Assessment: Individual Coursework 2

Due date: Friday 14th December 2018, 11.55pm

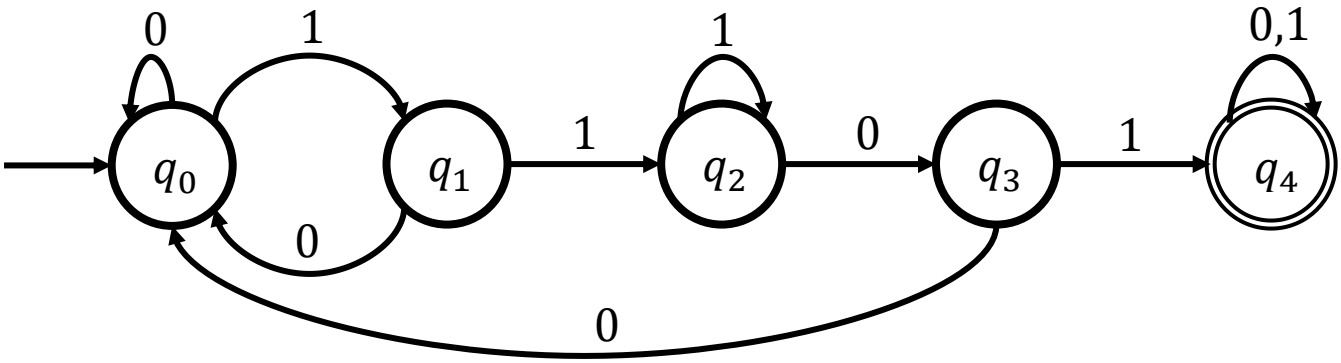
Question Sheet

Total Marks: 100

Assignment Rules:

1. *Submission and late submission:* The solutions **must be submitted in pdf** only via QOL. You may wish to complete your coursework electronically using Word (utilising Microsoft Equation Editor where appropriate), LaTex, or other technology which facilitates mathematical typesetting. If you complete your coursework on paper you must create a digital copy of your work using a scanner. **Photographs of paper based coursework will not be accepted.** Late submissions will be deducted 5% marks per day of delay. No submission will be accepted more than 7 days later than deadline.
2. *No plagiarism allowed:* This is an individual assignment. No plagiarism is permitted: you should not copy your solutions from each other or any resource. If you need to refer to online sources/books (e.g. for some new definition), you must refer to them appropriately. If plagiarism is detected you may lose marks and/or face other action.
3. This is an open book and open resource assignment. You are allowed to access books and online resources. However, you must attribute sources (see point 4) and the solutions must be in your own words.
4. *Attribution:* If at all you need to cite any sources/books (*standard definitions do not require a citation*), have a separate **references** section at the end. All the references should be present using a single standardised reference style (e.g. IEEE, APA, Harvard etc.).

1. Answer all the following questions on Deterministic Finite Automata (DFA).
    a. Describe, in English, the language recognised by the DFA illustrated in the following finite state machine.



[5 marks]

    b. Illustrate the following DFA using a finite state machine, given the definition $M = (Q, \Sigma, \delta, q_0, F)$ where
    $Q = \{S, q_1 q_2 q_3\}$
    $\Sigma = \{a, b\}$
    $\delta: Q \times \Sigma \to Q$ is defined by the transition diagram:

$\boldsymbol{Q} \setminus \boldsymbol{\Sigma}$	$\boldsymbol{a}$	$\boldsymbol{b}$
$\boldsymbol{s}$	s	q_1
$\boldsymbol{q_1}$	q_2	q_3
$\boldsymbol{q_2}$	s	q_1
$\boldsymbol{q_3}$	q_2	q_3

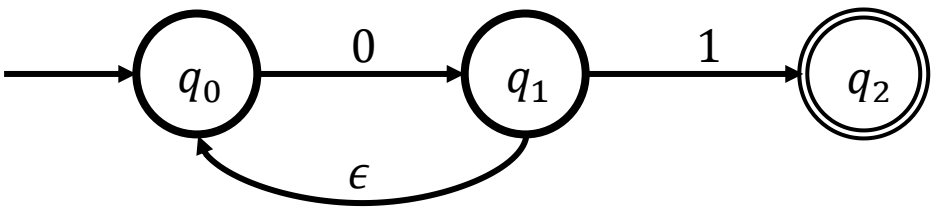
    $q_0: s$
    $F = \{q_3\}$

[5 marks]

    c. Design a DFA to recognise the language consisting of all binary strings which start with the pattern 11 and end with 00. **[You only need to illustrate the DFA, you do <u>not</u> need to formally define the DFA with a 5-tuple].**

[10 marks]

2. Answer the following questions related to Nondeterministic Finite Automata (NFA)
    a. Describe, in English, the language of the following NFA



[5 marks]

b. Convert the NFA in 2a) into a DFA which recognises the same language.
[It is not mandatory to give the details of the construction process of the DFA. However, it is recommended that you do show working out in case you make some mistake in which case partial marks can be awarded for showing the correct process.]

[10 marks]

c. Give a regular expression to describe the language of the NFA in 2a).
[It is not mandatory to give the details of the process used to deduce the regular expression. However, it is recommended that you do show working out in case you make some mistake in which case partial marks can be awarded for showing the correct process.]

[5 marks]

d. Design a NFA to recognise the language consisting of all strings, over the alphabet $\{a, b, c\}$, that do not end with the pattern bbc.

[10 marks]

3. Answer the following questions related to regular expressions.
   a. For each of the following languages over the alphabet $\Sigma = \{xyz\}$, give two strings that are members of the language.
      i. $(xy)^*$
      ii. $y^* \cup zx^+$
      iii. $\Sigma x \Sigma y \Sigma z$
      iv. $y^* z^* x^2$
      v. $(x \cup y) z^*$

      [5 marks]

   b. Illustrate the NFA which recognises the language $y^* \cup zx^+$ using a finite state machine.

      [5 marks]

   c. Write a regular expression for the following languages over the alphabet $\{x, y, z\}$.
      i. The set of all strings where any and all instances of x and y appear before any and all instances of z (For example, this would contain strings such as xy, yx, $xyzz$, $xxyyyzz$, $yxyyxzzz$ to name a few).

      [10 marks]

      ii. The set of all strings with exactly 2 y's appearing anywhere in the string.

      [10 marks]

4. Decide whether or not the following language, over the alphabet $\{a, b, c\}$ is regular. If so, design a DFA/NFA to recognise it, and if not, give a formal proof (based on the Pumping Lemma).
   a. $\{w | \, w \text{ in } (a^k \cup b^k) \text{ for } k \geq 0\}$

      [10 marks]

   b. $\{a^i b^j c^{2i+2j} \, | i, j, k \geq 0\}$

      [10 marks]