Name of the Student..Tanish..... Scholar Number..2311201229

MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY BHOPAL
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

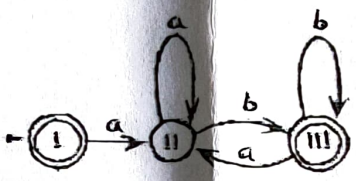
EXAMINATION: END TERM **MONTH and YEAR: MAY 2025**

Course: B.Tech. **Semester: 4th** **Subject Code: CSE 223**
Subject Name: Theory of Computation **Maximum Marks: 50**
Duration: 03:00 Hour **Date:** 14/05/2025 **Time:** 8:00 AM to 11:00 AM

Note: *Attempt all the questions. All questions carries equal marks.*

1 (a) Construct DFA for the following Language: **04** **CO1**
L = {w | w ∈ {a, b}*, w starts with 'a' and has even length or w starts with 'b' and has odd length}

(b) Consider following NFA that accepts language L. **04**



Let L_1 be the language accepted by the same NFA by interchanging accepting and non-accepting states. Find L (Informally English language statement) and Clearly describe language $L \cap L_1$.

(c) Show that $L = \{a^n b^m \mid n \neq m\}$ is non regular using pumping lemma. **02**

2 (a) Consider the following context free grammar over alphabet {a, b, c} **04** **CO1**

G_1: $S \rightarrow aSc \mid A$
$A \rightarrow bA \mid \in$

G_2: $S \rightarrow Sc \mid A$
$A \rightarrow Ab \mid B$
$B \rightarrow aB \mid \in$

The language generated by Grammar G_1 and G_2 are $L(G_1)$ and $L(G_2)$ respectively. Find the languages $L_1 = L(G_1) \cup L(G_2)$, $L_2 = L(G_1) \cap L(G_2)$ and $L_3 = L(G_1) - L(G_2)$ Also find and justify the type of language L_1, L_2 and L_3 from the set = {Regular, CFL but not Regular, CSL but not CFL}.

(b) Consider the following language L: **04**
$L = \{uww^r v \mid u, v, w \in \{0, 1\}^+, w^r$ is reverse of w}
Find whether L is regular or not. If yes then construct finite automata or regular expression for it. Otherwise find the category of L and construct suitable automata/machine to recognize it.

3 (a) Find the Context Free Grammar for the following languages: **04** **CO2**
(i) L = {w | w ∈ {a,b}* and each suffix of w has at least as many a's as b's}
(ii) $L = \{ w \mid w \in \{a,b\}^* \text{ and } \frac{n_a(w)}{2} \leq n_b(w) \leq \frac{3\, n_a(w)}{2} \}$

(b) Show that if L is a DCFL, then there is a DPDA accepting the language **04**
$L_1 = \{w_1 \# w_2 \mid w_1 \in L$ and $w_1 w_2 \in L\}$ where # is a symbol that does not occur in any string of L.

4 (a) Construct PDA for the following Language L **04** **CO2**
$L = \{w_1 \# w_2 \mid w_1, w_2 \in \{a,b\}^*$ and either w_2 contains suffix as w_1^r or w_1 contains prefix as $w_2^r\}$

(b) Construct PDA equivalent to the following grammar G({S, A, B, C}, {a, b}, S, P) **04** **CO3**
$S \rightarrow bS / Aa$
$A \rightarrow Ca / B$
$B \rightarrow aA / Cb$
$C \rightarrow Sb / \epsilon$

5 (a) Consider the following PDA $\mathbf{M = (\{q_0, q_1, q_2, q_3, q_f\}, \{0, 1, 2\}, \{0, 1, z\}, \delta, q_0, \{q_f\})}$ with the following transitions: **04** **CO3**

$\delta(q_0, a, z) = \{(q_0, AZ)\}, \delta(q_0, a, A) = \{(q_0, AA)\},$
$\delta(q_0, b, A) = \{(q_1, \epsilon)\}, \delta(q_1, b, A) = \{(q_1, \epsilon)\}$
$\delta(q_1, b, Z) = \{(q_1, BZ)\}, \delta(q_1, b, B) = \{(q_1, BB)\},$
$\delta(q_1, c, B) = \{(q_2, \epsilon)\}, \delta(q_1, c, A) = \{(q_2, AA)\},$
$\delta(q_2, c, B) = \{(q_2, \epsilon)\}, \delta(q_2, c, Z) = \{(q_2, AZ)\},$
$\delta(q_2, c, A) = \{(q_2, AA)\}, \delta(q_2, d, A) = \{(q_3, \epsilon)\},$
$\delta(q_3, d, A) = \{(q_3, \epsilon)\}, \delta(q_3, \epsilon, Z) = \{(q_f, Z)\}$

Where Z indicate bottom marker of the stack. Find and justify the language accepted by the above PDA.

(b) Let L_1 and L_2 are two recursive languages. So that $L_1 \cup L_2$ and $L_1.L_2$ are also recursive. **04** **CO4**

6 (a) Construct Turing Machine for the following Language L **04** **CO4**
$L = \{a^n x^m b^n y^m c^n \mid m, n \geq 1\}$

(b) Consider the following Turing Machine for Language $L = \{a^n b^m a^n b^m \mid m, n \geq 1\}$. There are some transitions missing in TM on the places 1 to 5. Find all the missing transitions. (Note: Any location may have multiple missing transitions; B represents Blank symbol and head of TM initially points to B) **04** **CO4**