



Final Assessment Test – May 2024

Course: BCSE304L - Theory of Computation
Class NBR(s): 0760/0763/0766/0768/0771/0774/
0784/0789/0797/0845/0861/1014/1015/1026/
1029/1036/1037/1042/1043/1045/1047/1049/
1051

Slot: B2+TB2

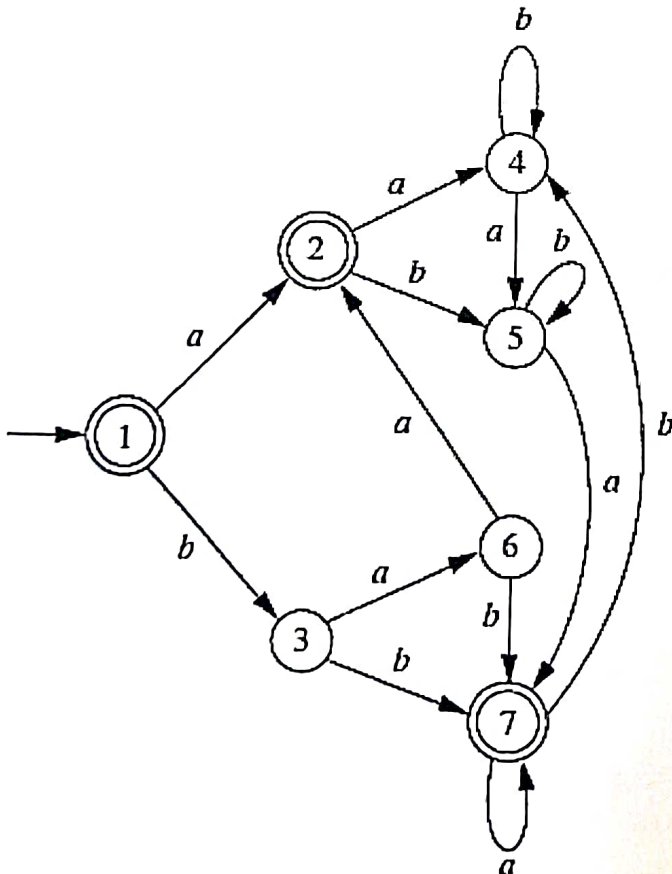
Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. a) Construct a Context Free Grammar for the following languages: [6]
 - i) $L = \{ a^m b^n \mid n = 2m, m, n \geq 1 \}$
 - ii) $L = \{ a^n b^m c^k \mid k = |n-m|, n, m \geq 1 \}$
- b) Use induction on n to show that $|u^n| = n |u|$ for all strings u and all n . [4]
2. a) Construct NFA over the alphabet $\Sigma = \{a, b\}$ which accepts all strings whose length is divisible by 5. [5]
- b) For the constructed NFA in Question 2a, construct an equivalent DFA. [5]
3. Construct a Minimized DFA using Table Filling Method



4. Consider the regular expression

$$R = (aa)^* + ba^* + (ab)^*$$

a) Construct an NFA for the above regular expression. [5]

b) Construct a regular grammar G, for the language generated by the regular expression $aa^* (ab/a)^*$. [5]

5. Construct a DFA for the following language over $\{a,b\}$.

$$L = \{w \mid w \text{ does not contain substring } aa \text{ or } bb\}.$$

From the obtained DFA, use any appropriate method and derive the corresponding regular expression.

6. Determine whether the string $w = \text{He eats a fish with a fork}$ is in the language generated by the given grammar G, using the CYK algorithm.

$$G = \{$$

$$S \rightarrow NP VP$$

$$VP \rightarrow VP PP \mid V NP \mid \text{eats}$$

$$PP \rightarrow P NP$$

$$NP \rightarrow \text{Det } N \mid \text{He}$$

$$V \rightarrow \text{eats}$$

$$P \rightarrow \text{with}$$

$$N \rightarrow \text{fish} \mid \text{fork}$$

$$\text{Det} \rightarrow a$$

}

7. a) Find an equivalent grammar in CNF for the given grammar. [6]

$$G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow ASB \mid \epsilon, A \rightarrow aAS \mid a, B \rightarrow SbS \mid A \mid bb\}, S)$$

b) Check whether the following grammar is ambiguous or not. Show the derivation steps. K is the start symbol. [4]

$$K \rightarrow QK \mid \epsilon, Q \rightarrow Qa \mid aQb \mid ab$$

8. Construct a Pushdown Automata (PDA) that accepts the language $L = \{a^n b^{m+n} c^m : n \geq 0, m \geq 1\}$ by empty stack method. Give the Instantaneous description for the string $aaabbbbcc$.

9. Design a Turing Machine transducer that takes the input $w \in \{a,b\}^*$ and produces a copy of it as an output. For example, if $w=aba$, then the output will be $abaaba$.

10. a) For an Universal Turing machine, obtain the code for $\langle M, 1010 \rangle$ where [6]

$M = (\{q_1, q_2, q_3\}, \{0,1\}, \{0, 1, B\}, \delta, q, B, \{q_2\})$ have moves

$$\delta(q_1, 1) = (q_3, 0, R)$$

$$\delta(q_3, 0) = (q_1, 1, R)$$

$$\delta(q_3, 1) = (q_2, 0, R)$$

$$\delta(q_3, B) = (q_3, 1, L)$$

b) Does PCP with two lists $x=\{b, bab^3, ba\}$ and $y=\{b^3, ba, a\}$ have a solution? Justify. [4]

11. Construct a Turing machine that will accept the language $L = \{a^n b^m a^{n+m} : n \geq 0, m \geq 1\}$ over the alphabet $\Sigma = \{a, b\}$.

12. a) Discuss recursive languages and recursively enumerable languages. [4]

b) Let G_1 be any unrestricted grammar, and G_2 be any regular grammar. Show that the problem $L(G_1) \cap L(G_2) = \emptyset$ is undecidable. [6]

