

WRITING TEST, Summer 2025 Course: Formal Languages and the Theory of Computation Course Id: CS3372, Duration: 60 minutes		Student name: Student Id: No. Class Id:
Assessors' name and signature	Proctors' name and signature	Total score

Test Id: 1 (This test consists of 10 questions)

Note: *No document is allowed.*

Questions with one correct answer

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

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

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

- | | |
|---|---|
| ☐ $0 \cup \{1, 2, \dots, 9\}^*$ | ☐ $\{0, 1\}^*$ |
| ☐ $\{0^n 1^n : 1 \leq n \leq 10\}$ | ☐ $\{0^n 1^n : n \geq 0\}$ |

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

$$\begin{aligned} S &\longrightarrow E \\ E &\longrightarrow E + E \mid E * E \mid (E) \mid N \\ N &\longrightarrow ND \mid D \\ D &\longrightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9 \end{aligned}$$

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 ?

- | | |
|-------------------------------------|----------------------------------|
| ☐ $baaa$ | ☐ $abbab$ |
| ☐ ϵ | ☐ $aabba$ |

Question 5. Consider the pushdown automaton $M = (Q, \Sigma, \Gamma, \delta, q_0, F)$, $Q = \{s, f\}$, $\Sigma = \{a, b\}$, $\Gamma = \{a\}$ and δ contains the five transitions: $((s, a, \epsilon), (s, a))$, $((s, b, \epsilon), (s, a))$, $((s, a, \epsilon), (f, \epsilon))$, $((f, a, a), (f, \epsilon))$, $((f, b, a), (f, \epsilon))$. 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 ?

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

Constructed-response questions

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

[illegible]

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

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.....

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 $S \rightarrow AA$, $A \rightarrow a$, $A \rightarrow b$, $A \rightarrow aA$ and $A \rightarrow bA$. Identify $L(G)$.

[illegible]

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 $(q_1, \triangleright \sqcup aaaa)$.

[illegible]

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Test Id: 2 (This test consists of 10 questions)

Note: No document is allowed.

Questions with one correct answer

Question 1. Let $\Sigma = \{0, 1, \dots, 9\}$ and let $\omega = 1^k 0^n$, $k > n > 0$. Which of the following languages does not contain ω ?

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

Question 2. Which of the following languages is not a finite language?

- | | |
|---|---|
| ☐ $0 \cup \{1, 2, \dots, 9\}^2$ | ☐ $\{0, 1\}^3$ |
| ☐ $\{0^n 1^n : 1 \leq n \leq 10\}$ | ☐ $\{0^n 1^n : n \geq 0\}$ |

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

$$\begin{aligned}
 S &\longrightarrow E \\
 E &\longrightarrow E + E \mid E * E \mid (E) \mid N \\
 N &\longrightarrow ND \mid D \\
 D &\longrightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9
 \end{aligned}$$

Which of the following strings is generated by G ?

- | | |
|--|---|
| ☐ $(09 * 01 * 3)$ | ☐ $(00 + 1) * 2 +$ |
| ☐ $2 * 3 * (4 - 5)$ | ☐ $x := (y + z)$ |

Question 4. Let M be the deterministic finite automaton $(Q, \Sigma, \delta, s, F)$, where $Q = \{s, f\}$, $\Sigma = \{0, 1\}$, $F = \{s\}$ and $\delta(s, 1) = s$, $\delta(s, 0) = f$, $\delta(f, 1) = f$, $\delta(f, 0) = s$. Which of following strings is accepted by M ?

- | | |
|-------------------------------------|--------------------------------|
| ☐ 0111 | ☐ 11001 |
| ☐ ϵ | ☐ 1000 |

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

- | | |
|--------------------------------|--------------------------------|
| ☐ aaa | ☐ abb |
| ☐ aba | ☐ bab |

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 ?

- | | |
|--|---|
| ☐ $(h, aba \sqcup \sqcup)$ | ☐ $(q, \triangleright aba \sqcup)$ |
| ☐ $(q, \triangleright \sqcup baa \sqcup)$ | ☐ $(q, \sqcup \triangleright a \sqcup ba)$ |

Constructed-response questions

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

[illegible]

Question 8. Give the regular expression representing the language $L = \{ba, b, bb, a\}^*$.

Question 9. Let $G = (V, \Sigma, R, S)$ be a context-free grammar, where $V = \{S, B\}$, $\Sigma = \{0, 1\}$ and R consists of the rules $S \rightarrow BBB$, $B \rightarrow 0$, $B \rightarrow 1$, $B \rightarrow B1$ and $B \rightarrow B0$. Identify $L(G)$.

[illegible]

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

[illegible]