COMP2210 CLASS TEST 1

Answers must be copied to the answer sheet or they will be ignored!
The test has 17 questions to complete in 40 minutes.
The total number of marks available is 50.
No documents allowed. The use of electronic calculators is forbidden.

Let $L = L(a^* + b^*)$. Answer the following three questions:

**Question 1** Does $aaa$ belong to $L$? (2pts, -1pt)

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

**Question 2** Does $aaabb$ belong to $L$? (2pts, -1pt)

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

**Question 3** Does $bbbbaa$ belong to $L$? (2pts, -1pt)

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

Let $M$ be the NFA over the alphabet $\Sigma = \{a, b, c\}$ shown below

![NFA Diagram]

Answer the following three questions:

**Question 4** Which of the following is true? (4pts, -1pt)

- **A** $L(M)$ is the set of all words $w \in \Sigma^*$ such that $w$ has an odd number of $a$’s and an odd number of $b$’s.
- **B** $L(M)$ is the set of all words $w \in \Sigma^*$ such that $w$ has an odd number of $a$’s and an even number of $b$’s.
- **C** $L(M)$ is the set of all words $w \in \Sigma^*$ such that $w$ has an even number of $a$’s and an even number of $b$’s.
- **D** None of the other answers is correct.
- **E** $L(M)$ is the empty set.
Corrected

**Question 5** Let $M'$ be the DFA obtained from $M$ using the subset construction. How many reachable states does $M'$ have? (5pts, -1pt)

A 4  
B 9  
C 8  
D 5  
E None of the other answers is correct.  
F 16

**Question 6** Let $M'$ be the DFA obtained from $M$ using the subset construction. How many states does $M'$ have? (3pts, -1pt)

A None of the other answers is correct.  
B 16  
C 8  
D 5  
E 4  
F 9

**Question 7** Let $\Sigma = \{0, 1, 2\} \cap \{1, 2, a\}$. What is the cardinality of $2^\Sigma$? (3pts, -1pt)

A 16  
B 32  
C 4  
D 8

**Question 8** Let $M$ be the NFA over the alphabet $\Sigma = \{a, b, 0, 1, 2\}$ shown below

Which of the following is true? (5pts, -1pt)

A $L(M) = \Sigma^*$.  
B None of the other answers is correct.  
C $L(M) = L((a + b)^*)$.  
D $L(M) = \Sigma^* \setminus \{\epsilon\}$.  
E $L(M) = L((a + b)^*) \setminus \{\epsilon\}$.  
F $L(M) = \Sigma^* \setminus \{\epsilon\}$.
Question 9  Which of the following is true? (3pts, -1pt)

A  A language $L$ is regular if and only if there is no regular expression $\alpha$ such that $L(\alpha) = L$.

None of the other answers is correct.

C  A language $L$ is regular if and only if $L$ is not accepted by any NFA.

D  A language $L$ is regular if and only if $L$ is not accepted by any $\epsilon$NFA.

E  A language $L$ is regular if and only if $L$ is not accepted by any DFA.

Let $M$ be the NFA shown below with set of states $Q = \{0, 1, 2\}$. For any $X \subseteq Q$ and $u, v \in Q$, we define $\alpha^X_{u,v}$ to be a regular expression that describes the set of words of all paths from $u$ to $v$ that start with $u$, end with $v$ and have all the intermediate states in $X$, if any.

Answer the following four questions:

Question 10  Is $L(\alpha^{Q}_{2,2}) = \emptyset$? (2pts, -1pt)

A  NO  B  YES

Question 11  Is $aaaba \in L(\alpha^{\emptyset}_{0,1})$? (2pts, -1pt)

A  NO  B  YES

Question 12  Is $L(a^* (a + ba^* b)) = L(M)$ and $L(\alpha^{Q}_{0,2}) = L(M)$? (2pts, -1pt)

A  NO  B  YES

Question 13  Is $L(\alpha^{\{0,1,2\}}_{0,2}) = L(\alpha^{\{0,1\}}_{0,2})$? (2pts, -1pt)

A  YES  B  NO

Question 14  (4pts, -1pt) Let $\alpha = (a(cd)^* b)^*$. Which of the following is true?

A  $abab \in L(\alpha)$ and $acdbab \in L(\alpha)$ and $acdbedcadab \notin L(\alpha)$.

B  $abab \notin L(\alpha)$ and $acdbab \notin L(\alpha)$ and $acdbedcadab \notin L(\alpha)$.

C  $abab \in L(\alpha)$ and $acdbab \in L(\alpha)$ and $acdbedcadab \in L(\alpha)$.

D  None of the other answers is correct.

Let $M$ be an $\epsilon$NFA with initial state $s$ and set of final states $F$. Let $M'$ be the $\epsilon$NFA obtained from $M$ by adding an $\epsilon$-move from $f$ to $s$, for any $f \in F$. 

Let $M$ be the NFA shown below with set of states $Q = \{0, 1, 2\}$. For any $X \subseteq Q$ and $u, v \in Q$, we define $\alpha^X_{u,v}$ to be a regular expression that describes the set of words of all paths from $u$ to $v$ that start with $u$, end with $v$ and have all the intermediate states in $X$, if any.
Furthermore, let $F'$ be the set of final states of $M'$.

Answer the following three questions:

**Question 15**  
Is $L(M') = L(M)^*$ when $s \in F$ and $F' = \{s\}$? (3pts, -1pt)

A  NO  B  YES

**Question 16**  
Is $L(M') = L(M)^*$ when $F' = F \cup \{s\}$ and there is no path from $s$ to $s$ (of length greater or equal to 1) in $M$? (3pts, -1pt)

A  NO  B  YES

**Question 17**  
Is $L(M') = L(M)^*$ when $F' = F \setminus \{s\}$? (3pts, -1pt)

A  YES  B  NO
Please fill your student id on the left boxes and write your first name and last name below.

Firstname and lastame:

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

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: A ■
Question 4: A B C ■ E
Question 5: A B C ■ E F
Question 6: A ■ C D E F
Question 7: A B ■ D
Question 8: A B C D ■
Question 9: A ■ C D E
Question 10: ■ B
Question 11: ■ B
Question 12: A ■
Question 13: ■ B
Question 14: ■ B C D
Question 15: A ■
Question 16: ■ B
Question 17: A ■