COMP2210 Theory of Computing CLASS TEST

Answers must be copied to the answer sheet or they will be ignored!

The test has 25 questions to complete in 45 minutes.

All questions have a single correct answer.

No documents allowed. The use of electronic calculators is forbidden.

Question 1  Let $\Sigma = \{0, 1, a, b, a\}$. What is the cardinality of $2^\Sigma$? (1pt)

A 32  B 16  C 8

Let $L_1 = \{a^n b^n | n \in \mathbb{N}\}$, and $\Sigma = \{a, b\}$. Answer Question 2 and Question 3:

Question 2  Is $L_1 \cup \Sigma^*$ regular? (1pt)

A NO  B YES

Question 3  Is $L_1^* \cap \emptyset$ regular? (1pt)

A NO  B YES

Let $M$ be the FA shown below over the alphabet $\Sigma$.

Answer from Question 4 to Question 7:

Question 4  Is $M$ an εNFA over any alphabets containing $a$ and $b$? (1pt)

B YES  A NO

Question 5  Is $L(M) = L((ab)^* + c)$? (1pt)

A NO  B YES

Question 6  Is $L(M) = L((ab)^*)$? (1pt)

B YES  A NO

Question 7  Is $M$ a DFA when $\Sigma = \{a, b, c\}$? (2pts)

A YES  B NO

Let $M$ be the DFA shown below.
Answer Question 8 and Question 9:

Question 8  Is there a path labeled $aabbabbaabab$ in $M$? (1pt)

- YES
- NO

Question 9  Is $aabb$ accepted by $M$? (1pt)

- NO
- YES

Let $M$ be the FA shown below, with set of final states $F$.

Answer from Question 10 to Question 13:

Question 10  For which set of final states $F$, $L(M) = \{a, b\}^*$? (2pts)

- $F = \{0, 2\}$
- $F = \{0, 1, 2, 3\}$
- $F = \emptyset$

Question 11  Is $M$ a DFA over the alphabet $\{a, b, c\}$? (2pts)

- YES
- NO

Question 12  Let $F = \{2\}$. Is $L(M)$ the set of all words in $\{a, b\}^*$ with an even number of $a$'s and an odd number of $b$'s? (2pts)

- NO
- YES

Question 13  For $F = \{1\}$, is $L(M)$ the set of all words in $\{a, b, c\}^*$ with an odd number of $a$'s and an even number of $b$'s? (2pts)

- YES
- NO
Let \( L = L(a^+ + b^+) \). Answer from Question 14 to Question 16:

**Question 14** Does \( aaabbb \) belong to \( L \)? (2pts)

- [ ] NO  
- [B] YES

**Question 15** Does \( aaa \) belong to \( L \)? (1pt)

- [A] NO  
- [ ] YES

**Question 16** Does \( aaabbb \) belong to \( LL \)? (2pts)

- [ ] YES  
- [B] NO

Let \( M \) be the FA shown below and \( Q = \{1, 2, 3\} \). For any \( X \subseteq Q \) and \( u, v \in Q \), we define \( a_{uv}^X \) to be a regular expression that describes all possible paths from \( u \) to \( v \) that start with \( u \), end with \( v \) and have all the intermediate states in \( X \).

![Diagram](attachment:Diagram.png)

Answer from Question 17 to Question 19:

**Question 17** Is \( a^*b^*a \) a regular expression for \( a_{0,2}^{(0,1,2)} \)? (3pts)

- [ ] NO  
- [B] YES

**Question 18** Is \( a^+ + \emptyset \) a regular expression for \( a_{0,2}^{\{0,2\}} \)? (1pt)

- [ ] YES  
- [B] NO

**Question 19** Is \( L(a^*(a + ba)) = L(M) \)? (2pts)

- [ ] YES  
- [B] NO

Let \( M \) be the NFA shown below over the alphabet \( \{a, b, c\} \), and \( M' \) be the DFA obtained by using the subset construction of \( M \).

![Diagram](attachment:Diagram2.png)

Answer from Question 20 to Question 22:

**Question 20** How many states does \( M' \) have? (2pts)

- [A] 4  
- [ ] 8  
- [C] 6  
- [D] 5  
- [E] 7
Question 21  How many reachable states does $M'$ have? (3pts)

A 6  B 5  C 4  D 8  E 7

Question 22  Is state $\{0, 1\}$ reachable in $M'$? (2pts)

A YES  B NO

Let $M$ be aNFA with initial state $s$ and the set of final states $F = \{f_1, f_2, f_3, f_4\}$ with $s \notin F$. Define $M'$ by adding to $M$ an $e$-move from $f_i$ to $s$, for any $i \in \{1, 2, 3, 4\}$. Furthermore, let $F'$ be the set of final states of $M'$. Answer from Question 23 to Question 25:

Question 23  Is $L(M') = L(M)^*$ when $F' = F$? (3pts)

A YES  B NO

Question 24  Is $L(M') = L(M)^*$ when $F' = \{s\}$? (3pts)

A YES  B NO

Question 25  Is $L(M') = L(M)^*$ when $F' = \{s\} \cup F$? (3pts)

A YES  B NO
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: A □ □ C
Question 2: A □
Question 3: A □
Question 4: □ B
Question 5: A □
Question 6: □ B
Question 7: A □
Question 8: □ B
Question 9: A □
Question 10: A □ □ C
Question 11: A □
Question 12: A □
Question 13: A □
Question 14: □ B
Question 15: A □
Question 16: □ B
Question 17: □ B
Question 18: □ B
Question 19: □ B
Question 20: A □ □ C □ D □ E
Question 21: A □ □ C □ D □ E
Question 22: A □
Question 23: A □
Question 24: A □
Question 25: A □