United College of Engineering & Research, Prayagraj

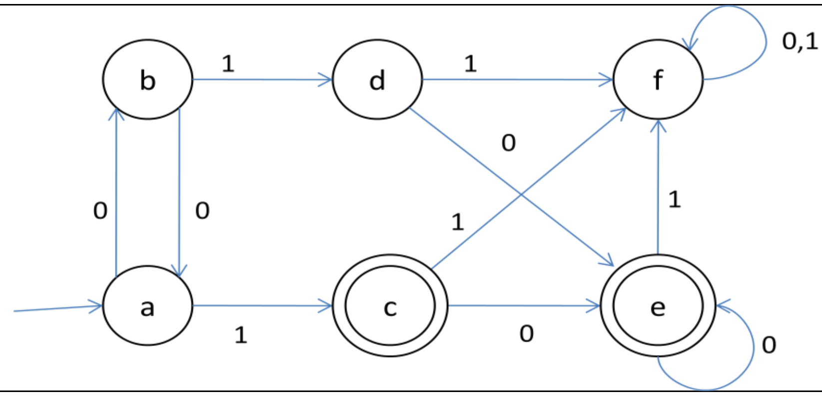
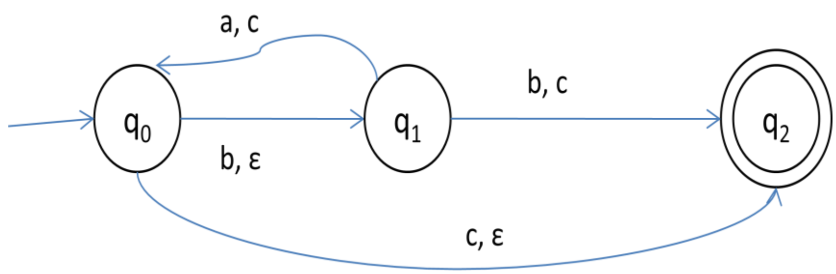
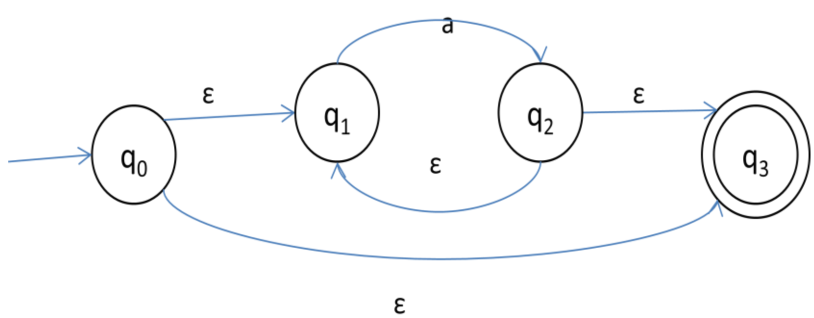
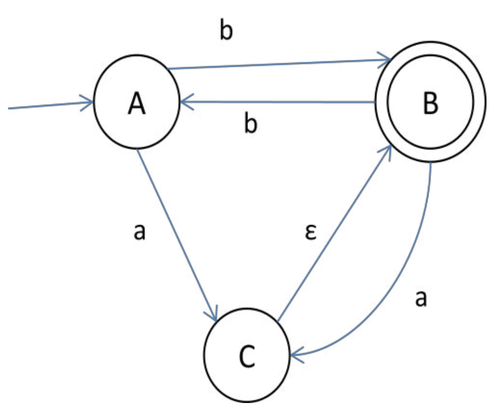
Department of Computer Science & Engineering

Question Bank

Automata Theory and Formal Languages (KCS-402)

Unit-1

Q. No.	Question	CO	Bloom's level
	Section-A	CO1	L1
1	Define Alphabet and String in Automata Theory.	CO1	L3
2	Give the definition of Deterministic Finite Automata (DFA).	CO1	L3
3	For the given language $L_1 = \varepsilon$, $L_2 = \{a\}$, $L_3 = \emptyset$. Compute $L_1 L_2^* \cup L_3^*$.	CO1	L4
4	Design a FA to accept the string that always ends with 101.	CO1	L3
5	Design the DFA that accepts an even number of a's and even number of b's.	CO1	L2
6	What is sentential form?	CO1	L1
7	Design a EA to accept the string that always ends with 00.	CO1	L2
8	Differentiate between the L^* and L^+.	CO1	L2
9	What is a Moore and Mealy'machine?	CO1	L1
10	Design a DFA to accept the binary number divisible by 3.	CO1	L2
11	What do you understand by Epsilon-closure of sate in finite automata?	CO1	L1
12	Define the language of a NFA with ε –moves.	CO1	L1
13	Define the language accepted by DFA and NFA.	CO1	L1
14	Define when two states are equivalent in DFA.	CO1	L1
15	Define NFA.		
	Section-B		
16	Give the complete description about the Chomsky's Hierarchy.	CO1	L3
17	Construct Non-Deterministic Finite Automata(NFA) for the language L which accepts all the strings in which third symbol from the right end is always **'a'** over {a,b}.	CO1	L2
18	Minimize the following DFA:-	CO1	L4

<table>
<tr><td></td><td>
</td><td></td><td></td></tr>
<tr><td>19</td><td>Design FA for ternary number divisible by 5.</td><td>CO1</td><td>L2</td></tr>
<tr><td>20</td><td>Construct a minimum state DFA from given FA

</td><td>CO1</td><td>L2</td></tr>
<tr><td>21</td><td>Compute the epsilon-closure for the given NFA. Convert it into DFA.

</td><td>CO1</td><td>L2</td></tr>
<tr><td>22</td><td>Convert the following NFA with epsilon into DFA

</td><td>CO1</td><td>L2</td></tr>
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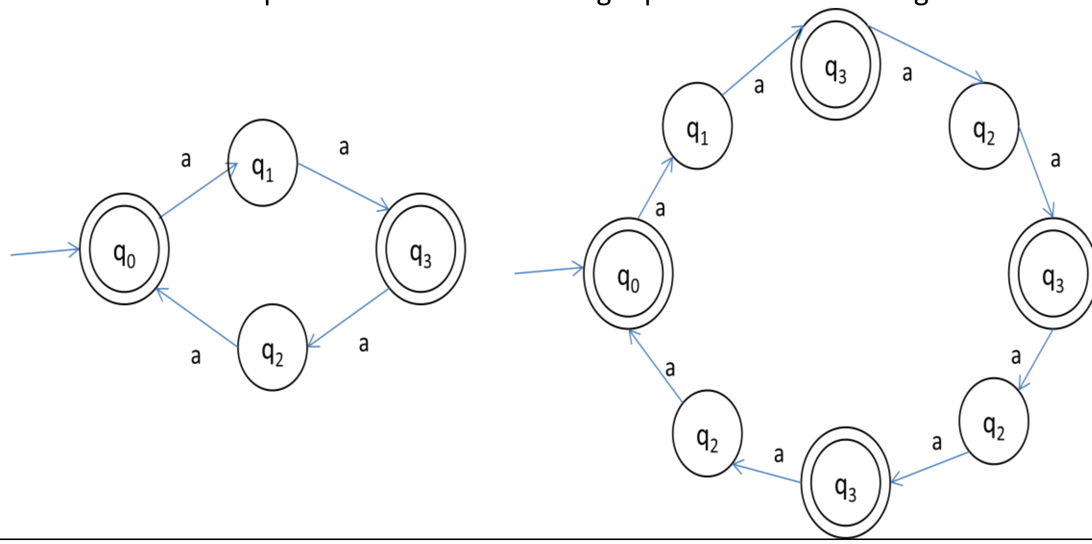
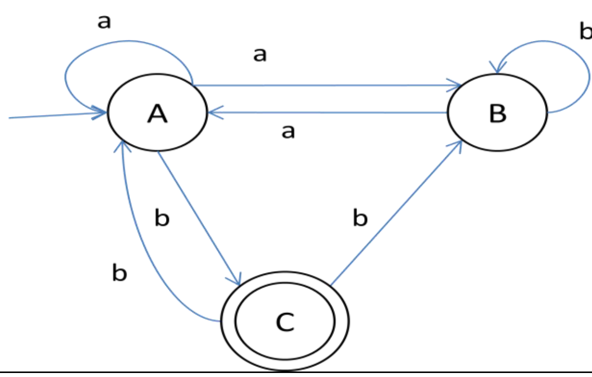
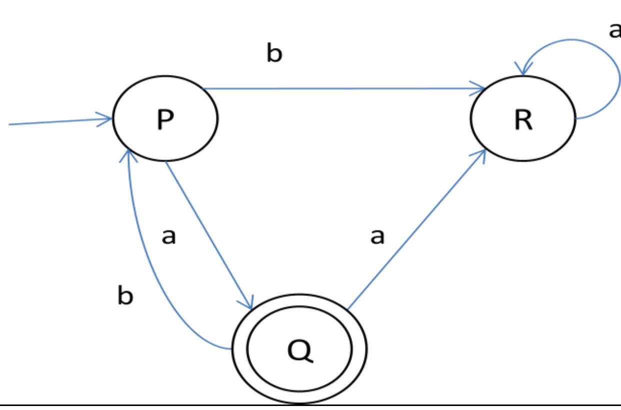
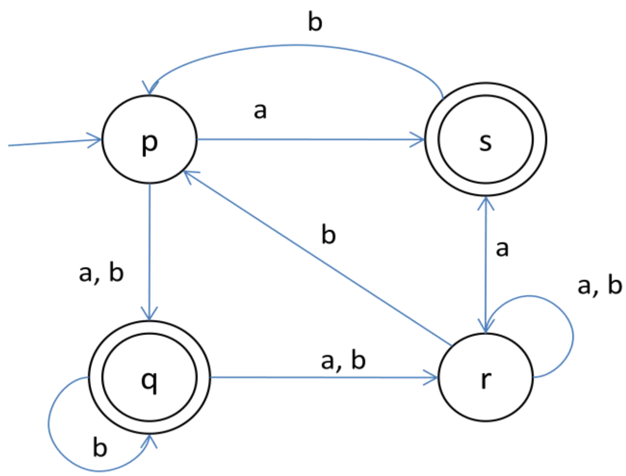
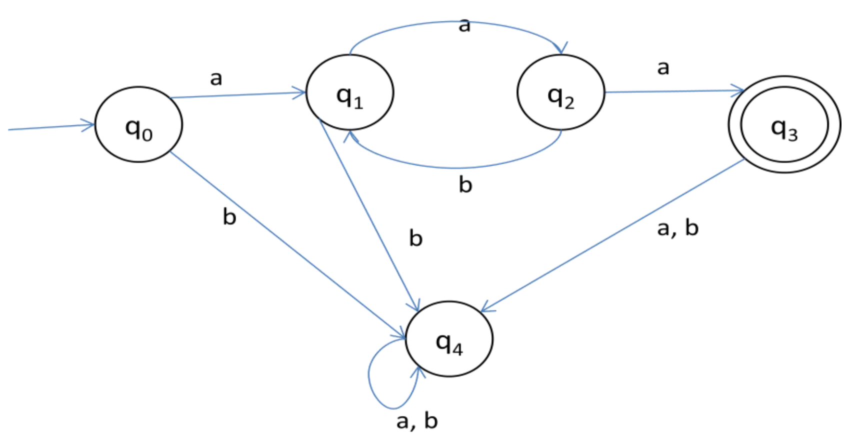
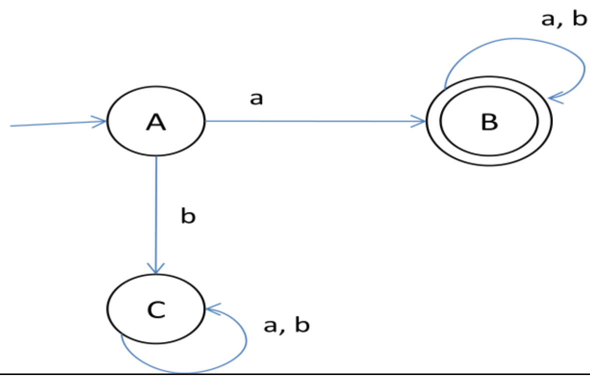
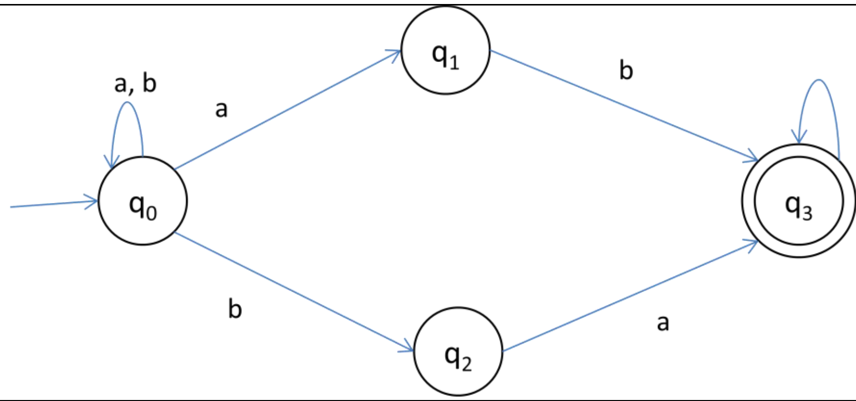
23	Check with the comparison method for testing equivalence of two FA given 	CO1	L4
24	Construct DFA equivalent to following NFA:- 	CO1	L3
25	Let L_1 be some language over $\sum$ and $L_2 = \emptyset$. Then prove that (a) $L_1.L_2 \neq L_1$ (b) $L_1+L_2 \neq \emptyset$	CO1	L2
26	Construct a DFA accepting all strings over alphabet set $\sum = \{0,1\}$ that are ended with 00.	CO1	L3
27	Describe the language accepted by following finite automata:- 	CO1	L4

28	Draw DFA of the following languages over {0, 1}? (a) All strings with even number of 0's and even number of 1's. (b) All strings of length at most 5.	CO1	L4
29	Convert the following NFA to equivalent DFA:- 	CO1	L4
30	Show that every context free language is context- sensitive.	CO1	L4
31	Draw DFA for the following over set ∑ = {0, 1}. (a) L = { w ! |w| mode 3 = 0 } (b) L = { w ! |w| mode 3 > 1 }	CO1	L4
32	Find the regular grammar for the language L = { a^n b^m ! n+m is even }	CO1	L4
33	Design a Transducer (Mealy or Moore) machine to compute multiplication of two n-bit binary numbers.	CO1	L4
34	Consider the DFA given below and identify the L accepted by the machine. 	CO1	L4
35	Find regular grammar for the language L = {a^n b^m c^l ! m, n, l ≥2	CO1	L4

Unit-2

Q. No.	Question	CO	Bloom's level
	Section-A		
1	Explain in brief about the Kleen's Theorem.	CO2	L1
2	What are Right Linear and Left Linear Grammars?	CO2	L3
3	Write regular expression for set of all strings such that number of a's divisible by 3 over $\Sigma = \{a,b\}$.	CO2	L3
4	What do you mean by ε-Closure in FA?	CO2	L4
5	State the pumping lemma theorem for regular languages.	CO2	L3
6	Convert the FA given below to left linear grammar. 	CO2	L2
7	State and prove kleene's theorem with an example.	CO2	L1
8	Write regular expression for set of all strings such that number of 0's is odd.	CO2	L2
9	Write ARDEN's Theorem.	CO2	L2
10	Find regular expression for the set, $L = \{a^m\ b^n\ !\ m > 1,\ n > 2 \text{ and } mn > 7\}$	CO2	L2
	Section-B	CO2	
11	Prove that the compliment, homomorphism, inverse homomorphism, and closure of a regular language is also regular.	CO2	L3
12	Explain Myhill-Nerode Theorem using suitable example.	CO2	L2
13	Prove that the language $L=\{a^n b^n\ !\ n \geq 1\}$ is not regular language.	CO2	L4
14	Explain in detail about the Pumping Lemma and application of Pumping Lemma for Regular Languages.	CO2	L2
15	Explain the Closure properties of regular expression.	CO2	L2
16	Find the regular expression corresponding to the finite automata given bellow:	CO2	L2

			
17	Show that L={a^p ! p is prime) is not regular?	CO2	L2
18	For regular expression, prove that (a+b)* ≠ a*+b*.	CO2	L4
19	Describe the language to the given regular expression:- (1+01)*(0+01)*	CO2	L3
20	What is regular expression? Construct regular expression for the regular expression, (00+001)*1.	CO2	L2
21	Describe the closure properties of regular languages. Prove that regular languages are closed under complementation.	CO2	L3
22	Write regular expression for each of the following languages over the alphabet {a,b}:- (a) The set of all strings in which every pair of adjacent 0's appears before any pair of adjacent 1's. (b) The set of all strings not containing 101 as a substring.	CO2	L4
23	Design a NFA to recognize following set of strings 0101, 101 and 011. Alphabet set is {0, 1}. Find the equivalent regular expression.	CO2	L2
24	Prove that following are not regular languages:- (a) L={0^n ! n is perfect square} (b) The set of strings of form $\mathbf{0^i1^j}$ such that greatest common divisor of i and j is 1.	CO2	L3
25	State and Prove Pumping Lemma of RE.	CO2	L4

Unit-3

Q. No.	Question	CO	Bloom's level
	Section-A		
1	Define Context Free Grammar(CFG).	CO3	L1
2	Write the context free grammar for the regular expression (0+1)*.	CO3	L3
3	Construct the CFG for the Language L = $\{a^{2n}b^n \mid n \geq 3\}$.	CO3	L3
4	Consider the following grammar: S->aB/bA A->a/aS/bAA B-> b/bS/aBB. Identify the strings obtained from this grammar.	CO3	L4
5	Eliminate unit productions in the grammar. S->A/bb A->B/b B->S/a.	CO3	L3
6	Construct the CFG for the regular expression (0+1)*.	CO3	L2
7	Construct context free grammar for the language, L= $\{ a^n b^n \mid n \geq 0 \}$.	CO3	L1
8	Explain Chomsky Normal Form and Greibach Normal Form.	CO3	L2
9	Define Reduced grammar.	CO3	L2
10	Define nullable variable and null production.	CO3	L2
	Section-B	CO3	
11	Explain in detail about the following:- (a) Closure properties of Context Free Languages. (b) Decidability-Decision properties of Regular Languages.	CO3	L3
12	Check whether the grammar is ambiguous or not. R→R+R|R*R|a|b|c Find the derivation tree for the following string w = a+b*c.	CO3	L2
13	Convert the following CFG to its equivalent GNF: S → AA | a, A → SS | b.	CO3	L4
14	Design the CFG for the following language: i) L = $\{0^m1^n \mid m \neq n \;\&\; m, n \geq 1\}$ ii) L = $\{a^l b^m c^n \mid l + m = n \;\&\; l,m \geq 1\}$	CO3	L2
15	Prove that the following Language L = $\{a^nb^nc^n\}$ is not Context Free.	CO3	L2
16	Convert the following CFG into CNF S → XY | Xn | p X → mX | m Y → Xn | o	CO3	L2
17	Convert the following CFG into CNF S → ASA | aB, A → B | S, B → b | ε	CO3	L2
18	Design CFG for the language consisting of all the strings of even length over {a, b}.	CO3	L4
19	Explain the parse tree with an example. Reduce the context free grammar into GNF whose productions are S→aSb. S→ab.	CO3	L3
20	Prove that the given language L is derived from a context free grammar. L = $\{ a^i b^j c^j \; ! \; i, j \geq 1 \}$	CO3	L2
21	Show that context free grammar(CFG) with productions S→a | Sa | bSS | SSb | SbS is ambiguous.	CO3	L3

22	Prove that every regular language is a CFL.	CO3	L4
23	Convert the following grammar into Chomsky Normal Form(CNF):- $S \rightarrow ABa$, $A \rightarrow aab$, $B \rightarrow Ac$	CO3	L2
24	Consider the following grammar:- $S \rightarrow A1B$, $A \rightarrow 0A/ \varepsilon$, $B \rightarrow 0B/1B/ \varepsilon$ Find leftmost and rightmost derivation of strings 00101.	CO3	L3
25	Show that following grammar is ambiguous :- $E \rightarrow I$, $E \rightarrow E+E$, $E \rightarrow E*E$, $E \rightarrow (E)$, $I \rightarrow a/b/c$.	CO3	L4
26	Find context free grammar for the following languages with (n, m, k ≥ 0);- (a) $L= \{a^n b^n c^k \,!\, k \geq 3\}$ (b) $L=\{a^m b^n c^k \,!\, n=m \text{ or } m \leq k \}$	CO3	L2
27	Given context free grammar, how do you determine that grammar as (a) Empty or Non-Empty (b) Finite or Non-Finite (c) Whether a string x belong to languages of grammar.	CO3	L3
28	For given CFG, find equivalent CFG with no useless variables. $S \rightarrow AB/AC$, $A \rightarrow aAb/bAa/a$, $B \rightarrow bbA/aaB/AB$, $C \rightarrow abCa/aDb$, $D \rightarrow bD/aC$	CO3	L4
29	Convert the following CFG into equivalent Greibach Normal Form: $S \rightarrow AA$, $A \rightarrow SS$, $S \rightarrow a$, $A \rightarrow b$	CO3	L2
30	Prove that the languages L_1 and L_2 are closed under intersection and complementation if they are regular but not closed under these operations if they are context free languages.	CO3	L3

Unit-4

Q. No.	Question	CO	Bloom's level
	Section-A		
1	Discuss briefly about the Pushdown Automata(PDA).	CO4	L1
2	What do you mean by Two stack Pushdown Automata?	CO4	L3
3	Define PDA. Draw the graphical representation for PDA.	CO4	L3
4	Design a PDA which accepts set of balanced parentheses ({ { } }).	CO4	L4
5	Describe the instantaneous description of a PDA.	CO4	L3
6	Define Pushdown Automata(PDA). Describe the language accepted by a PDA.	CO4	L2
7	Define Deterministic Pushdown Automata(DPDA).	CO4	L1
8	Design PDA for $L = \{a^n b^m \ ! \ m,n > 0\}$.	CO4	L2
9	Can we make Deterministic Pushdown Automata for the language $L=\{ww^R \mid w \in \{a,b\}^*\}$? Justify.	CO4	L2
10	Is the power of PDA and DPDA equal? Justify.	CO4	L2
	Section-B		
11	Convert the grammar $S \rightarrow aAA$, $A \rightarrow a \mid aS \mid bS$ to a PDA that accepts the language by empty stack.	CO4	L3
12	Design a PDA for the following language: $L = \{a^i b^j c^k \mid i = j \text{ or } j = k\}$	CO4	L2
13	Design a PDA for the Language $L = \{ww^R \mid w \in \{a,b\}^*\}$	CO4	L4
14	Generate CFG for the given PDA M which is defined as $M = (\{q_0, q_1\}, \{0,1\} \{x, z_0\}, \delta, q_0, z_0, q_1)$ Where, δ is given as follows: $\delta(q_0, 1, z_0) = (q_0, xz_0)$ $\delta(q_0, 1, x) = (q_0, xx)$ $\delta(q_0, 0, x) = (q_0, x)$ $\delta(q_0, \varepsilon, x) = (q_1, \varepsilon)$ $\delta(q_1, \varepsilon, x) = (q_1, \varepsilon)$ $\delta(q_1, 0, x) = (q_1, xx)$ $\delta(q_1, 0, z_0) = (q_1, \varepsilon)$	CO4	L2
15	Construct PDA to accept language, $L = \{0^n 1^n \mid n > 0\}$.	CO4	L2
16	Construct a PDA from the following CFG. $G = (\{S, X\}, \{a, b\}, P, S)$ where the productions are – $S \rightarrow XS \mid \varepsilon$, $A \rightarrow aXb \mid Ab \mid ab$	CO4	L2
17	Consider the CFG ({S, A, B} {a, b}, P, S), where productions P are as follows: $S \rightarrow aABB / aAA$, $A \rightarrow aBB/a$, $B \rightarrow bBB / A$. Convert the given grammar to PDA that accept the same language by empty stack.	CO4	L2
18	Obtain PDA to accept all strings generated by the language, $L=\{a^n b^m a^n \ ! \ m, n \geq 1\}$.	CO4	L4

19	Define Pushdown automata. Differentiate PDA by empty stack and final state by giving their definitions.	CO4	L3
20	Construct PDA for the language L ={ wcw^R | w ∈ {a,b}* }, where R stands for reverse string.	CO4	L2
21	Let G be a CFG and its language is L(G). How do you decide that L(G) is finite?	CO4	L3
22	Construct PDA for the following language:- L = { $a^n c b^{2n}$! n ≥1}	CO4	L4
23	Consider following PDA:- M= ({ q_0 },{0,1},{a,b, Z_0 }, δ, q_0, Z_0, Ø) Where, δ is defined as following:- $\delta(q_0,0, Z_0) = (q_0, aZ_0)$ $\delta(q_0,1, Z_0) = (q_0, bZ_0)$ $\delta(q_0,0, a) = (q_0, aa)$ $\delta(q_0, 1, b) = (q_1, bb)$ $\delta(q_0, 0, b) = (q_0, \varepsilon)$ $\delta(q_0,1, a) = (q_0, \varepsilon)$ $\delta(q_0, \varepsilon, Z_0) = (q_0, \varepsilon)$ Convert this PDA into corresponding CFG.	CO4	L3
24	Prove that language recognized by final state PDA is also recognized by empty stack PDA and vice-versa i.e. L(M) = N(M).	CO4	L4
25	Construct PDA for the following language L = { $a^n b^m c^m d^n$! m, n ≥1}.	CO4	L3

Unit-5

Q. No.	Question	CO	Bloom's level
	Section-A		
1	What do you mean by basic Turing Machine Model?	CO5	L1
2	What do you understand by the Halting Problem?	CO5	L3
3	What are the features of Universal Turing Machine?	CO5	L3
4	Define the languages generated by Turing machine.	CO5	L4
5	Define the Turing Machine.	CO5	L3
6	What do you mean by Turing decidable language?	CO5	L2
7	What do you mean by Turing acceptable language?	CO5	L1
8	Define Multitape TM.	CO5	L2
9	What do you mean by Turing computable function?	CO5	L2
10	Find the TM for language L = $\{a^l b^m c^n \; ! \; l, m, n \geq 1\}$.	CO5	L2
	Section-B	CO5	
11	Explain in detail about Turing Church's Thesis and Recursively Enumerable languages.	CO5	L3
12	Write short notes on the following:- (a) Turing Machine as Computer of Integer Functions. (b) Universal Turing Machine	CO5	L2
13	Design the Turing Machine for the following language L=$\{a^n b^n c^n \; ! \; n \geq 1\}$.	CO5	L4
14	Write short note on: i) Recursive Language and Recursively Enumerable Language. ii) PCP problem and Modified PCP Problem	CO5	L2
15	Design a TM for the following language: L = $\{ a^{n+2} b^n \mid n > 0 \}$	CO5	L2
16	Design a TM to recognize all strings consisting of an odd number of α's.	CO5	L2
17	Prove that the halting problem is undecidable.	CO5	L2
18	Prove that single tape machines can simulate multi tape machines.	CO5	L4
19	Write short notes on the following: (a) Halting Problem (b) Turing Church's Thesis (c) Recursively Enumerable languages.	CO5	L3
20	What is Chomsky hierarchy? Explain post correspondence problem.	CO5	L2
21	Construct a Turing machine which accepts the regular expression, L = $\{0^n 1^n \; ! \; n \geq 1\}$.	CO5	L3
22	Construct Turing Machine for the language, L = =$\{wcw \mid w \in \{a,b\}^* \}$	CO5	L4
23	Construct a Turing Machine for the integer function that computes addition of two integers, i.e. f(x,y) = x+y.	CO5	L2
24	Define the recursive language. Do you agree that every recursive language is recursive enumerable? Justify your answer.	CO5	L3
25	Design a TM that can compute proper subtraction function, it is defined as	CO5	L4

	f(m,n) = m-n , if m > n = 0 , otherwise		
26	State True or False with reason:- (a) Every language described by Regular Expression can be recognized by DFA. (b) Every Recursive Enumerable Language can be generated by CFL. (c) The Halting Problem of TM is decidable. (d) Complement of recursive enumerable language is also recursive enumerable language. (e) Every CFL can be recognized by TM.	CO5	L2
27	Let A = {1, 110, 0111} and B = {111, 001, 11}. Find the solution of PCP.	CO5	L4
28	Find any three solutions of the lists X= (b, bab^3, ba) and Y = (b^3, ba, a).	CO5	L2
29	Explain Modified Post Corresponding Problem. Does the following Post Corresponding Problem have a solution? A= (101, 100, 10, 0, 010), B = (10, 01, 0, 100, 1)	CO5	L3
30	Design a Turing machine to calculate function f(m,n)=m*n , where m and n are integers.	CO5	L4