# UNIVERSITI TEKNOLOGI MALAYSIA

**MIDTERM TEST**
**SEMESTER I 2016/2017**

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|---|---|
| **CODE OF SUBJECT** | **: SCJ3203 / SCJ3203** |
| **NAME OF SUBJECT** | **: Theory of Computer Science** |
| **TIME** | **: 2.15 PM – 4.45 PM (2 1/2 Hours)** |
| **DATE** | **: 17 October 2016** |
| **VENUE** | **:** |

## INSTRUCTIONS TO THE STUDENTS:

**THIS PAPER CONSISTS OF 10 QUESTIONS. ANSWER ALL QUESTIONS IN THE SPACE PROVIDED IN THIS QUESTION PAPER. THE MARKS FOR EACH QUESTION IS AS INDICATED.**

Attention: All electronic devices (cell phones, smartphones, tablets and other) must be turned off during the examination period and placed them face up on your desk visible to the exam supervisor at all times.

It is not permitted to take your electronic devices into the toilet. You should leave these devices switched off on your desk, not in your pocket.

| | |
|---|---|
| **Name** | |
| **Identity card (or matric) Number:** | |
| **Section** | **01 / 02 /03 / 04 / 05** (Please circle) |
| **Lecturer's Name** | |

This examination book consists of **8** printed pages excluding this page.

**STRUCTURED QUESTIONS** **[100 MARKS]**

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This paper consists of 10 structured questions. Answer all questions in the space provided in this question paper.  The marks for each part of the question is as indicated.

## Question 1 (10 marks)

a)      Write a regular expression for the following languages.                (6 marks)

      ii)       The language L = {$w \in \{a, b\}$ : $w$ contains the substring *aa*}.

      _____

      ii)       The language of all strings over {$a, b$} in which $b$ is the second letter and $a$ is the second-last letter of the strings.

      _____


b)      Give a description of the following languages in your own words.         (4 marks)

      i)        (*ab*)*ba*

      _____

      _____

    ii)        ($a + b$)*($b + aa$)($a + b$)*

      _____

      _____


## Question 2 (10 marks)

    Given A = {$a, b$}

    a)   List down all the strings with length at most three and state whether the sets are finite or infinite.                                                            (2 marks)

    _____

    b)   Give a regular expression of language A* that start and end with different symbol.

                                              (2 marks)
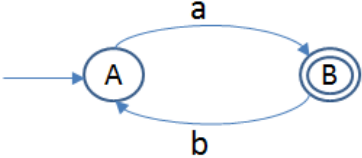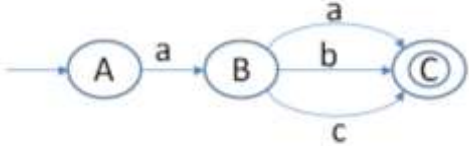
    _____

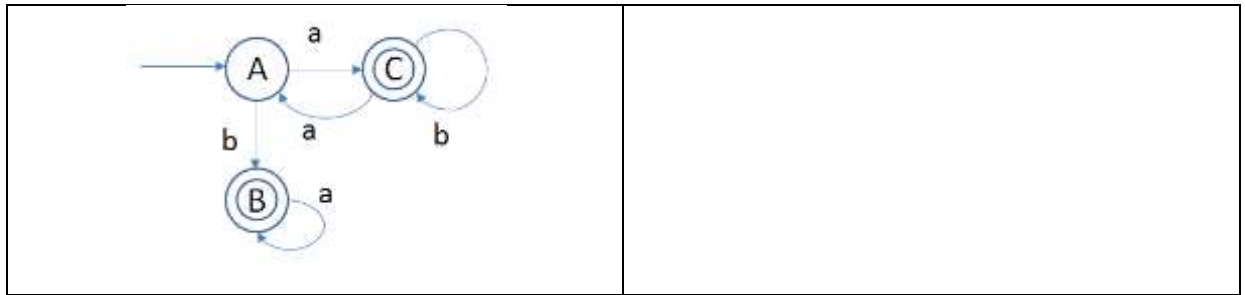c) Given B = {*a*, *b*, *c*}. Write the language of AB². (3 marks)

_____

d) Draw a state diagram of DFA which accepts set of all string over A* of length two. (3 marks)

## Question 3 (10 marks)

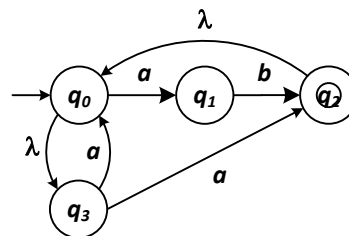Complete the table below with the corresponding finite automata or regular expression.

| Finite Automata | Regular Expression |
|---|---|
|  | |
| | (ab + ba)* |
|  | |
| | ab*c |

## Question 4 (10 marks)

Consider the following NFA.

a) Determine whether the following strings are IN or NOT IN the language by putting/writing them in the right column in Table 1. (4 marks)



*a, aa, ab, ba, aab, abb, abab, abaab*

**Table 1.**

| IN the language | NOT IN the language |
|---|---|
|  |  |

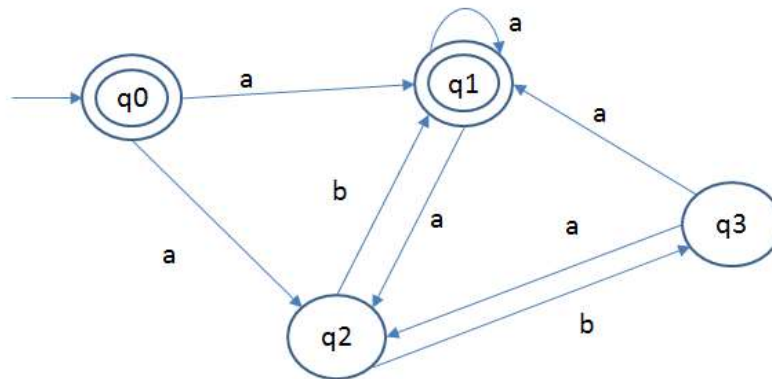b) Convert the NFA to the equivalent DFA. (4 marks)

c) Write the regular expression for the DFA. (2 marks)

_____

## Question 5 (10 marks)

Given an NFA state diagram below:



a) Which of the strings *ababa*, *aababa*, *ababaabb*, *abaaba* are accepted by the NFA?

_____ (4 marks)

b) Construct a transition table of the above NFA. (2 marks)

c) Convert the NFA to an equivalent DFA. (4 marks)

4

**Question 6 (10 marks)**

a)  Given a regular expression $a\Sigma^*b\Sigma^*c$ for set of alphabet $\Sigma$ = {a, b, c}. List THREE strings that can be generated and TWO strings that cannot be generated by the regular expression.   (5 marks)

_____

_____

b)  Write the regular expression over the alphabet $\Sigma$ = {0, 1} for each of the following language:

   i)   {w | w has *at most one 0*}.   _____   (1 mark)

   ii)  {w | w has *exactly two 0's*}.   _____   (2 marks)

   iii) {w | w has *no more than two 0's*}. _____   (2 marks)

**Questions 7 (10 marks)**

a)  Draw the DFA for the language L1 = {w | w has odd number of 0's and odd number of 1's}. $\Sigma$ = {0, 1}.                                                                                   (5 marks)

b)  Draw the NFA for the language L2 = {w | w contains the substring 101}. $\Sigma$ = {0, 1}.(5 marks)
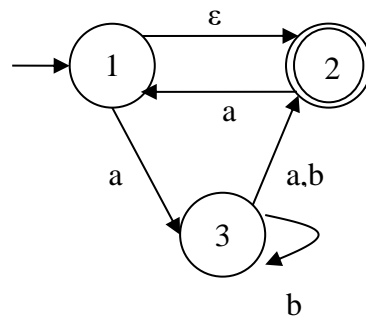
## Questions 8 (10 marks)

You are given a finite automaton M with states $q_0$, $q_1$, $q_2$, $q_3$ having $q_0$, $q_1$, $q_2$ as final states and {*a, b, c*} as input alphabet. The transition functions are given by the table:

| $\delta$ | *a* | *b* | *c* |
|---|---|---|---|
| $q_0$ | $q_0$ | $q_1$ | $q_2$ |
| $q_1$ | $q_3$ | $q_1$ | $q_2$ |
| $q_2$ | $q_3$ | $q_3$ | $q_2$ |
| $q_3$ | $q_3$ | $q_3$ | $q_3$ |

a)      Draw a state diagram for M. Is it a DFA or NFA? _____                    (3 mark)

b)      Give a regular expression for the language accepted by M. _____

(3 marks)

c)      Give 2 possible strings accepted by M.                    (2 marks)

_____

d)      Trace the computations that process the strings *abbbbc*.                    (2 marks)

**Question 9 (10 marks)**

Based on the diagram below, answer the questions.



a) Write the transition table of the NFA above. (3 marks)

b) Draw the possibility tree for the computation of the following strings. (4 marks)

    i.    *abba*

    ii.    *abaa*

c)  What is the regular expression of the FA above?  _____ (3 marks)

**Question 10 (10 marks)**

Given an FA description for Elevator/Lift.

- **States: Floor**
    - **Initial: Every floor**
    - **Final: Every floor.**
        - **e.g. A building has 4 floors. If 3$^{th}$ floor cannot be used (renovating, …), so 3$^{th}$ floor is <u>not a final state</u>.**
        - **Final states = 1$^{st}$ floor, 2$^{nd}$ floor, 4$^{th}$ floor**
- **Input: Pressed buttons (which floor you want to go to) (e.g. 1, 2, 3 or 4)**
- **Rules:**
    - **when a lift is ascending(↑), it can only descend(↓) when no more upper floor is request for the lift**
    - **Vice versa**
    - **… etc.**

a)  Draw the state diagram for the Elevator. (3 marks)

b)  Give the set notation to define the 5-tuple of ($Q, \Sigma, \delta, q_0, F$) for the Elevator. (5 marks)

c)  If you start from 1$^{st}$ floor to the 4$^{th}$ floor, and no one else is using the elevator, give the

regular expression. _____ (2 marks)

**- END -**