

1. Construct the Push down automata that accepts the following language and show the steps for accepting the string aabbbbccc using instantaneous descriptions.

$$L = \{a^i b^j c^k \mid \min(i, j) \leq k\}$$

(5 marks)

2. a. Convert the following grammar to Chomsky Normal Form. Show the step-by-step procedure.

$$\begin{aligned} S &\rightarrow abAB \\ A &\rightarrow bAB \mid \epsilon \\ B &\rightarrow BAa \mid A \mid \epsilon \end{aligned}$$

(4 marks)

- 2b. State the advantages of converting a grammar to Chomsky Normal Form

(1 mark)

3. Consider the following Turing Machine M with input alphabet $\{a, b\}$, blank symbol B . Rest of the components of the TM can be inferred from the following transition table.

	B	X	a	b
$\rightarrow q_0$	(q2, B, L)	(q0, X, R)	(q0, a, R)	(q1, X, L)
q1		(q1, X, L)	(q0, X, R)	
q2	(q3, B, R)	(q2, X, L)		
*q3				

- (i) By giving trace (sequence of IDs) find whether **ababab** is in the $L(M)$ or not.
 (ii) By giving trace (sequence of IDs) find whether **aaabbbba** is in the $L(M)$ or not.
 (5 marks)

4. Prove or disprove the following statements (Your answer should be a mathematically valid one).

(i) $(A \leq_m B \text{ and } B \text{ is a regular language}) \Rightarrow A \text{ is a regular language.}$

(ii) The language $\{ \langle M \rangle \mid M \text{ is a Turing Machine and } L(M) \text{ is a regular language} \}$ is a decidable language.
 (5 marks)