand	This would require the learner to **recall** the finite automata,and show the steps for the conversion of NFA with ϵ to NFA.	CO 1
6	Demonstrate NFA that strings such that the third symbol from the right end is a 0 over an alphabet $\sum$ ={0,1}. And Convert it into equivalent DFA.	Understand	This would require the learner to **recall** the Non Deterministic finite automata and **discuss** the steps for the construction of NFA and the conversion of NFA to DFA.	CO 1
7	Convert the NFA to equivalent DFA, as shown in fig. below  	Understand	This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA to DFA.	CO 1
8	Describe the transition Table for the below NFA and then convert its equivalent transition diagram for DFA.  	Understand	This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA to DFA.	CO 1

9	Describe a DFA that will accept those words from $\sum$= {a, b} where the number of a's is divisible by two and the number of b's is divisible by three. Sketch the transition table of the finite automata.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA.	CO 1
10	Describe a DFA that will accept those words from alphabets $\sum$= {a, b} where the number of bs is divisible by three. Sketch the transition table and diagram of the finite Automata.	Understand	This would require the learner to **recall** the finite automatand **discuss** the steps for the construction of DFA.	CO 1
11	Design a Moore machine for a binary input sequence such that if it has a substring 101, the machine output A, if the input has substring 110, it outputs B otherwise it outputs C.	Understand	This would require the learner to **recall** the finite automat and **discuss** the steps for the construction of Moore machine.	CO 1
12	Design a Mealy machine for a binary input sequence such that if it has a substring 101, the machine output A, if the input has substring 110, it outputs B otherwise it outputs C.	Understand	This would require the learner to **recall** the finite automata and **discuss** the steps for the construction of mealy machine.	CO 1
PART-B LONG ANSWER QUESTIONS				
1	Explain the concept of alphabet, string and language with suitable examples each.	Understand	This would require the learner to **recall** the finite automata and **discuss**with the basic example.	CO 1
2	Give a brief note on deterministic finite automaton and non-deterministic finite automaton with example each.	Understand	This would require the learner to **recall** the finite automata and **discuss** the steps for the construction of DFA and NFA	CO 1
3	List out the various differences between DFA and NFA	Remember	-	CO 1

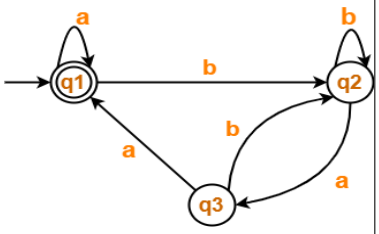
4	Describe how various rules used for construction of ϵ NFA with suitable example and also write th steps for NFA with ϵ to NFA conversion with an example.	Understand	-This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA with ϵ to NFA.	CO 1
5	Describe a a procedure for converting NFA to DFA with suitable example and also discuss about discuss about Finite Automata with Epsilon- Transitions	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA.	CO 1
6	Define Regular Expression? what are the rules of Regular Expression and what operations performed on Regular Expression each with an example.	Remember	-	CO 1
7	Construct a DFA for the Regular expression (0+1)* (00+11) (0+1)*.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
8	Design deterministic finite automata (DFA) for the following languages shown below $\sum$ = { a,b} a) L={w | w is any string that max 3 a's and any number of b's} b) L={w | w is any string that contain atmost three a's}	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
9	Convert the following NFA with ϵ to NFA. 	Understand	This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA with ϵ to NFA	CO 1

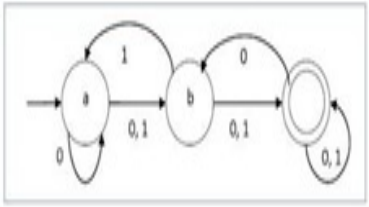
10	Describe Finite Automata and draw FA for the strings over an alphabet $\sum$ = { 0,1} a. The string with even number of 0's and even number of 1's b. The string with odd number of 0's and odd number of 1's	Understand	This would require the learner to **recall** the finite automata and **discuss** the steps for the construction of FA	CO 1
11	Describe a DFA, the language recognized by the Automaton being L={w | w contains either the substrings ab or ba}.Draw the transition table.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of FA	CO 1
12	Convert the following NFA into DFA 	Understand	This would require the learner to **recall** the finite automata and **show** the steps for the conversion of NFA to DFA.	CO 1
13	Design a DFA for the following language L={|w| mod3=0,w belongs to (a,b)*} L={| w | mod3=1,w belongs to (a,b)*}	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
14	Describe a DFA for the following language over an alphabet $\sum$ = { 0,1} a)The string with odd number of 0's and even number of 1's b)The string with even number of 0's and odd number of 1's	Understand	This would require the learner to **recall**the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1

15	Convert the following NFA into equivalent DFA. 	Understand	This would require the learner to **recall**the Deterministic finite automata and **show** the steps for the conversion of NFA to DFA.	CO 1
16	Convert the following NFA with ϵ to NFA withot ϵ 	Understand	This would require the learner to **recall**the finite automata and **show** the steps for the conversion of NFA-ϵ to DFA.	CO 1
17	Design ϵ -NFA for Regular Language L = (0+1)*(00 + 11) and L = ab + ba	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
18	Convert the following NFA with ϵ to NFA. 	Understand	This would require the learner to **recall**the finite automata and **show** the steps for the conversion of NFA-ϵ to DFA.	CO 1
19	Draw transition diagram and also transition table for language that accepts all strings of length at least 2.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1

20	Design a mealy machine that scans sequence of input of 0 and 1 and generates output 'A' if the input string terminates in 00, output 'B' if the string terminates in 11, and output 'C' otherwise.	Understand	This would require the learner to **recall** the finite automata and **discuss** the steps for the Mealy machine	CO 1
21	Design a Moore machine with the input alphabet {0, 1} and output alphabet {Y, N} which produces Y as output if input sequence contains 1010 as a substring otherwise, it produces N as output..	Understand	This would require the learner to **recall** the finite automata and **discuss** the steps for generation of moore machine	CO 1
22	Compare between Mealy Machine and Moore Machine with examples.	Understand	This would require the learner to **recall** the finite automata and **discuss** the Difference between Mealy Machine moore machine	CO 1
PART-C SHORT ANSWER QUESTIONS				
1	Define DFA.	Remember	-	CO 1
2	Differentiate between DFA and NFA.	Understand	This would require the learner to textbfrecall the finite automata and textbfexplain the differences between NFA and DFA	CO 1
3	Define the String with an example.	Remember	-	CO 1
4	Define transition function of DFA.	Remember	-	CO 1
5	Define NFA with ϵ–transitions.	Remember	-	CO 1
6	Define power of an alphabet ($\sum^{\star}$).	Remember	-	CO 1
7	List the applications of finite automata.	Remember	-	CO 1
8	Define Null string.	Remember	-	CO 1
9	Define Kleene Star?	Remember	-	CO 1
10	Define NFA with example.	Remember	-	CO 1
11	Describe transition diagram for DFA accepting string ending with 00	Remember	-	CO 1

12	Describe DFA for a string accepting odd number of 1's and even number of 0's.	Remember	-	CO 1
13	Describe transition diagram for DFA to accept exactly one 'a' defined over an alphabet $\sum$= {a,b}.	Remember	-	CO 1
14	Demonstrate DFA for odd number of 1's.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
15	Define ϵ - closure.	Remember	-	CO 1
16	Describe FSM and its structure with an example.	Remember	-	CO 1
17	State the Mathematical definition of Finite Automata.	Remember	-	CO 1
18	Demonstrate DFA for even number of 1's.	Understand	This would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
19	State the reasons of NFA's with epsilon moves more powerful than NFA's without epsilon moves	Remember	-	CO 1
20	Demonstrate DFA for the language accepting strings which contains 001 as substring.	Understand	his would require the learner to **recall** the Deterministic finite automata and **discuss** the steps for the construction of DFA	CO 1
21	Define Mealy Machine with example.	Remember	-	CO 1
22	Define Moore Machine with example.	Remember	-	CO 1
MODULE II				
REGULAR LANGUAGES				
PART-A PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				

1	Convert Regular Expression [ab + (b + aa)b* a] to Finite Automata.Draw the Transition Table For NFA	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for the conversion of Regular Expression to Finite Automata.	CO 2
2	convert the given finite automata to regular expression. 	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for the conversion of Regular Expression to Finite Automata.	CO 2
3	Describe Pumping Lemma for Regular Languages. Prove that the language $L = \{a^i b^i \mid i >= 0\}$ is not regular	Understand	This would require the learner to **recall** the Regular Languages and **show** the steps for for the checking the language is not regular.	CO 2
4	Describe the DFA Transition diagram for equivalent Regular expression (bb)*(aa)*	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for for the conversion of Regular Expression to Deterministic Finite Automata	CO 1
5	Convert the following Regular Expression (0 + 1)*(00 + 11) to epsilon NFA.	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for for the conversion of Regular Expression to Deterministic Finite Automata	CO 2
6	Convert the following Regular expression (0+1)*(01+110)10 + (0 + 11)0* 1 to DFA.	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for for the conversion of Regular Expression to Non Deterministic Finite Automata	CO 1

7	Convert the following automata into Regular expression M=({q1,q2,q3},{0,1}, δ, q1, {q2,q3}) where δ is given by [δ (q1,0)={q2}, δ (q1,1)={q3}] [δ (q2,0)={q1}, δ (q2,1)={q3}] [δ (q3,0)={q2}, δ (q3,1)= {q2}]	Understand	This would require the learner to **recall** the Finite Automata and **show** the steps for the conversion of Finite Automata to Regular Expression.	CO 2
8	Describe the following language is not regular *i*)$L = \{ a^n b^n \mid n$ is a positive integer $\}$ over alphabet $\sum = \{ a,b\}$ ii) L= $\{a^n b^{2n} \mid n \geq 0 \}$	Understand	This would require the learner to **recall** the Regular Languages and **show** the steps for the checking the language is not regular.	CO 2
9	Convert the automata in which strings end with 101 over an alphabet $\sum = \{0,1\}$ to the Left Linear Grammar and Right Linear grammar.	Understand	This would require the learner to **recall** the Finite Automata and **show** the steps for the conversion of Finite Automata to Regular Grammars.	CO 2
10	Convert the following Finite Automata to regular expression. 	Understand	This would require the learner to **recall** the Finite Automata and **show** the steps for the conversion of Finite Automata to Regular Expression.	CO 1
PART-B LONG ANSWER QUESTIONS				
1	Convert Regular Expression $01^* + 1$ to Finite Automata.	Understand	This would require the learner to **recall** the Regular Expression and **show** the steps for the conversion of Regular Expression to Finite Automata.	CO 1

2	Convert Regular Expression 01* + 1 Right linear, Left linear Regular Grammars	Understand	This would require the learner to recall the Regular Expression and show the steps for the conversion of Regular Expression to Regular Grammars.	CO 2
3	Describe Regular expression? Simplify the following Regular Expression i)ϵ+1*(011)*(1*(011)*)*= (1+011)* *ii*)$(0 + 11 * 0) + (0 + 11 *$ $0)(10+10*1)*(10+10*1)* =$ $1 * 0(10 + 10 * 1)*$	Remember	-	CO 2
4	Convert the given Finite Automata (a+b)*ab* to Regular grammar .	Understand	This would require the learner to recall the Finite Automata and show the steps for the conversion of Finite Automata to Regular Grammar.	CO 1
5	Convert the given Finite Automata 0*11(0+1)*to Regular grammar .	Understand	This would require the learner to recall the Finite Automata and show the steps for the conversion of Finite Automata to Regular Grammar.	CO 1
6	Describe Regular expression, Regular set and Finite Automata. Distinguish those with example representations.	Remember	-	CO 2
7	Convert Regular Expression (0+1)*00(0+1)* to the Finite Automata(NFA-ϵ) .	Understand	This would require the learner to recall the Regular Expression and show the steps for the conversion of Regular Expression to Finite Automata.	CO 2
8	Convert Regular Expression (b+aa)*a* to Finite Automata(NFA-ϵ).	Understand	This would require the learner to recall the Regular Expression and show the steps for the conversion of Regular Expression to Finite Automata.	CO 2

9	State Pumping Lemma for Regular Languages with a suitable example and also write about the identity rules of Regular Expressions.	Remember	-	CO 2
10	Convert given Regular expression (a* + b*) to NFA-ϵ.	Understand	This would require the learner to recall the Regular Expression and show the steps for the conversion of Regular Expression to Finite Automata.	CO 2
11	Convert the following automata into Regular expression M=({q1,q2,q3},{0,1}, δ, q1, {q1}) where δ is given by [δ (q1,0)={q1}, δ (q1,1)={q2}] [δ (q2,0)={q3}, δ (q2,1)={q2}] [δ (q3,0)={q1}, δ (q3,1)= {q2}]	Understand	This would require the learner to recall the Finite Automata and show the steps for the conversion of Finite Automata to Regular expression	CO 2
12	Describe Pumping lemma. Prove that the language L={ww^ry | w,y belongs$\{0,1\}^+$}is not regular.	Remember	-	CO 2
13	Describe Regular grammar? Explain the types of regular grammar with examples.	Remember	-	CO 2
14	IIustrate the steps for conversion of regular grammar to finite automata? Construct the FA for the following grammar S→aS/bA/b ,A→aA/bS/a	Understand	This would require the learner to recall the Regular Grammar and show the steps for the conversion of Regular Grammar to Finite Automata.	CO 2
15	Convert the given Regular Expression 10 + (0 + 11)0* 1 to FA and convert it into NFA.	Remember	-	CO 2

16	Show that the following languages is not regular L = $\{a^n b^n \mid n \geq 1\}$ L=$\{a^P \mid p$ is prime$\}$	Remember	-	CO 2
17	Convert the following regular expression to Regular grammar (0+1)*00(0+1)*	Understand	This would require the learner to recall the Regular Expression and show the steps for the conversion of Regular Expression to Regular Grammar.	CO 2
18	Describe the Left Linear Grammar for the strings start with 'a' over an alphabet $\sum$ ={a,b}.	Remember	-	CO 2
19	Illustrate the steps for conversion from Finite Automata to Regular Expression with example?	Understand	This would require the learner to recall the Finite Automata and show the steps for the conversion of Finite Automata to Regular Expression.	CO 1
20	Describe Pumping lemma. Prove that the language is reular $L = \{xww^r y \mid$ w,x,y belongs to $\{a,b\}^+\}$	Remember	-	CO 3
PART-C SHORT ANSWER QUESTIONS				
1	Define Regular Languages.	Remember	-	CO 2
2	List out any two applications of regular expression.	Remember	-	CO 2
3	Define Pumping Lemma for Regular Languages.	Remember	-	CO 3
4	Show an example for a regular set?	-	CO 2	
5	Define the Regular Expression for the empty string.	Remember	-	CO 2
6	Describe regular expression for denoting language containing empty.	Understand	This would require the learner to recall regular languages and explain the regular expressions for given laguage.	CO 2
7	Define right linear grammars.	Remember	-	CO 4

8	Show the Regular Expression for the set of binary strings.	Remember	-	CO 2
9	Define Regular grammars.	Remember	-	CO 3
10	List out the advantages of regular expressions.	Remember	-	CO 2
11	Define Regular set?	Remember	-	CO 2
12	Describe regular expressions for the Set of strings over 0, 1 whose last two symbols are the same.	Understand	This would require the learner to recall strings, regular expressions and explain the regular expressions for given set of strings.	CO 2
13	Describe the regular language generated by regular expression (0+1)*001(0+1)*.	Understand	This would require the learner to recall regular expressions and explain the languages for given expression.	CO 2
14	List the difference between left linear and right linear grammars.	Remember	-	CO 4
15	Describe the Regular Expression to generate at least one b over $\sum$={a,b}	Understand	This would require the learner to recall regular sets and explain the regular expression for given regular set.	CO 3
16	Describe that following languages are not regular L={$a^n b^m$| n, m and n<m }	Remember	-	CO 2
17	Describe that following languages are not regular L={a^n| n is a perfect square }	Remember	-	CO 2
18	Define Regular Expression for even number of 0's.	Remember	-	CO 2
19	Define Regular Expression for odd number of 0's.	Remember	-	CO 2
20	Define Regular Expression for the regular sets consists strings having two consecutive a's.	Remember	-	CO 2
MODULE III				
CONTEXT FREE GRAMMARS				

PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	Describe a grammar for valid expressions over operator - and /. The arguments of expressions are valid identifiers over symbols a,b, 0 and Derive Left Most Derivation and Right Most Derivation for string W= (a11-b0) / (b00-a01). Draw parse tree for Left Most Derivation.	Understand	This would require the learner to **recall** the context free grammars and **explain** the left most derivation and Right most derivation	CO 3
2	Describe Leftmost Derivation. , Rightmost Derivation,Derivation Tree for the following grammar with respect to the string aaabbabbba. S→aB | bA , A→aS | bBA | a , B→bS | aAB | b	Understand	This would require the learner to **recall** the context free grammars and **explain** the left most derivation and Right most derivation.	CO 3
3	Convert the following grammar into GNF S→ABA/AB/BA/AA/B A→aA/a, B→bB/b	Understand	This would require the learner to **recall** the context free grammars and **explain** the steps for the conversion of the CFG to GNF.	CO 4
4	Describe the context free grammars in the four tuple form.(V,T,P,S) for the given languages on $\sum$={a,b} i. All strings having at least two a's ii. All possible strings not containing triple b's	Understand	This would require the learner to **recall** the context free grammars and **explain** the CFG for the given set of strings.	CO 4
5	Describe the string "aabbabba" for leftmost derivation and rightmost derivation using a CFG given by S→Ab|Ba A→a| aS| Baa B→b | bS |aBB	Understand	This would require the learner to **recall** context free grammars and **explain** the rleft most derivation and Right most derivation	CO 4

6	Describe the minimized CFG productions for CFG S→Ab|Bb , A→a |aS |Baa B→b|bS |aBB	Understand	This would require the learner to **recall** context free grammars and **explain** the steps for the minimization of the CFG.	CO 4
7	Convert the following grammar into GNF A1→A2A3 ,A2→A3A1 | b, A3→A1 A2 | a	Understand	This would require the learner to **recall** context free grammars and **explain** the steps for the conversion of the CFG to GNF	CO 4
8	Convert the following grammar into Chomsky Normal form L(G) – S→AaA | CA | BaB,A→aaBa | CDA | aa | DC ,B →bB | bAB | bb | aS, C →Ca | bC | D, D →bD | A	Understand	This would require the learner to **recall** context free grammars and **explain** the steps for the conversion of the CFG to CNF.	CO 4
9	Describe the steps to show the following is not CFG. L= { $a^n b^n c^n$ | $n \geq 0$ }	Understand	This would require the learner to **recall** context free grammars and **explain** the steps for the checking of the given grammar is CFG or not.	CO 4
10	Describe the CFG for the language L={$a^n b^{2n}$where n≥1}and Explain the steps for the minimization of the CFG	Understand	This would require the learner to **recall** context free grammars and **explain** the for the minimization of the CFG“	CO 4
PART-B LONG ANSWER QUESTIONS				
1	Describe Leftmost Derivation. , Rightmost Derivation, Derivation Tree for the following grammar with respect to the string aaabbabbba. S→aB | bA,A→aS| bAA|a B→bS | aBB | b	Remember	-	CO 4
2	Describe a CFG for the languages L={$a^i b^j$| i≤2j}	Remember	-	CO 4

3	Describe leftmost and rightmost derivations for the strings, if the language is given as S→AS | ϵ, A→aa|ab|ba|bb Strings: aabbba baabab aaabbb	Remember	-	CO 4
4	Explain about the enumeration of properties of context free language	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG.	CO 4
5	write the procedure for finding Ambiguity in context free grammars and also minimization of CFG with example.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG	CO 4
6	Discuss about: a) Context Free Grammar b) Left Most Derivation c) Right Most Derivation.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG	CO 4
7	Convert the grammar to CNF S→aSa/aa,S→bSb/bb S→a/b.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG	CO 4
8	Describe Chomsky Normal Form and Greibach Normal Form each with an example.	Remember	-	CO 4
9	Define Normalization of CFG? What is the use of Normalization? Explain different types of normal forms.	Remember	-	CO 4
10	Illustrate the construction of Greibach normal form with an example.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the conversion of the CFG into GNF	CO 4

11	Show that the following CFG ambiguous. S→iCtS | iCtSeS | a, C→ b.	Understand	-	CO 4
12	Describe the Pumping lemma for Context Free Languages concept with example$\{a^n b^n c^n$where n≥0$\}$.	Remember	-	CO 4
13	Describe the minimized CFG productions in S → aS1b, S1 → a S1b/ ϵ	Remember	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG.	CO 4
14	Convert the following CFG into GNF. S→AA/a,A→ SS/b	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the conversion of the CFG to GNF.	CO 4
15	Describe unit production? Explain the procedure to eliminate unit production.	Remember	-	CO 4
16	Describe the procedure to eliminate ϵ productions in grammar.	Remember	-	CO 4
17	Convert the following grammar into GNF G=({A1,A2,A3},{a,b},P,A) A1→A2A3, A2→A3A1/b ,A3→A1A2/a	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the conversion of the CFG to GNF.	CO 4
18	Describe the minimized CFG productions from the following grammar A→aBb/bBa ,B→aB/bB/ϵ	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG	CO 4
19	Describe CFG and Explain a CFG for the following language L = $\{ 0^i 1^j 0^k \mid$ j > i + k $\}$and write the minimization steps.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG.	CO 4
20	Describe the minimized CFG for the following grammar S→ABCa | bD, A→BC | b, B→b | ϵ C→| ϵ, D→d	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG.	CO 4

21	Covert the CFG to Greiback Normal form by taking an example	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the conversion of the CFG to GNF.	CO 4
22	Convert the grammar G given by S→aAa, A→Sb| bcc|DaA, C→abb| DD, E→ ac, D→aDa into an equivalent grammar by removing useless symbols and useless productions from it.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the steps for the minimization of the CFG.	CO 4
PART-C SHORT ANSWER QUESTIONS				
1	Define a context free grammar(CFG).	Remember	-	CO 4
2	Define the parse tree with example.	Remember	-	CO 2
3	Differentiate the Rightmost derivation with Left most derivation with example.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the differences between right most derivation and left most derivation.	CO 4
4	Describe a short notes about leftmost derivation with example.	Remember	-	CO 4
5	CList any two applications of Context Free Grammar.	Remember	-	CO 4
6	Define the left sentential form?	Remember	-	CO 4
7	Describe the different ways to derive a string from a CFG.	Remember	-	CO 4
8	Describe the language generated by CFG or G?	Remember	-	CO 4
9	Describe the concept of parse tree?	URemember	-	CO 2
10	Describe the concept of subtree.	Remember	-	CO 2
11	DDescribe the CFL for S→aSb | aAb , A→bAa , A→ba.	Remember	-	CO 4

12	Describe the usage of normalization?	Remember	-	CO 4
13	Define the ambiguous grammar with example?	Remember	-	CO 3
14	Describe the language generated by the following grammar S→ AB A→aAa|bAb|a|b B→Ab|Bb| ϵ	Remember	-	CO 3
15	List the steps for the CFG to reduce UNIT production.	Remember	-	CO 3
16	Describe the elimination of useless symbols in productions.	Remember	-	CO 3
17	List the steps for the given grammar to get the minimized CFG S → a S/A, A→a / B	Remember	-	CO 3
18	Describe the ambiguity concept in CFG with an example	Remember	-	CO 3
19	Differentiate the CNF and GNF.	Understand	This would require the learner to **recall** the normalization of context free grammars and **Explain** the differences between CNF and GNF.	CO 3
20	List the steps for the given grammar to get the minimized CFG - S ? aS1b S1?aS1b/?.	Remember	-	CO 3
MODULE IV				
PUSH DOWNAUTMATA				
PART A- PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS				
1	Construct PDA for equal number of x's and y's. eg: xyyxxy	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the construct of the PDA	CO 5

2	Construct NDPDA for L = { $WW^R \mid W \in (X + Y)^*$}	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the construct of the NPDA	CO 5
3	Convert the following PDA to CFG δ(q0,0,z0)=q0,xz0) d(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)	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA CFG	CO 5
4	Construct DPDA for L = { $W = W^R \mid W \in (X + Y)^*$}	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the construct of the DPDA	CO 5
5	Design the pushdown automata for language $\{a^n b^n \mid n > 0\}$ using final state.	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the construct of the PDA	CO 5
6	Construct a PDA with final state acceptance for the language B= { bin(i)$mir(bin(i+1)) \mid i $\geq$0 } $\subseteq \{0, 1, \$\}^*$ Here is bin(i)$\in${0,1}*the binary representation (without leading zero's) of the number i. Eg. bin(11) =1011 and mir(bin(12)) =0011	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the construct of the PDA	CO 5

7	Construct CFG corresponding to PDA whose transition mapping is as follows. δ(S,a,X)= (s, A,X) δ(S,b,A) =(s, AA) δ(S,a,A) = (s, AA)	Apply	This would require the learner to **recall** the Context Free Grammars and **Explain** the concept of the PDA and Apply the concepts for the conversion of the PDA to CFG.	CO 5
8	Show that given CFG with following productions S→aBc A→abc,B→aAb,C→AB, C→c constructs a PDA M such that the language generated by M and G are equivalent.	Apply	This would require the learner to **recall** the Context Free Grammars and Understand the concept of the PDA and **Apply** the concepts for the construct of the PDA.	CO 5
9	Construct a PDA for the following grammar. S→0A A→0AB ,B→1	Apply	This would require the learner to **recall** the Context Free Grammars and Explain the concept of the PDA and **Apply** the concepts for the construct of the PDA	CO 5
10	Construct PDA for the following grammar S→AA | a A→SA | b	Apply	This would require the learner to **recall** the Context Free Grammars and Explain the concept of the PDA and **Apply** the concepts for the construct of the PDA.	CO 5
PART-B LONG ANSWER QUESTIONS				
1	Define the NPDA(Nondeterministic PDA) and DPDA(deterministic PDA) equivalent? Illustrate with an example.	Remember	-	CO 5

2	Describe the grammar for the following PDA. M=({q0, q1},{0,1},{X,z0},δ,q0,Z0,ϕ) and where δ is given by δ(q0,0,z0)={(q0,XZ0)}, δ(q0,0,X)={(q0,XX)}, δ(q0,1,X)={(q1, e)}, δ(q1,1,X)={(q1, e)}, δ(q1, e,X)={(q1, e)}, δ(q1, e, Z0)={(q1, e)}.	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the CFG from PDA	CO 5
3	Describe PDA for string of form $a^n b^{2n}$ n≥1	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA.	CO 5
4	Define PDA mathematically. With a neat diagram explain the working of a acceptance by final state and acceptance by empty stack and its equivalence		-	CO 5
5	Describe the equivalence of context free language and pushdown automata	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the CFG accepts the given language.	CO 5
6	Describe a PDA for the following grammar S→0A, A→0AB/1,B→1	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
7	Prove that L is accepted by a PDA M1 by empty store, if and only if L is accepted by a PDA M2 by final state	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
8	Describe the PDA mathematically. Describe the PDA for the following language. L= {w | w of form $a^n b^n$}.	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5

9	Describe PDA For the language L = $\{xcx^r \mid$ x$\in$ {a,b}*}and trace it for string 'bacab'	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
10	Describe the Pushdown automaton A is specified by M=({q0,q1},{a,b},{X,Z}, δ,q$_{in}$, Z,ϕ) and where δ contains the following transitions: δ(q0,a,Z)=(q0,λ) δ(q0,a,Z)=(q0,Xz$_{in}$) δ(q0,a,X)=(qo,XX) δ(q0,b,X)=(q1,λ) δ(q1,b,X)=(q1,λ) δ(q1,a,z0)=(qo,Z) Infer a (reduced) context-free grammar G for the empty stack language of A, i.e., L(G) = Le(A).	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
11	Describe PDA for the below grammar as shown below S→aABB |aAA A→aBB |a B→BB | A that accepts the language generated by given grammar	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
12	Describe a PDA for the below CFG which generates the palindrome accepted by L(G) S→aSa| bSb|a|b	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
13	Define a PDA and describe a context free grammar for the language L=$\{a^i b^j c^k; i < j or j < k\}$	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5

14	Covert the following context free grammar to push down automata S→aAbB A→aB—a B→b Verify the string aab accepted by equivalent PDA	Understand	This would require the learner to **recall** the Context Free Grammars and **Explain** the steps for the conversion of CFG to PDA	CO 5
15	Describe DPDA for L= $a^n b^n$where n≥1	Understand	This would require the learner to recall the Push Down Automata and Explain the steps for the construct of the DPDA	CO 5
16	Describe PDA accepts PDA M for the language L={WW^R|W∈{a,b}*} such that L=L(M)	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
17	Illustrate PDA M for the language L= {x∈ {a,b}* | $n_a(x) > n_b(x)$}	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA.	CO 5
18	Show that the below languages are deterministic context free languages L1={0^n1^m|n=m and n≥1} L2={o^{n}1^m|n=2m and n≥1}	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the checking DCFL or not.	CO 5
19	Describe deterministic context free languages and deterministic push down automata	Remember	-	CO 5
20	Describe PDA that recognizes the language L={x=x^R : x∈{a,b}$^+$}	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the construct of the PDA	CO 5
PART-C SHORT ANSWER QUESTIONS				
1	Differentiate between deterministic and nondeterministic PDA.	Understand	This would require the learner to **recall** the context free grammars and **Explain** the difference between DPDA - NPDA	CO 5
2	Define the concept of PDA.	Remember	—	CO 5

3	Describe the concept of NPDA.	Remember	—	CO 5
4	Define the language of DPDA.	Remember	—	CO 5
5	Generate CFG for the PDA which accepts the lanuage L=$\{0^n1^n \mid n \geq 0\}$	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
6	Obtain CFG for given PDA M = $(\{q_0, q_1\}, \{0,1\}, \{X, Z_o\}, \delta, q_0, Z_o, \{\})$ $\delta(q_0, 0, Z_0) = (q_0, XZ_o)$ $\delta(q_0, 0, X) = (q_0, XX)$ $\delta(q_0, 1, X) = (q_1, \epsilon)$ $\delta(q_1, 1, X) = (q_1, \epsilon)$ $\delta(q_1, \epsilon, X) = (q_1, \epsilon)$ $\delta(q_1, \epsilon, Z_o) = (q_1, \epsilon)$	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
7	Illustrate the processing steps for convertion from PDA to CFG and vice versa.	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
8	Generate CFG for the non-deterministic PDA which accepts strings that contain the same number of 0s and 1s.	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
9	List out the steps to convert CFG to PDA	Remember	—	CO 5
10	Describe the acceptance of PDA by final state.	Remember	—	CO 5
11	Describe the acceptance of PDF by empty stack.	Remember	—	CO 5
12	Construct a PDA that accepts the language L over {0, 1} by empty stack which accepts all the string of 0's and 1's in which a number of 0's are twice of number of 1's.	Understand	This would require the learner to**recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5

13	Design a non deterministic PDA for accepting the language L ={w w∈{a,b}* | w contains equal no. of a's and b's}	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
14	Construct PDA for the given CFG, and test whether 010000 is acceptable by this PDA. S → 0BB B → 0S | 1S | 0	Understand	This would require the learner to **recall** the Push Down Automata and **Explain** the steps for the conversion of PDA to CFG	CO 5
15	Define the PDA and design PDA for L={x∈{a,b}*| $n_a(x) > n_b(x)$}	Remember	—	CO 5
16	How push down automata differ from the finite state automata?	Remember	—	CO 5
17	Why stack is used in PDA?	Remember	—	CO 5
18	what equivalences of context free language and pushdown automat	Remember	—	CO 5
19	Define the PDA acceptance by final state and acceptance by empty stack	Remember	—	CO 5
20	How PDA perform acceptance of context free languages	Remember	—	CO 5
MODULE V				
TURING MACHINE				
PART A-PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Construct a Turing Machine that accepts the language L = {$a^{2n}b^n$|n≥0}.Give the transition diagram for the Turing Machine obtained.	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and Explain the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6
2	Construct a Turing Machine that gives two's compliment for the given binary representation.	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and Apply the concepts for the construct of the TM.	CO 6

3	Examine Type 3 and Type 2 grammars with example.	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and Apply the concepts for the construct of the TM	CO 6
4	Extend the Type 1 and Type 0 grammars with example.	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and Apply the concepts for the construct of the TM.	CO 6
5	Design a Turing Machine that accepts the set of all even palindromes over{0,1}	Apply	This would require the learner to **recall**the Chomsky hierarchy of languages and Explain the concept of the TM and A**Apply** the concepts for the construct of the TM	CO 6
6	Design Turing Machine for L={$a^n b^n c^n$| n=1}	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and Apply the concepts for the construct of the TM.	CO 6
7	Construct Turing Machine to calculate GCD of two given numbers	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6
8	Compare and contrast the Finite state machine , PDA and Turing Machine	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM.	CO 6

9	Construct a Turing Machine to accept the following languages L = { $w^n x^n y^n z^n$| n≥1}	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM.	CO 6
10	Design a Turing Machine that accepts the language denoted by regular expression (000)*	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM.	CO 6
PART-B LONG ANSWER QUESTIONS				
1	Describe short notes on Context sensitive language and linear bounded automata.	Remember	-	CO 6
2	Classify briefly about Chomsky hierarchy of languages	Understand	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the all types of languages.	CO 6
3	Describe a Turing Machine. With a neat diagram explain the working of a Turing Machine.	Remember	-	CO 6
4	Write short notes on the following. a) Chomsky Hierarchy of Languages b) Linear Bounded Automata c) context sensitive language.	Understand	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the differences between TM and other automata.	CO 6
5	Construct a Transition diagram for Turing Machine to accept the language L={w≠w^R| w∈(a+b)*}	Apply	This would require the learner to **recall**the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM.	CO 6

6	Express short notes on Recursive and Recursively Enumerable languages.	Understand	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the Recursive and Recursively enumerable languages.	CO 6
7	Describe the properties of recursive and recursively enumerable languages.	Remember	-	CO 6
8	Develop a Turing Machine to accept strings formed with 0 and 1 and having the set of strings with an equal number of 0's and 1's.	Apply	This would require the learner to **recall**the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6
9	Construct a Transition diagram for Turing Machine to accept the language L= $\{ww^R\|$ w is any string of 0's and 1's$\}$	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6
10	Design a Transition table for Turing Machine L= $\{a^n b^n c^n\|$n $\geq 1\}$	Apply	This would require the learner to **recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6
11	Construct a Transition table for Turing Machine to accept the following language. L = $\{ 0^n 1^n 0^n\|$ n =1$\}$	Remember	—	CO 6
12	Construct a Turing Machine that accepts the language L = $\{1^n 2^n 3^n\|$ n $\geq 1\}$. Give the transition diagram for the Turing Machine obtained and also show the moves made by the Turing machine for the string 111222333.	Apply	This would require the learner to **Recall** the Chomsky hierarchy of languages and **Explain** the concept of the TM and **Apply** the concepts for the construct of the TM	CO 6

13	Enumerate Linear bounded automata and explain its model?	Remember	-	CO 6
14	Demonstrate the power and limitations of Turing machine.	Remember	-	CO 6
15	Construct Transition diagram for Turing Machine L={$a^n b n c^n$|n≥1}	Remember	-	CO 6
16	Construct a Transition diagram for Turing Machine to implement addition of two unary numbers(X+Y).	Understand	This would require the learner to **recall** the concept of the TM and **explain** the construction of the transition diagram for the TM.	CO 6
17	Construct a Linear Bounded automata for a language where L= $\{a^n b^n \mid n \geq 1\}$	Understand	This would require the learner to **recall** the concept of the LBA and **explain** the construction of the Linear Bounded automata for the given language.	CO 6
18	Classify the types of Turing machines	Understand	This would require the learner to recall the Turing machines and Explain the all types of Turing machines.	CO 6
19	Describe briefly about the following a)Church's Hypothesis b)Counter machine	Remember	-	CO 6
20	Construct Transition diagram for Turing Machine that accepts the language L= $\{0^n 1^n 2^n \mid n \geq 1\}$ .Give the transition diagram for the Turing Machine obtained and also show the moves made by the Turing machine for the string 001122	Understand	This would require the learner to recall the Chomsky hierarchy of languages and Explain the differences between FSM,PDA,TM.	CO 6
PART-C SHORT ANSWER QUESTIONS				
1	Describe the Chomsky hierarchy of languages.	Remember	—	CO 6

2	Define Context sensitive language.	Remember	—	CO 6
3	Describe the Turing Machine	Remember	—	CO 6
4	Describe the Type 0 grammars .	Remember	—	CO 6
5	Describe the Type 1 grammars .	Remember	—	CO 6
6	Describe the Type 2 grammars .	Remember	—	CO 6
7	Describe the Type 3 grammars	Remember	—	CO 6
8	List out the types of grammars.	Remember	—	CO 6
9	Describe the moves in Turing Machine.	Remember	—	CO 6
10	Define an Instantaneous Description of a Turing Machine.	Remember	—	CO 6
11	Describe the Language of Turing Machine.	Remember	—	CO 6
12	List out types of TMs.	Remember	—	CO 6
13	Differentiate the PDA and TM	Remember	—	CO 6
14	Describe the multi head Turing Machine	Remember	—	CO 6
15	Describe the multi dimensional Turing Machine.	Remember	—	CO 6
16	Describe the multiple tapes Turing Machine.	Remember	—	CO 6
17	Describe the recursive languages	Remember	—	CO 6
18	Describe the recursively enumerable languages.	Remember	—	CO 6
19	Describe the two way infinite Turing Machine.	Remember	—	CO 6
20	Describe the the non deterministic Turing Machine.	Remember	—	CO 6
21	Describe the Turing Machine for 1's complement for binary numbers.	Understand	—	CO 6

22	Describe the Recursive languages and Recursively enumerable languages.	Remember	This would require the learner to **recall** the concept of the TM and **explain** the construction of the TM.	CO 6
23	Define Church's Hypothesis	Remember	—	CO 6

Course Coordinator: **HOD-IT**
Dr.U.Sivaji, Associate Professor