**United College of Engineering & Research, Prayagraj**

**Department of Computer Science & Engineering**

**Question Bank**

**Automata Theory and Formal Languages (KCS-402)**

**Unit-1**

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| **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 L1 = ε, L2 = {a}, L3 = Ø. Compute L1 L2\* U L3\* . | 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 |
| 19 | Design FA for ternary number divisible by 5. | CO1 | L2 |
| 20 | Construct a minimum state DFA from given FA | CO1 | L2 |
| 21 | Compute the epsilon-closure for the given NFA. Convert it into DFA. | CO1 | L2 |
| 22 | Convert the following NFA with epsilon into DFA | CO1 | L2 |
| 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 L1 be some language over ∑ and L2 = Ø. Then prove that  (a) L1.L2 ≠ L1  (b) L1+L2 ≠ Ø | CO1 | L2 |
| 26 | Construct a DFA accepting all strings over alphabet set ∑ = {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 = { an bm ! 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 = {an bm cl ! m, n, l ≥2 | CO1 | L4 |

**Unit-2**

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| **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 Σ = {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 = {am bn ! m >1, n >2 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={anbn ! n ≥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={ap ! 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={0n ! n is perfect square}  (b) The set of strings of form **0i1j** 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**

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| **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 = {a2nbn |n ≥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= { an bn |n ≥ 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 = {0m1n | m ≠ n & m, n ≥ 1}  ii) L = {al bmcn | l + m = n & l,m ≥ 1} | CO3 | L2 |
| 15 | Prove that the following Language L = {anbncn } 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 = { ai bj cj ! i, j ≥ 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🡪ABa, A🡪aab, B🡪Ac | CO3 | L2 |
| 24 | Consider the following grammar:-  S🡪A1B, A🡪0A/ ε, B🡪0B/1B/ ε  Find leftmost and rightmost derivation of strings 00101. | CO3 | L3 |
| 25 | Show that following grammar is ambiguous :-  E🡪I, E🡪E+E, E🡪E\*E, E🡪(E), I🡪a/b/c. | CO3 | L4 |
| 26 | Find context free grammar for the following languages with (n, m, k ≥ 0 );-  (a) L= {anbnck ! k ≥ 3}  (b) L={ambnck ! n=m or m ≤ 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🡪AB/AC, A🡪aAb/bAa/a, B🡪 bbA/aaB/AB,  C🡪abCa/aDb, D🡪bD/aC | CO3 | L4 |
| 29 | Convert the following CFG into equivalent Greibach Normal Form:  S🡪AA, A🡪SS, S🡪a, A🡪b | CO3 | L2 |
| 30 | Prove that the languages L1 and L2 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**

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| **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 = {anbm ! m,n > 0}. | CO4 | L2 |
| 9 | Can we make Deterministic Pushdown Automata for the language L={wwR | w{a,b}\* }? Justify. | CO4 | L2 |
| 10 | Is the power of PDA and DPDA equal? Justify. | CO4 | L2 |
|  | **Section-B** |  |  |
| 11 | Convert the grammar S🡪aAA, A🡪a|aS|bS to a PDA that accepts the language by empty stack. | CO4 | L3 |
| 12 | Design a PDA for the following language: L = {ai bj ck | i = j or j = k} | CO4 | L2 |
| 13 | Design a PDA for the Language L ={wwR | w{a,b}\* } | CO4 | L4 |
| 14 | Generate CFG for the given PDA M which is defined as  M = ({q0, q1}, {0,1} {x, z0}, δ, q0, z0, q1)  Where, δ is given as follows:  δ (q0,1, z0) = (q0, xz0)  δ (q0,1, x) = (q0, xx)  δ (q0,0, x) = (q0, x)  δ (q0, ε, x) = (q1, ε)  δ (q1, ε, x) = (q1, ε)  δ (q1,0, x) = (q1, xx)  δ (q1,0, z0) = ( q1, ε) | CO4 | L2 |
| 15 | Construct PDA to accept language, L= {0n1n | n > 0}. | CO4 | L2 |
| 16 | Construct a PDA from the following CFG.  G = ({S, X}, {a, b}, P, S)  where the productions are –  S → XS | ε , A → aXb | Ab | ab | CO4 | L2 |
| 17 | Consider the CFG ({S, A, B} {a, b}, P, S), where productions P are as follows:  S🡪aABB/ aAA,  A🡪aBB/a,  B🡪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={an bm an ! m, n ≥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 ={wcwR | 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 = {ancb2n ! n ≥1} | CO4 | L4 |
| 23 | Consider following PDA:-  M= ( {q0},{0,1},{a,b,Z0}, δ,q0,Z0, Ø )  Where, δ is defined as following:-  δ (q0,0, Z0) = (q0, aZ0)  δ (q0,1, Z0) = (q0, bZ0)  δ (q0,0, a) = (q0, aa)  δ (q0, 1, b) = (q1, bb)  δ (q0, 0, b) = (q0, ε)  δ (q0,1, a) = (q0, ε)  δ (q0, ε, Z0) = ( q0, ε)  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 = {anbmcmdn ! m, n ≥1}. | CO4 | L3 |

**Unit-5**

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| **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 = {al bm cn ! l, m, n ≥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={anbncn ! n≥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 = { an+2bn | 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 = {0n1n ! n ≥1}. | CO5 | L3 |
| 22 | Construct Turing Machine for the language,  L = ={wcw | w{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  f(m,n) = m-n , if m > n  = 0 , otherwise | CO5 | L4 |
| 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, bab3, ba) and Y = (b3, 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 |