REG.NO.: 24BDS0093

SLOT: D2+TD2

VIT

Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
FALL SEMESTER 2025-2026

Programme Name & Branch	: BTECH – CSE & Business Systems
Course Code and Course Name	: CBS2002: Formal Languages and Automata Theory
Faculty Name(s)	: Dr. Lakshmanan K., Dr. Saravanan R.
Class Number(s)	: VL2025260104778, 3280
Date of Examination	: 08/10/2025 (Forenoon)
Exam Duration	: 90 minutes

Formal Language and Automata Theory

Maximum Marks: 50

General instruction(s):

- Answer All Questions
- The empty string / null string is denoted Λ or λ or ε.

Q. No	Question	Mod.	Marks	CO	BL
1.	a. Show that the following grammar is ambiguous. (3 marks) $S \rightarrow AB \mid aaaB$, $A \rightarrow a \mid Aa$, $B \rightarrow b$. b. Convert the following grammar into CNF (Chomsky Normal Form). $S \rightarrow ASB$ $A \rightarrow aAS \mid a \mid \varepsilon$ $B \rightarrow SbS \mid A \mid bb$ (7 marks)	3	10	CO4	2
2.	Converting the following context-free grammar into equivalent GNF. $S \rightarrow AB / RR$, $R \rightarrow r / SR$, $A \rightarrow a$, $B \rightarrow b$.	3	10	CO4	3
3.	Consider the language $L_b = \{a^{2n}b^{2m}c^n \mid n,m \geq 0\}$. The objective is to construct a pda (pushdown automata) for this language and below are the partial transition rules. The main idea of the construction is to push a 0 in the stack whenever two a's are read in the input tape. q_1 can be assumed an intermediate state change which helps to do this. The 0's in the stack need to be matched/cancelled aganist when the corresponding the letter of _ is read in the input tape (guess which alphabet is from the language and the occurrences of other letter can be ignored as if not present in the string; however that letter need to be checked whether present in even occurrences). You are expected to fill-out the remaining rules which are left unattempted (denoted with - in the rules) and complete the rules such that the constructed pda will accept the given language L_b. FYI, the transition function δ of the PDA is defined as: $\delta : Q \times \Sigma \cup \{\varepsilon\} \times \Gamma \longrightarrow$ finite subset of $Q \times \Gamma^*$. You are allowed to use only one (new) additional state which is q_f, the final state. **Write only incomplete rules 2,4,5,6,7,8 for answering the question. Also, given the input strings *aabbc* and *aabbcc* just mention the pda will halt/stuck at which state(s)?** (no ID - instantaneous Description required). Note that ε or equivalently λ denotes the empty string and z is the start symbol. q_3/q_0 means either q_3 state or q_0 state. 1. $\delta(q_0,a,z) = (q_1,z)$ 2. $\delta(q_1,a,-) = (q_0,0z)$ 3. $\delta(q_0,a,0) = (q_1,0)$ 4. $\delta(q_1,a,0) = (q_0,0-)$ 5. $\delta(q_0,b,0) = (q_2,-)$ 6. $\delta(q_2,b,-) = (-,-)$ 7. $\delta(q_0,c,0) = (q_3,-)$ 8. $\delta(q_3,c,-) = (-,\varepsilon)$ 9. $\delta(q_3/q_0,\varepsilon,z) = (q_f,z)$	3	10	CO4	3

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4.	a. Differentiate PDA with LBA in terms of working functionality and memory in the following tabular form only (3 bullet points; 3 marks) b. Construct a Linear Bounded Automata that accepts the language L = {wcw: w ∈ {0,1}*, c is a median symbol}. Describe the idea of your construction in maximum four bullet points. (7 marks)	4	10	CO4	3
5.	Consider the language $L_b = \{w \in \{a,b\}^* \mid \|w\|_a = \|w\|_b\}$, where $\|w\|_\gamma$ tells that the number of occurrences of symbol γ in the word w. The objective is to construct a Turing Machine (TM as acceptor) for this language and below are the partial transition rules for the Turing Machine. The idea of the construction is the following. The TM needs to match for every a, whether there is a matching b and vice versa. Whenever one (unmatched) a is read, it is encoded with X and the state changes to q_1 and the job of q_1 is to find the matching first b on the right and replace it with Y. Likewise, whenever one unmatched b is read, it is encoded with Y and the state changes to q_2 and the job of q_2 is to find the unmatched first a on the right and to replace it with X. The TM comes leftmost until the Blank space (denoted with B) with the state q_3 and then moves right to find the next unmatched a or b symbol and repeat this process. The R and L in the rules indicate the direction of the TM read/write head to move right or left. Similarly, X/Y means either X or Y. The final state is q_f. Your task is to identify the suitable symbol(s) to be present in – or ? in the transition rules. 1. $\delta(q_0,a) = (q_1,-,R)$ 2. $\delta(q_1,a) = (q_1,a,R)$ 3. $\delta(q_1,-) = (q_1,-,R)$ 4. $\delta(q_1,b) = (q_3,Y,L)$ 5. $\delta(q_0,b) = (q_2,-,R)$ 6. $\delta(q_2,b) = (q_2,b,R)$ 7. $\delta(q_{2,})= (q_2,-,R)$ 8. $\delta(q_{2,})= (q_3,X,L)$ 9. $\delta(q_3,\sigma) = (q_3,\sigma,L), \sigma \in \{?\}$ 10. $\delta(q_3,B) = (-,B,R)$ 11. $\delta(q_0,X/Y) = (q_o,X/Y,-)$ 12. $\delta(q_0,-) = (q_f,-,R)$ When there is more occurrences of b than a what will be state and the symbol the TM will read and halt (in a non-final state)?	5	10	CO4	2

Sl. No.	PDA	LBA
1.		
2.		
3.		