30. (a) Design PDA for the language $L=\{a^{n+1}b^n / n\geq 1$ by using empty stack and final state method also solve find — 12 | 3 | 3
    i) Transition function
    ii) PDA tuples
    iii) Trace the string for n=2

(OR)

(b) Convert the PDA P=({P, Q},{0, 1}, {x, z_0}, delta, q_0, z_0, ϕ) to a CFG if delta is given by

$\delta(q_0, 0, z_0) = (q_0, x\ z_0)$
$\delta(q_1, 1, x) = (q_1, \varepsilon)$
$\delta(q_0, 0, x) = (q_0, xx)$
$\delta(q_1, \varepsilon, x) = (q_1, \varepsilon)$
$\delta(q_0, 1, x) = (q_1, \varepsilon)$
$\delta(q_1, \varepsilon, z_0) = (q_1, \varepsilon)$

31. (a) Design a Turing machine to check whether a string over {a, b} contains equal number of a's and b's. Also verify the string "w = baab" accepted or not. — 12 | 3 | 4

(OR)

(b) Design a Turing machine to compute multiplication of two unary numbers. Also simulate the working of machine for 3 * 2.

32. (a) i) Explain post correspondence problem with an example. — 12 | 1 | 5
    ii) Prove that the halting problem of a Turing machine is unsolvable.

(OR)

(b) i) Explain Rice theorem with an example.
    ii) Prove the theorem "union of two recursive languages L1 and L2 is also recursive.

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Reg. No | | | | | | | | | | | | | | | |

B.Tech. DEGREE EXAMINATION, JUNE 2023

Fifth Semester

18AIC303T - FORMAL LANGUAGES AND AUTOMATA THEORY

(For the candidates admitted during the academic year 2018-2019 to 2021-2022)

Note:

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40 minutes.
ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

Part - A (20 × 1 Marks = 20 Marks) — Marks | BL | CO

Answer **All** Questions

1. Select the language for the following description — 1 | 2 | 1
Set of all strings over alphabet {0,1}, such that number of 1's even and number 0's is a multiple of 3.
(A) L= {000, 11, 11000, 00011, 1111000, 0001111, 1111000000,..}
(B) L= {11, 1100, 011, 110000, 1110000,...}
(C) L= {0001, 1000, 111000, 111100,...}
(D) L= {00111, 111000, 111100, 1000000,...}

2. How many states will be needed for a DFA if the L={set of all strings that contains substring aabb} — 1 | 3 | 1
(A) 4
(B) 5
(C) 6
(D) 7

3. Choose the string accepted by the following DFA. — 1 | 3 | 1
(A) 111
(B) 011
(C) 010
(D) 1111

4. Given an arbitrary non-deterministic finite automata with N states, the maximum number of states in an equivalent minimised DFA is at least ---------- — 1 | 2 | 1
(A) N^2
(B) 2^N
(C) 2N
(D) N!

5. A polynomial time algorithm which constructs instances of a problem P2 from the instances of some other problem P1 is called as ------- — 1 | 2 | 5
(A) NP complete
(B) Np-hard
(C) P-time reduction
(D) NP

6. Write the regular expression for the following language. — 1 | 2 | 2
Set of all strings over alphabet {1} having odd length of strings.
(A) 1^*
(B) $1(11)^*$
(C) $(111)^*$
(D) 1^+

7. Find the regular expression of the language accepted by the following automata. — 1 | 3 | 2
(A) ab + cd . e^n
(B) (a +b) + (c+ d) . e^n
(C) (a .b) . (c+ d) . e^n
(D) (a +b) . (c+ d) . e

8. Choose the wrong statement from the following. — 1 | 1 | 2
(A) $R^* R^* = R^*$
(B) R + R =R
(C) $(1+0)^* = (0^* 1^*)^*$
(D) $1 + 1^* = 1^+$

9. Which one is not a regular language? — 1 | 2 | 2
(A) L={ $a^n b^n$ | n<=1}
(B) L={ $a^n b^n c^m$ | n,m<=1}
(C) L={p^n| p is a even number}
(D) L={ $a^i b^j$ | i=2j}

10. Which of the following is/are true for recursively enumerable language? 1 3 5
(A) partially decidable (B) Turing decidable
(C) Turing Recognisable (D) partially Acceptable

11. Equivalent CFG notation for the transition function $\delta(q_1, a, A) = (q_2, \varepsilon)$ 1 3 3
(A) $[q_1, A, q_2] \rightarrow a[q_1, A, q_2]$ (B) $[q_1, A, q_2] \rightarrow a$
(C) $[q_1, A, q_2] \rightarrow \varepsilon$ (D) $[q_2, A, q_1] \rightarrow a$

12. Push down machine represents--------- 1 1 3
(A) Type 0 grammar (B) Type 1 grammar
(C) Type 2 grammar (D) Type 3 grammar

13. If G = ({S}, {a}, {S -> SS), S), then language generated by G is 1 3 3
(A) L (G) = φ (B) $L(G) = a^n$
(C) L (G) = a* (D) $L(G) = a^n b a^n$

14. Which of the following string is not generated by the given grammar : S -> SaSbS | ε 1 3 3
(A) aabb (B) abab
(C) abaabb (D) baaa

15. Which among the following options are correct? 1 3 5
1.Every Turing decidable language is Turing Acceptable
2.Every Turing acceptable language need not be Turing decidable
(A) 1 and 2, both are correct (B) 1 is correct but 2 is false
(C) 2 is correct while 1 is false (D) 1 and 2, both are false

16. Identify the language accepted by the given Turing Machine? 1 4 4
(A) Strings of odd number of 0's (B) Strings starting with 00
(C) Strings ending with 00 (D) Strings with 00 as substring

17. Find the output if the string 11111 is given as input to the following Turing Machine? 1 4 4
(A) 011111 (B) 111111
(C) 100000 (D) 111110

18. A Turing machine operates over-------- 1 1 4
(A) finite memory tape (B) infinite memory tape
(C) depends on the algorithm (D) none of the mentioned

19. The ability for a system of instructions to simulate a Turing Machine is called _____ 1 2 4
(A) Turing Completeness (B) Simulation
(C) Turing Halting (D) None of the mentioned

20. If a language L and its complement L' are recursively enumerable then L is ---------- 1 2 5
(A) Recursive language (B) Recursively Enumerable language
(C) Universal language (D) Diagonal Language

Part - B (5 × 4 Marks = 20 Marks) Marks BL CO
Answer **any 5** Questions

21. Construct DFA that accepts the language over {a,b} where L(D) ={w | w contains all strings that start and end with same symbol } and also write formal Tuple representation of the DFA diagram. 4 3 1

22. Construct a DFA with sigma $\sum$ = {a, b}, accepts those strings which has even number of "a" and even number of "b". 4 3 1

23. Show that the following grammar is ambiguous by showing (a) two parse trees (b) two leftmost derivations. 4 3 2
S -> a | abSb | aAb
A -> bS | aAAb

24. Write the regular expressions for the following 4 3 2
a. Identifiers in C programming language
b. Strings over {0,1} with even number of 1's.

25. Construct push down automata for the following languages. Acceptance either by empty stack or by final state.**(Transition diagram)** 4 3 3
$L = \{ 0^p 1^q 2^r \mid p, q, r \in N, p+q=r \}$

26. Design the Turing machine to implement the function operation f(m,n)=m+n. Design the transition function prove with accepted string. 4 1 4

27. If both a language L and its complement are RE, then L is recursive. Prove it. 4 2 5

Part - C (5 × 12 Marks = 60 Marks) Marks BL CO
Answer **All** Questions

28. Consider the following ε -NFA and answer the questions. 12 3 1
i) Computer ε-closure of each state
ii) Convert the automata to a DFA
iii) Find the language accepted by the DFA

	a	b	c	ε
→p	ϕ	{q}	{r}	{q, r}
q	{p}	{r}	{p, q}	ϕ
*r	ϕ	ϕ	ϕ	ϕ

(OR)

(b) Construct NFA with ε which access a language consisting of a string of any number of 'a' followed by any number of 'b' and followed by any number ' c '. Convert the NFA with ε to NFA without ε.
i) Find ε-reachable states from the current states
ii) Computed δ' transitions
iii) Develop Transition table and Find the final states.

29. (a) Begin with the Grammar 12 3 2
S -> ASB | epsilon
A -> aAS | a
B -> SbS |A | bb
a) Are there any useless symbols? Eliminate them.
b) Eliminate - productions
c) Put the grammar into CNF

(OR)

(b) Consider the grammar G = (V, S, R, S), where
V = {a, b, S, A},
S = {a, b},
R = { S -> AA,
A -> AAA,
A -> a,
A -> bA,
A -> Ab }.
(a) Which strings of L(G) can be produced by derivations of four or fewer steps?
(b) Give at least four distinct derivations for the string babbab.
(c) For any m, n, p > 0, describe a derivation in G of the string $b^m a b^n a b^p$.