Reg. No: 24BBS0160

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: CBS2002 - Formal Languages and Automata Theory

Class NBR(s): 3282 | Slot: D1+TD1

Time: Three Hours | Max. Marks: 100

KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Demonstrate the knowledge of mathematical models of computation and describe how they relate to formal languages.
CO2	Derive an appropriate model of computation for a given language and vice versa.
CO3	Infer the equivalence of languages described using different automata or grammars.
CO4	Distinguish the computability power of automata and their limitations

Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

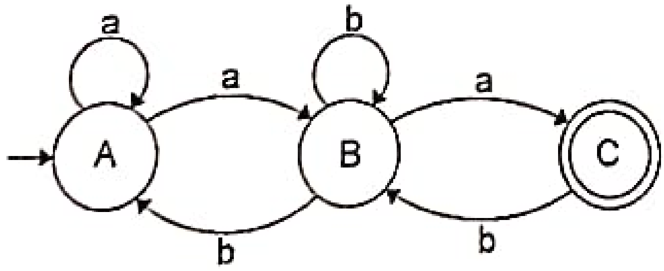
1. a) Write a note on Chomsky hierarchy. Explain with diagram, and suitable examples. Mention the corresponding automaton. [6+4] CO1 BL1

   b) Write a grammar that accept all strings of balanced parentheses.

2. Design a deterministic finite automaton over the alphabet $\Sigma = \{0,1,2,3,\cdots,9\}$ that models ATM Personal Identification Numbers (PINs) with the following requirements: CO1 BL5

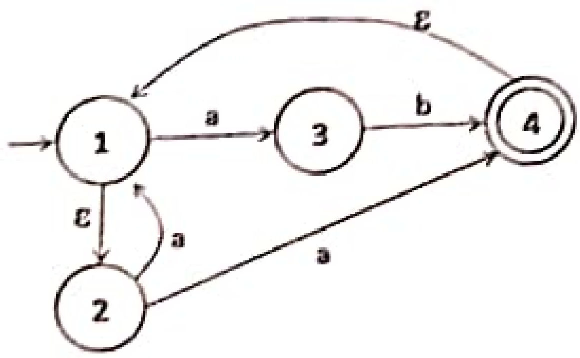
   i. A valid PIN is exactly 4 digits long (no shorter, no longer).
   ii. A valid PIN may start with 0 (i.e., leading zeros allowed).
   iii. Additionally the PIN must not be any of the following:
      (a) All four digits identical (e.g. 0000, 1111, ..., 9999).
      (b) Four strictly consecutive increasing digits (e.g. 0123, 1234, ..., 6789).

3. a) Obtain the regular expression for the following deterministic finite automaton using Arden's theorem. [5+5] CO2 BL6



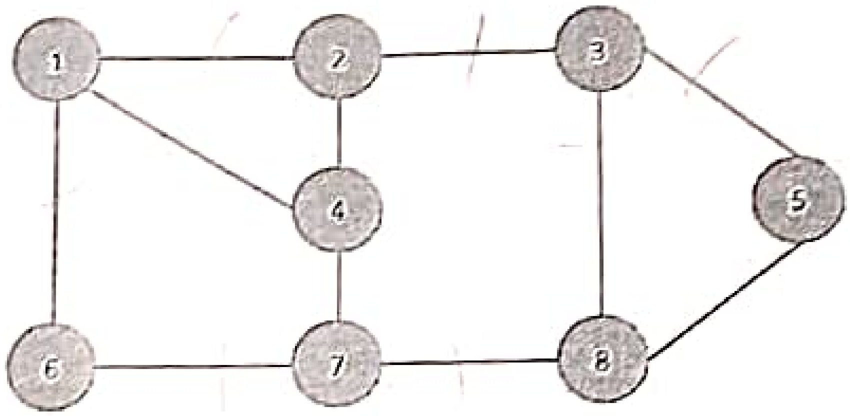
   b) Prove or disprove that the language $L = \{bab^R \mid b, a \in \{0,1\}^*\}$ is regular. Use pumping lemma to support your answer.

4. Convert the following non deterministic finite automaton with null moves to equivalent deterministic finite automaton. CO2 BL5



5. Design a recursive function $Exp(x, y)$ for computing x^y and hence compute $Exp(4,3)$. CO4 BL6

6. Define vertex cover problem. Show that the vertex cover problem is NP complete. Justify by using the following graph. CO4 BL3



7. Design a linear bounded automata to accept the language $L=\{a^n b^n c^n \mid n \geq 1\}$. Verify the design considering the string $w = aaabbbccc$ CO3 BL4

8. Design a pushdown automaton to accept the language $L=\{a^n b^m c^m d^n \mid m \geq 1, n \geq 0\}$, by final state. Verify the design considering the string $w = a^2bcd^2$. CO3 BL6

9.a) Design a Turing machine for the following language, where $N_a(w)$ refers to number of a's in w. Verify the construction by considering even and odd cases as examples. CO3 BL6

$$L=\{w \in \{a,b\}^* \mid n_a(w) \bmod 3 = 2 \text{ and } n_b(w) \bmod 2 = 1\}$$

OR

9.b) Design a Turing machine for multiplying two positive unary numbers. Verify the construction considering the multiplication of 3 and 4. C

10.a) Determine whether the string $w = 110011$ is in the language generated by the context free grammar $G = (V_N, T, P, Q_0)$ with productions $Q_0 \rightarrow AB$, $A \rightarrow BB \mid 0$ and $B \rightarrow BA \mid 1$. Use CYK algorithm to support your answer. C

OR

10.b) Construct a context free grammar $G = (V_N, T, P, Q_0)$ generating the language $(L_1 \cup L_2)$, where C(

$L_1 = \{a^{n+2} b^m \mid n \geq 0 \text{ and } m > n\}$ and

$L_2 = \{w^R 2w \mid w \in \{0,1\}^*, w^R$ is the reverse of w}.

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