GUJARAT TECHNOLOGICAL UNIVERSITY

BE-6 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:

THEORY OF COMPUTATION (3160704)

Unit 1: Review of Mathematical Theory

Repeated Questions:

1. Write and explain the principle of mathematical induction using example. (S22 - Q1b, 04 marks) & Write Principle of Mathematical Induction. And prove for every n≥1, Σ_{i=1}^{n} 1/(i(i+1)) = n/(n+1). (W23 - Q1c, 07 marks) & Write the Strong Principle of Mathematical Induction and prove that for any integer n≥2, n is either a prime or a product of two or more primes. (S25 - Q1b, 07 marks) & Prove "There must be a prime number between n and n!" (W22 - Q1b, 04 marks)

Other Important Questions:

1. Say whether the statement (p∧(p→q))→q is tautology or contradiction. (W23 - Q1a, 03 marks)
2. The given relation R on set A={1,2,3} determine whether the Relation is reflexive, symmetric or transitive, give reason. R={(1,1),(1,2),(2,1),(2,2),(3,2),(3,3)} (W23 - Q1b, 04 marks)
3. Define: Set, Subset, Complement. (S22 - Q1a, 03 marks)
4. Differentiate between constructive proofs and proofs using contradiction with examples. (S25 - Q1a, 07 marks)
5. Let f be a function from the set A={1,2,3,4} to B={p,q,r,s} such that, f={(1,p)(2,p)(3,q)(4,s)}. Is f^{-1} a function? (S23 - Q1a, 03 marks)
6. L is defined recursively as follows: 1. ϵ∈L 2. ∀x∈L, both 0x and 0x1 are in L. Prove that: For every n>=0, every x belongs to L obtained by n applications of rule 2 is an element of L. (S23 - Q1b, 04 marks)
7. Suppose A and B are sets, f = A→B and g = B→A. If f(g(y)) = y for every y∈B, then f is a function and g is a function. Give reasons for your answers. (S24 - Q1a, 03 marks)
8. Given three statements p, q and r. p: a=1, q: b=0, r: c=3. Write the following statements symbolically, using p,q,r,∀,∧,¬ and → only. 1. Either a=1 or b≠0. 2. b=0, but neither a=1 nor c=3. (S24 - Q1b, 04 marks)
9. Define the following functions: one-one, on-to, and inverse. (W22 - Q1a, 03 marks)

Unit 2: Regular Languages and Finite Automata

Repeated Questions:

1. Draw Finite automata for following regular expression: (i). (0+1)*(1+00)(0+1)* (ii). (111+100)* 0 (S22 - Q1c, 07 marks) & Construct a Finite Automata that accepts all strings over {0,1}* NOT containing the sub-string 101. (S25 - Q3a, 07 marks)
2. Find a regular expression corresponding to each of the following subsets of {0,1}* (i). the language of all strings that do not end with 01 (ii). the language of all strings that begin with or end with 00 or 11 (S22 - Q2b, 04 marks) & Find a regular expression of following subsets of {0,1}* 1. The language of all strings that begin or end with 00 or 11. 2. The language of all strings ending with 1 and not containing 00. (W23 - Q2b, 04 marks)
3. Prove Kleene's theorem part-1 (S22 - Q2c, 07 marks) & Write Kleen's Theorem part -1. (W23 - Q4c, 07 marks)
4. Explain procedure to minimize finite automata (S22 - Q2c OR, 07 marks) & Find minimum state FA for following figure. [Figure given - refer Question paper of W23] (W23 - Q3c OR, 07 marks)
5. Write regular expressions for the following. (i) Binary numbers that are multiple of 2. (ii) Strings of a's and b's with no consecutive a's. (iii) Strings of a's and b's containing consecutive a's. (W24 - Q1b, 04 marks) & Construct the regular expressions for the following languages. L1 = {Where the no. of 'a' is odd}, Σ={a,b} L2 = {Where every string starts with '0' and of even length}, Σ={0,1} (W22 - Q3b, 04 marks)
6. Construct a DFA for the language over {0,1}* such that it contains "000" as a substring. (W24 - Q1c, 07 marks) & Construct a Finite Automata that accepts all strings containing 010 or 111 as substring only. [CONTINUE]
   [CONTINUE from Unit 2, next question]
7. Apply the subset construction technique and draw the FA accepting the same language represented by given NFA. [Figure/Table likely given] (S25 - Q2c, 07 marks) & Convert NFA-∧ to FA for following figure. [Figure/Table given - refer Question paper of W23] (W23 - Q3c, 07 marks) & Convert the given NFA in Table-1 and convert it to FA and identify the language. q0 is the initial state and q1 is the accepting state. [Table given - refer Question paper of S23] (S23 - Q2c OR, 07 marks) & Apply the rules and convert the given NFA-λ to FA. [Figure given - refer Question paper of S24] (S24 - Q2c, 07 marks) & Define the steps to convert ϵ-NFA into NFA. Then convert the following ϵ-NFA into NFA. [Figure given - refer Question paper of W22] (W22 - Q2c OR, 07 marks)

Other Important Questions:

1. Explain Regular language & Regular expressions. (S22 - Q2a, 03 marks)
2. Define FA and Write recursive definition of NFA. (W23 - Q2a, 03 marks)
3. Draw Finite Automata to accept following over input alphabets Σ={0,1} (i) The language accepting strings not ending with '01'. (ii) The language accepting strings not containing substring '00'. (W23 - Q2c, 07 marks)
4. Let M1 and M2 be the FAs pictured in Figure, recognizing languages L1 and L2 respectively. Draw FAs recognizing the following languages. a. L1 U L2 b. L1 - L2. [Figures given - refer Question paper of W23] (W23 - Q2c OR, 07 marks)
5. Define mealy machine. Design a mealy machine that gives output 'x' if input of sequence is abb, otherwise z. (W23 - Q3b, 04 marks)
6. Convert the given Moore machine into Mealy machine. Draw state transition diagram of Mealy machine. [Table given - refer Question paper of W23] (W23 - Q3b OR, 04 marks)
7. Explain the importance of distinguishable strings and equivalent classes' w.r.t. regular languages. (S25 - Q1c, 07 marks)
8. Define Pushdown Automata. (S25 - Q2a, 03 marks)
9. Explain the idea of Finite State Machines with examples. (S25 - Q2b, 04 marks)
10. Convert the given regular expression to its equivalent NFA-λ. r = 1 + (101)* 0 + 01(01)* + 11(101)* + 00(11)* (S25 - Q2c OR, 07 marks)
11. Given two languages L1 and L2, defined as: L1 = {x| all x start with aba} L2 = {x| all x ends

in bb}. Write the regular expression for both the languages and construct FAs M1 and M2 such that M1 accepts L1 and M2 accepts L2. Derive L1 ∩ L2. (S23 - Q2c, 07 marks)

12. Draw NFA lambda for the given regular expression: (0)*(00+11)*(001)(01+10). (S23 - Q3a, 07 marks)
13. Find the ∧-closure of a set of states for each state of the given NFA lambda in Figure-1. [Figure given - refer Question paper of S23] (S23 - Q3a OR, 07 marks)
14. Define: Grammar. (S23 - Q2a, 03 marks)
15. What are similarities and differences between Moore machines and Mealy machines? (S23 - Q2b, 04 marks)
16. Discuss "Distinguishability" of one string from another and explain how it affects the number of states in an FA. Considering the example of L={a,b}*{aba}, how do the distinguishable strings in L relate to the number of states in its FA? (S23 - Q1c, 07 marks)
17. Discuss pumping lemma for regular languages. (S24 - Q1c, 07 marks)
18. Prove by pumping lemma, that the language 0^n1^n is not regular. (W24 - Q2c, 07 marks)
19. Define ϵ-closure(q) with an example. (W24 - Q2a, 03 marks)
20. State the difference between NFA and DFA. (W24 - Q2b, 04 marks)
21. Write down 5-tuple definition for the finite automata. Construct the minimal finite automata over Σ={a,b} for the following languages. L1 = {Where all the strings start and ends with different symbol} L2 = {Where every string has odd occurrences of "ba"}. (W22 - Q1c, 07 marks)
22. Enlist types of grammars, types of languages and types of automata. (W22 - Q2a, 03 marks)
23. Define pumping lemma for regular language. Show that the language L = {a^n b^n c^a / n>=1} is non-regular using pumping lemma theory. (W22 - Q2b, 04 marks)
24. Construct the Moore machine that counts the no. of occurrences of substring "bba" over Σ={a,b}. Now convert this Moore machine into Mealy machine. Show the transition table and transition diagram for both the machines. (W22 - Q2c, 07 marks)
25. Define a Moore machine. (S24 - Q2b, 04 marks)
26. Draw the NFA-λ for r = (0)11* + (101)* 0 and also construct the equivalent NFA and FA for the same. (S24 - Q2c OR, 07 marks)

Unit 3: Context Free Grammar (CFG)

Repeated Questions:

1. Define Context free grammar & context free language. (S22 - Q3a, 03 marks) & Define type 2 grammar with example. (W22 - Q3a, 03 marks)
2. Write CFG for following (i) L = {a^i b^j c^k | i=j or j=k} (ii) L = {a^i b^j c^k | j>i+k} (S22 - Q3b, 04 marks) & Find context-free grammar for the language: L = {a^i b^j c^k | i = j + k}. (W23 - Q3a, 03 marks) & Construct the CFG for the language L = {x ∈ {0,1}* | n_0(x) ≠ n_1(x)}. (S25 - Q3c, 07 marks) & Construct a CFG for set of strings that contain equal number of a's and b's over Σ={a,b}. (W24 - Q4a, 03 marks)
3. Convert following CFG to CNF: S -> S(S)/∧ (S22 - Q3c, 07 marks) & Convert the following grammar to CNF. S→ ABA A→ aA|ϵ B→ bB|ϵ (S23 - Q3c, 07 marks) & Apply the rules and show step by step conversion of the following grammar to CNF. S→ ASA|aB A→ B|S B→ b|ϵ (S24 - Q3c, 07 marks) & Show the steps to convert CFG into CNF. Convert the following CFG into equivalent CNF. S→ TU T→ 0T1|ϵ U→ 1U0|ϵ (W22 - Q3c OR, 07 marks) & Given the context-free grammar G, find a CFG G' in Chomsky Normal Form. S→ AaA|CA|BaB A→ aaBa|DC B→ bb|aS C→ Ca|bC|D D→ bb|A. (W23 - Q4c OR, 07 marks)
4. Define Regular grammar and give example. (S22 - Q3a OR, 03 marks) & Define grammar and Chomsky hierarchy. (W23 - Q5a OR, 03 marks) & Discuss the Chomsky hierarchy. (S25 - Q5b, 04 marks)
5. Explain types of derivation and ambiguity. (S22 - Q3b OR, 04 marks) & Define Ambiguous grammar. for following grammar say whether the grammar is ambiguous or not. give reason S→ ABA A→ aA|Λ B→ bb|Λ (W23 - Q3a OR, 03 marks) & Is the following grammar ambiguous? 1. E→ E+E|E*E|id 2. E→ E+E|E*E|(E)a Justify your answer. (W24 - Q2c OR, 07 marks)
6. Convert following CFG to CNF: S->aX/Yb X->S/∧ Y->bY/b (S22 - Q3c OR, 07 marks) & Convert the following grammar into CNF S→ cBA, S→ A, A→ cB, A→ AbbS, B→ aaa. (W24 - Q4c, 07 marks)

Other Important Questions:

1. Show what languages are generated by the given context free grammar in each case. 1. S→ aSb|bSa|... 2. S→ SS|bS|aλ. (S25 - Q3b, 04 marks)
2. Show that the language pal of palindrome is not regular. (S25 - Q4a, 03 marks)
3. Find CFG generating the language of even-length strings in {a,b}* with the two middle symbols equal. (S25 - Q4b, 04 marks)
4. Apply the rules and show step by step conversion of the following grammar to CNF. S→ ABCBCDA A→ CD B→ Cb C→ a|λ D→ bD|λ. (S25 - Q4c, 07 marks)
5. Explain unambiguous grammar with an example of converting ambiguous grammar to unambiguous. (S25 - Q4b OR, 04 marks)
6. Given two languages L1 and L2 defined over Σ={a,b}*, L1 accepts palindrome strings and L2 accepts strings with equal number of 0's and 1's. Which one of these languages is regular? Give reasons. (S24 - Q3a, 03 marks)
7. If a regular expression is given as (001)*(01+10). Apply the rules to construct a regular grammar for this language. (S24 - Q3c, 07 marks)
8. Define Chomsky Normal Form of grammar. (S24 - Q2a, 03 marks)
9. What is chomsky normal form? Explain with an example. (W24 - Q4b, 04 marks)
10. Convert the following grammar G in greibach normal form. [Incomplete in source] (W24 - Q4c OR, 07 marks)
11. Construct the regular expressions for the following languages. L1 = {Where every string starts with 'b' and does not contain 2 consecutive a's}, Σ={a,b} L2 = {Where every string starts with '1' and of odd length}, Σ={0,1}. (W22 - Q3b, 04 marks)

Unit 4: Pushdown Automata, CFL And NCFL

Repeated Questions:

1. What is a pushdown automaton? Explain. (S22 - Q4a, 03 marks) & Define Push Down Automata. (W23 - Q4a OR, 03 marks) & State the definition of Pushdown automata. (W24 - Q3a, 03 marks) & Define PDA. State whether a PDA can accept a CFL or not. (S23 - Q4a, 03 marks) & Define DPDA with clear definition of δ (transition function). (S24 - Q4a, 03 marks)
2. Explain the pumping lemma for context free languages. (S22 - Q4a OR, 03 marks) & State pumping lemma for context free language. (W23 - Q4a, 03 marks) & State and prove the pumping lemma for CFL. What is its main application? Give an example. (W24 - Q3a OR, 03 marks) & Define pumping lemma for context free language. Show that the language L = {ww / w ∈ {a,b}*} is not context free language using pumping lemma theory. (W22 - Q4b, 04 marks) & Apply pumping lemma to show that the language L = {a^n b^n c^n | n ≥ 0} is not context free. (S24 - Q3b, 04 marks)
3. Design and draw deterministic PDA Accepting "Balance string of brackets". (S22 - Q4c, 07 marks) & Draw a TM for the Language of strings with balanced parenthesis "(" and ")" only. (S23 - Q4c OR, 07 marks)
4. Explain conversion from PDA to CFG. (S22 - Q4b OR, 04 marks) & Show how, if a pushdown automaton recognizes some language, then it is context free. (S24 - Q3b, 04 marks)
5. Design and draw PDA to accept string with more a's than b's. (S22 - Q4c OR, 07 marks) & Construct PDA for L = {ww^R | w∈(a+b)*}. (W24 - Q3c, 07 marks) & Design a PDA to accept L = {xcy | x,y∈(a,b)* a d |x| = |y|}. (W23 - Q5b, 04 marks)

Other Important Questions:

1. Construct PDA for S→0AB A→1A|1 B→0B|1A|0. Trace the string 01011 using PDA. (W23 - Q4b, 04 marks)
2. Using kleene's Theorem Draw NFA-Λ for a given RE aa(ba)*+b*aba*. (W23 - Q4b OR, 04 marks)
3. Explain deterministic pushdown automata. (S22 - Q4a OR, 03 marks)
4. Give the difference between top down and bottom up parsing. (S22 - Q4b, 04 marks)
5. Apply Ogden's Lemma. (S25 - Q4a OR, 03 marks)
6. Discuss the decision problems involving CFL. (S25 - Q4b OR, 04 marks)
7. Explain Non-CFLs? Give at-least two examples of non-CFLs. (S23 - Q3b OR, 04 marks)
8. Discuss the closure properties of CFLs. (S23 - Q4b, 04 marks)
9. For the given Turing Machine in Table-2, trace the transition for the strings 1011 and 10101 and identify the language recognized by this TM. [Table given - refer Question paper of S23] (S23 - Q4c, 07 marks)
10. Compare NPDA with DPDA. (S23 - Q4a OR, 03 marks)
11. Show that if there are strings x and y in the language L so that x is a prefix of y and x≠y then no DPDA can accept L by empty stack. (S23 - Q4b OR, 04 marks)
12. Is NPDA (Nondeterministic PDA) and DPDA (Deterministic PDA) equivalent? Illustrate with an example. (W24 - Q3b, 04 marks)
13. Compare Deterministic PDA and Non deterministic PDA. (W24 - Q3b OR, 04 marks)
14. Is it true that non deterministic PDA is more powerful than that of deterministic PDA? Justify your answer. (W24 - Q3c OR, 07 marks)
15. Define the following operations for Push Down Automata: PUSH, POP, and SKIP. (W22 - Q4a, 03 marks)
16. What is Instantaneous Description? Construct the pushdown automata over Σ={a,b} for the language L = {a^n c^n / n>=1}. (W22 - Q3c, 07 marks)
17. Enlist closure properties for the context sensitive language. (W22 - Q4a OR, 03 marks)
18. The language of DPDA is called DCFL. Explain whether this statement is true or false. (S24 - Q4a OR, 03 marks)
19. Discuss intersection of CFLs with an example. (S24 - Q4b, 04 marks)
20. Discuss complement of CFLs with an example. (S24 - Q4b OR, 04 marks)
21. Design a PDA to accept L = {a^i b^j C^i | j = i + k}. [CONTINUE]

[CONTINUE from Unit 4, next question]

22. (Continued) (W23 - Q5b OR, 04 marks)

Unit 5: Turing Machine (TM)

Repeated Questions:

1. What is Turing machine? Explain its capabilities. (S22 - Q5a, 03 marks) & What is a Turing machine? (W24 - Q4a, 03 marks) & Define and explain the working of Turing Machines. (S25 - Q5c, 07 marks)
2. Explain Universal Turing machine (S22 - Q5b OR, 04 marks) & Explain Universal Turing Machine (W23 - Q5a, 03 marks) & Discuss universal turing machine with example. (W22 - Q4b OR, 04 marks)
3. Design a Turing machine to copy a string. (S22 - Q5c, 07 marks) & Construct a Turing machine to accept the strings x, x^{rev}. (S25 - Q4c OR, 07 marks) & Design a Turing machine to accept even palindrome over Σ={a,b}*. (S24 - Q4c OR, 07 marks)
4. Design a Turing Machine to accept palindromes over {a,b}*. (W23 - Q5c, 07 marks) & Develop a Turing Machine to accept the language L = {X / N_d(X) = N_b(X), X ∈ {a,b}*}. (W23 - Q5c OR, 07 marks) & Apply the rules and step by step create a Turing Machine to accept {a,b}*{aba}. (S25 - Q4c, 07 marks)

Other Important Questions:

1. Explain Church Turing thesis. (S22 - Q5b, 04 marks)
2. Explain Primitive Recursive Functions. (S22 - Q5a OR, 03 marks)
3. Design a Turing machine to delete a symbol. (S22 - Q5c OR, 07 marks)
4. Explain the halting problem? (S25 - Q5a, 03 marks)
5. Explain the difference between decidability and acceptability of a language with respect to TM? (S25 - Q5a OR, 03 marks)
6. Explain Context- Sensitive Grammars and give example of a context-sensitive language. (S25 - Q5b OR, 04 marks)
7. Discuss the summary of Church- Turing thesis. (S25 - Q5c OR, 07 marks)
8. When can we say that the language is decidable or undecidable? (S23 - Q5a, 03 marks)
9. Draw only the transition table of Turing Machine to accept the language L = {0^n1^n :where n≥1}. (S23 - Q5b, 04 marks)
10. Define: Bounded Minimalization and show that, if P is a primitive recursive (n+1) place predicate, its bounded minimalization mP is a primitive recursive function. (S23 - Q5c, 07 marks)
11. When can the language be called a recursive language or a recursively enumerable language? (S23 - Q5a OR, 03 marks)
12. Show that a Turing Machine to recognize the language L = L(0*1) can accept the string without moving the head in L direction. (S23 - Q5b OR, 04 marks)
13. Define: μ-Recursive functions and show how all computable functions are μ-recursive. (S23 - Q5c OR, 07 marks)
14. Design a Turing machine with no more than three states that accepts the language a(a+b)*. Assume Σ={a,b}. (W24 - Q4b, 04 marks)
15. When we say a problem is decidable? Give an example of an undecidable problem. (W24 - Q5a, 03 marks)
16. Mention the difference between P and NP problems. (W24 - Q5b, 04 marks)
17. Prove that for two recursive languages L1 and L2 their union and intersection is recursive. (W24 - Q5c, 07 marks)
18. What is a recursively enumerable language? (W24 - Q5a OR, 03 marks)
19. Mention the difference between decidable and undecidable problems. (W24 - Q5b OR, 04 marks)
20. Explain NP-complete problems with an example. (W24 - Q5c OR, 07 marks)
21. Enlist and explain the operations performed by tape in turing machine. (W22 - Q4a, 03 marks)
22. Write down 7-tuple definition for the turing machine. Construct the turing machine and its transition table over Σ={a,b} for the language L = {a^n b^n / n>=1}. (W22 - Q4c OR, 07 marks)

23. State the following functions: Partial, Constant and Total. (W22 - Q5a, 03 marks)
24. What is minimization? Explain with suitable example. (W22 - Q5b, 04 marks)
25. Discuss Post's Correspondence Problem with example. (W22 - Q5c, 07 marks)
26. Define the following terms: Recursive language, and Recursive Enumerable Language. (W22 - Q5a OR, 03 marks)
27. Explain in detail: Class P and Class NP. (W22 - Q5b OR, 04 marks)
28. Describe: Recursive function. Prove that every recursive function is computable. (W22 - Q5c OR, 07 marks)
29. Apply the rules and step by step create a Turing Machine to accept L = {a^n b^n}. (S24 - Q4c, 07 marks)
30. Explain the concept of undecidable problems. (S24 - Q5a, 03 marks)
31. Discuss multi-tape Turing machine. (S24 - Q5b, 04 marks)
32. Write a note on Primitive Recursive functions. (S24 - Q5c, 07 marks)
33. A language is decidable if and only if some nondeterministic Turing machine decides it. Explain the statement. (S24 - Q5a OR, 03 marks)
34. Regular languages and CFLs are both decidable and Turing-recognizable. Explain whether true or false. (S24 - Q5b OR, 04 marks)
35. Define and explain Bounded Quantification. (S24 - Q5c OR, 07 marks)

Unit 6: TM Definition, Model of Computation, Variations, and Hierarchy

(Topics: TM Definition, Model Of Computation, TM as Language Acceptor, Combining TM, Variations Of TM, Non Deterministic TM, Universal TM, Context-sensitive languages and Chomsky hierarchy)

Repeated Questions:

1. What is Turing machine? Explain its capabilities. (S22 - Q5a, 03 marks) & What is a Turing machine? (W24 - Q4a, 03 marks) & Define and explain the working of Turing Machines. (S25 - Q5c, 07 marks)
2. Explain Universal Turing machine (S22 - Q5b OR, 04 marks) & Explain Universal Turing Machine (W23 - Q5a, 03 marks) & Discuss universal turing machine with example. (W22 - Q4b OR, 04 marks)
3. Explain Church Turing thesis. (S22 - Q5b, 04 marks) & Discuss the summary of Church-Turing thesis. (S25 - Q5c OR, 07 marks)
4. Define grammar and Chomsky hierarchy. (W23 - Q5a OR, 03 marks) & Discuss the Chomsky hierarchy. (S25 - Q5b, 04 marks)

Other Important Questions:

1. Turing Machine as Language Acceptor: Apply the rules and step by step create a Turing Machine to accept {a,b}*{aba}. (S25 - Q4c, 07 marks) & Design a Turing Machine to accept palindromes over {a,b}*. (W23 - Q5c, 07 marks) & Develop a Turing Machine to accept the language L = {X / N_d(X) = N_b(X), X ∈ {a,b}*}. (W23 - Q5c OR, 07 marks) & Apply the rules and step by step create a Turing Machine to accept L = {a^n b^n}. (S24 - Q4c, 07 marks) & Construct a Turing machine to accept even palindrome over Σ={a,b}*. (S24 - Q4c OR, 07 marks)
2. Variations of TM: Discuss multi-tape Turing machine. (S24 - Q5b, 04 marks)
3. Context-sensitive languages: Explain Context- Sensitive Grammars and give example of a context-sensitive language. (S25 - Q5b OR, 04 marks)
4. TM Definitions & Operations: Enlist and explain the operations performed by tape in turing machine. (W22 - Q4a, 03 marks) & Write down 7-tuple definition for the turing machine. Construct the turing machine and its transition table over Σ={a,b} for the language L = {a^n b^n / n>=1}. (W22 - Q4c OR, 07 marks)
5. Combining/Designing TMs: Design a Turing machine to copy a string. (S22 - Q5c, 07 marks) & Construct a Turing machine to accept the strings x, x^{rev}. (S25 - Q4c OR, 07 marks) & Design a Turing machine with no more than three states that accepts the language a(a+b)*. Assume Σ={a,b}. (W24 - Q4b, 04 marks) & Design a Turing machine to delete a symbol. (S22 - Q5c OR, 07 marks)
6. For the given Turing Machine in Table-2, trace the transition for the strings 1011 and 10101 and identify the language recognized by this TM. [Table given - refer Question paper of S23] (S23 - Q4c, 07 marks)
7. Draw only the transition table of Turing Machine to accept the language L = {0^n1^n :where n≥1}. (S23 - Q5b, 04 marks)
8. Show that a Turing Machine to recognize the language L = L(0*1) can accept the string without moving the head in L direction. (S23 - Q5b OR, 04 marks)
9. Draw a TM for the Language of strings with balanced parenthesis "(" and ")" only. (S23 - Q4c OR, 07 marks)

Unit 7: Computable Functions and Undecidability

(Topics: Partial/Total/Constant Functions, Primitive Recursive Functions, μ-Recursive Functions, Undecidable Problems, Post's Correspondence Problem, Classes P and NP)

Repeated Questions:

1. Explain Primitive Recursive Functions. (S22 - Q5a OR, 03 marks) & Write a note on Primitive Recursive functions. (S24 - Q5c, 07 marks)
2. When we say a problem is decidable? Give an example of an undecidable problem. (W24 - Q5a, 03 marks) & When can we say that the language is decidable or undecidable? (S23 - Q5a, 03 marks) & Mention the difference between decidable and undecidable problems. (W24 - Q5b OR, 04 marks)
3. Mention the difference between P and NP problems. (W24 - Q5b, 04 marks) & Explain in detail: Class P and Class NP. (W22 - Q5b OR, 04 marks) & Explain NP-complete problems with an example. (W24 - Q5c OR, 07 marks)

Other Important Questions:

1. **Decidability & Undecidability:** Explain the halting problem? (S25 - Q5a, 03 marks) & Explain the concept of undecidable problems. (S24 - Q5a, 03 marks) & A language is decidable if and only if some nondeterministic Turing machine decides it. Explain the statement. (S24 - Q5a OR, 03 marks) & Regular languages and CFLs are both decidable and Turing-recognizable. Explain whether true or false. (S24 - Q5b OR, 04 marks) & Prove that for two recursive languages L1 and L2 their union and intersection is recursive. (W24 - Q5c, 07 marks)
2. **Recursive Languages:** When can the language be called a recursive language or a recursively enumerable language? (S23 - Q5a OR, 03 marks) & Define the following terms: Recursive language, and Recursive Enumerable Language. (W22 - Q5a OR, 03 marks) & Explain the difference between decidability and acceptability of a language with respect to TM? (S25 - Q5a OR, 03 marks)
3. **Primitive & μ-Recursive Functions:** Define: Bounded Minimalization and show that, if P is a primitive recursive (n+1) place predicate, its bounded minimalization mP is a primitive recursive function. (S23 - Q5c, 07 marks) & Define: μ-Recursive functions and show how all computable functions are μ-recursive. (S23 - Q5c OR, 07 marks) & Describe: Recursive function. Prove that every recursive function is computable. (W22 - Q5c OR, 07 marks)
4. **Function Types:** State the following functions: Partial, Constant and Total. (W22 - Q5a, 03 marks)
5. **Post's Correspondence Problem:** Discuss Post's Correspondence Problem with example. (W22 - Q5c, 07 marks)
6. **Minimization & Quantification:** What is minimization? Explain with suitable example. (W22 - Q5b, 04 marks) & Define and explain Bounded Quantification. (S24 - Q5c OR, 07 marks)
7. **Non-RE Languages & Undecidable Problems about TM:** Discuss the decision problems involving CFL. (S25 - Q4b OR, 04 marks) *[Note: This falls under "Undecidable Problems Involving Context-Free Languages"]*
8. **What is a recursively enumerable language?** (W24 - Q5a OR, 03 marks)

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