COMP2210 CLASS TEST 2

Answers must be copied to the answer sheet or they will be ignored!
The test has 29 questions to complete in 45 minutes.
No documents allowed. The use of electronic calculators is forbidden.

We denote with $\mathbb{N}$ the set of natural numbers including 0.

**Question 1**  Is $\{a^nb^m \mid n, m \in \mathbb{N} \& n > m\} \cup \{a^nb^m \mid n, m \in \mathbb{N} \& n < m\}$ regular? (2pt)

- [ ] NO
- [B] YES

**Question 2**  Is $\{a^nb^m \mid n, m \in \mathbb{N} \& n > m\} \cup \{a^nb^m \mid n, m \in \mathbb{N} \& n \leq m\}$ regular? (2pt)

- [A] NO
- [ ] YES

**Question 3**  Is $\{a, b\}^* \setminus \{a^n b^n \mid n \in \mathbb{N} \& n > 0\}$ regular? (2pt)

- [ ] NO
- [B] YES

**Question 4**  Is there a regular language $L$ such that $L = L_1 \cup L_2$ where both $L_1$ and $L_2$ are not regular languages? (2pt)

- [B] NO

**Question 5**  Is $\{a^n b^n \mid n \in \mathbb{N} \& n > 0\} \cup L(a^*b^*)$ regular? (2pt)

- [B] NO

**Question 6**  Is $\{a^n b^{2m} \mid n, m \in \mathbb{N} \& n, m > 0\}$ regular? (2pt)

- [A] NO
- [ ] YES

A string of parentheses is balanced when each left parenthesis has a corresponding right parenthesis, and the pairs are well-nested. For example, $(O)(O)$ and $(O)O$ are balanced while $(O)$ and $O))$ are not. Consider the context-free grammar $G = (\{S\}, \{(),\}, P, S)$ where $P$ is defined as follows:

$$S \rightarrow (S) \mid SSSS \mid \epsilon$$

Answer the following 3 questions:

**Question 7**  Is $L(G)$ the set of all balanced parentheses? (2pt)

- [A] NO
- [B] YES

**Question 8**  Is $((O)(O))$ a sentence of $G$? (2pt)

- [A] NO
- [B] YES
Corrected

**Question 9**  Is the following a derivation of $G$? (2pt)

$$S \Rightarrow (S) \Rightarrow (SSSS) \Rightarrow ((S)SS) \Rightarrow ((S)(S)) \Rightarrow (((S))S) \Rightarrow (((S))(S)))$$

- A YES  
- NO

End of this group.

Let $M$ be the pushdown automaton defined below.

![Diagram of pushdown automaton](image)

Answer the following 4 questions:

**Question 10**  Is $\{ a^n b^m \mid m, n \in \mathbb{N} \& m > n \}$ the language of all strings accepted by $M$ by final state? (2pt)

- A YES  
- NO

**Question 11**  Is $\{ a^n b^m \mid m, n \in \mathbb{N} \& m \geq n \}$ the language of all strings accepted by $M$ by empty stack? (2pt)

- NO  
- B YES

**Question 12**  Is the following an accepting computation of $M$ by final state? (1pt)

$$(0, abb, \bot) \rightarrow (0, bb, a\bot) \rightarrow (1, b, \bot) \rightarrow (1, \epsilon, \bot) \rightarrow (2, \epsilon, \epsilon)$$

- A NO  
- YES

**Question 13**  Is the following an accepting computation of $M$ by empty stack? (1pt)

$$(0, abb, \bot) \rightarrow (0, bb, a\bot) \rightarrow (1, b, \bot) \rightarrow (1, \epsilon, \bot)$$

- NO  
- B YES

End of this group.

Let $G = \{N, \{a, b, c\}, P, S\}$ be the context-free grammar where $P$ is defined as follows:

$$S \rightarrow aSc \mid aA \mid B \quad A \rightarrow aAc \mid aA \mid \epsilon \mid C \quad B \rightarrow bBc \mid bC \quad C \rightarrow bCc \mid bC \mid \epsilon$$

Answer the following 2 questions:

**Question 14**  Is $L(G) = \{wc^n \mid n \in \mathbb{N} \& w \in L(a^*b^*) \& |w| > n\}$? (2pt)

- YES  
- NO
Corrected

**Question 15**  Is \( L(G) \subseteq \{a^nb^m c^k \mid m, n, k \in \mathbb{N} \) & \( k \neq n + m \}? \) (2pt)

[A] YES  [B] NO

End of this group.

**Question 16**  Is \( \{a^m b^n \mid n, m \in \mathbb{N} \) & \( n \geq m \} \cup \{a^m b^n \mid n, m \in \mathbb{N} \) & \( n \leq m \} \) regular? (2pt)

[A] NO  [B] YES

Let \( G = (N, \{a, b\}, P, S) \) be a context-free grammar with

\[ P = \{(S, ABC),(S, aBb),(A, B),(B, C),(C, \epsilon),(C, A)\} \]

Answer the following 5 questions:

**Question 17**  Is \( \{(S, ABC),(A, B),(B, C),(C, A)\} \) the set of all unit-production of \( G \)? (1pt)

[A] NO  [B] YES

**Question 18**  Is \( G \) in Greibach normal form? (1pt)

[A] NO  [B] YES

**Question 19**  Is \( \epsilon \) derivable from \( S \) in \( G \)? (1pt)

[A] NO  [B] YES

**Question 20**  Is \( B \) derivable from \( S \)? (1pt)

[A] NO  [B] YES

**Question 21**  Is \( \{a^n b^n \mid n \in \mathbb{N} \} \subseteq L(G) \)? (2pt)

[A] YES  [B] NO

End of this group.

Let \( L = \{a^{2n}b^{2n} \mid n \in \mathbb{N} \} \). Consider the demon game. Suppose that for any \( k > 0 \) picked by the demon, we pick \( x = a^k, y = a^k b^k \), and \( z = b^k \). Answer the following 3 questions.

For all \( u, v, w \) such that \( y = uvw \) and \( v \neq \epsilon \),

**Question 22**  is \( xuw^0wz \notin L \)? (2pt)

[A] NO  [B] YES

**Question 23**  is \( xuw^2wz \notin L \)? (2pt)

[A] NO  [B] YES
**Corrected**

**Question 24**  
is $xuv^2wz \notin L$? (2pt)

- **YES**
- **B NO**

End of this group.

**Question 25**  
Let $G$ be any context-free grammar in Chomsky normal form and in Greibach normal form. Is $L(G)$ regular? (2pt)

- **A NO**
- **B YES**

**Question 26**  
Is $\{a^n b^m c^k \mid m, n, k \in \mathbb{N} \& m, n, k > 0 \& m = n\} \cap \{a^n b^m c^k \mid m, n, k \in \mathbb{N} \& m, n, k > 0 \& n = k\}$ regular? (2pt)

- **A YES**
- **B NO**

Let $G = \{N, \{a, b, c\}, P, S\}$ be the context-free grammar with

$$P = \{(S, aSc), (S, S'), (S', bS'c), (S', S), (S', \epsilon)\}$$

Answer the following 3 questions:

**Question 27**  
Is $L(G) = \{wc^n \mid n \in \mathbb{N} \& w \in L(a+b)^* \& |w| = n\}$? (2pt)

- **YES**
- **B NO**

**Question 28**  
Is $\{a^n b^m c^k \mid m, n, k \in \mathbb{N} \& n + m = k\} \subseteq L(G)$? (2pt)

- **YES**
- **B NO**

**Question 29**  
Is $L(G) \subseteq \{a^n b^m c^k \mid m, n, k \in \mathbb{N} \& n + m = k\}$? (2pt)

- **A YES**
- **B NO**

End of this group.
Corrected

ANSWER SHEET

Enter your registration id on the left boxes and write your first name and last name below.

Firstname and lastname:

.....................

Answers must be given exclusively on this sheet: answers given on the other sheets will be ignored. Please fill completely with your pen the box of the answer you want to select (ticking it or crossing it is not enough).

Question 1: ■ B
Question 2: A ■
Question 3: ■ B
Question 4: ■ B
Question 5: ■ B
Question 6: A ■
Question 7: A ■
Question 8: A ■
Question 9: A ■
Question 10: A ■
Question 11: ■ B
Question 12: A ■
Question 13: ■ B
Question 14: ■ B
Question 15: ■ B
Question 16: A ■
Question 17: ■ B
Question 18: ■ B
Question 19: A ■
Question 20: A ■
Question 21: A ■
Question 22: ■ B
Question 23: A ■
Question 24: ■ B
Question 25: A ■
Question 26: A ■
Question 27: ■ B
Question 28: ■ B
Question 29: A ■