| Duration: 60 minutes | Class Id: ..... |
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| Assessors' name and signature | Proctors' name and signature | Total score |
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**Test Id: 1** **(This test consists of 10 questions)**

**Note:** ***No document is allowed.***

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**Questions with one correct answer**

**Question 1.** Let $\Sigma = \{0, 1, \ldots, 9\}$. Which of the following languages is not regular?

- ☐ $0 \cup \{1\}\Sigma^* \cap \Sigma^*\{0, 2\}$
- ☐ $\{0, 1\}^*$
- ☐ $0 \cup \{1, 2, \ldots, 9\}\Sigma^*$
- ☐ $\{0^n 1^n : n \geq 0\}$

**Question 2.** Which of the following languages is a finite language?

- ☐ $0 \cup \{1.2, \ldots, 9\}^*$
- ☐ $\{0, 1\}^*$
- ☐ $\{0^n 1^n : 1 \leq n \leq 10\}$
- ☐ $\{0^n 1^n : n \geq 0\}$

**Question 3.** Let $G = (V. \Sigma, R, S)$ be a context-free grammar, where $V = \{S, E, N, D\}$, $\Sigma = \{0, 1, \ldots, 9, (,), *, +\}$ and $R$ consists of the rules:

$$S \longrightarrow E$$
$$E \longrightarrow E + E \mid E * E \mid (E) \mid N$$
$$N \longrightarrow N\ D \mid D$$
$$D \longrightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9$$

Which of the following strings is generated by $G$?

- ☐ $2 * 3 * 4 - 5$
- ☐ $0 + 01 * 2$
- ☐ $00 + 1 * 2+$
- ☐ $x := y + z$

**Question 4.** Let $M$ be the deterministic finite automaton $(Q, \Sigma, \delta, q_0. F)$, where $Q = \{q_0, q_1\}, \Sigma = \{a, b\}, F = \{q_0\}$ and $\delta(q_0, a) = q_0$, $\delta(q_0, b) = q_1$. $\delta(q_1, a) = q_1$. $\delta(q_1, b) = q_0$. Which of following strings is accepted by $M$?

- ☐ $baaa$
- ☐ $abbab$
- ☐ $\varepsilon$
- ☐ $aabba$

**Question 5.** Consider the pushdown automaton $M = (Q, \Sigma, \Gamma, \delta, q_0, F)$, $Q = \{s, f\}$, $\Sigma = \{a, b\}$, $\Gamma = \{a\}$ and $\delta$ contains the five transitions: $((s, a, \varepsilon), (s, a))$, $((s, b. \varepsilon), (s, a))$, $((s, a, \varepsilon), (f, \varepsilon))$, $((f, a, a), (f, \varepsilon))$, $((f, b, a), (f, \varepsilon))$. Which of the following strings is accepted by $M$?

- ☐ $aaa$
- ☐ $baa$
- ☐ $aba$
- ☐ $abb$

**Question 6.** Consider the Turing machine $M = (Q, \Sigma, \delta, q, \{h\})$, $\Sigma = \{a, b, \sqcup, \triangleright\}$. Which of the following pairs is a configuration of $M$?

- ☐ $(q, \triangleright \underline{\sqcup} baa)$
- ☐ $(q, \triangleright \underline{a} ba \sqcup \triangleright)$
- ☐ $(q, \sqcup \triangleright a \sqcup \underline{b}a)$
- ☐ $(h, \triangleright \underline{a} ba \sqcup)$

## Constructed-response questions

**Question 7.** Draw the state diagram for a nondeterministic finite automaton that accepts the language: $(ab)^*(ba)^* \cup bb$.

**Question 8.** Give the regular expression generating the language $L = \{ab, ba, aa\}^*$.

**Question 9.** Let $G = (V, \Sigma, R, S)$ be a context-free grammar, where $V = \{S, A\}$, $\Sigma = \{a, b\}$ and $R$ consists of the rules $S \to AA$, $A \to a$, $A \to b$, $A \to aA$ and $A \to bA$. Identify $L(G)$.

**Question 10.** Consider the Turing machine $M = (Q, \Sigma, \delta, s, H)$, where $Q = \{q_0, q_1, h\}$, $\Sigma = \{a, \sqcup, \triangleright\}$, $s = q_0$, $H = \{h\}$ and $\delta(q_0, a) = (q_1, \sqcup)$, $\delta(q_0, \sqcup) = (h, \sqcup)$, $\delta(q_0, \triangleright) = (q_0, \rightarrow)$, $\delta(q_1, a) = (q_0, a)$, $\delta(q_1, \sqcup) = (q_0, \rightarrow)$, $\delta(q_1, \triangleright) = (q_1, \rightarrow)$. Trace the computation of $M$ starting from $(q_1, \triangleright \sqcup aaaa)$.