

Each of the problems is worth 10 points. Write your name, student ID, and your TA's name on the solution sheet.

Please write your solutions clearly and concisely. If you do not explain your answer you will be given no credit. You are encouraged to collaborate on the homework, but you *must* write your own solutions and list your collaborators on your solution sheet. Copying someone else's solution will be considered plagiarism and may result in failing the whole course.

Please turn in the solutions by 11.59pm on Thursday 22 September. The homework should be dropped off in the box labeled CSC 3130 on the 9th floor of SHB. Late homeworks will not be accepted.

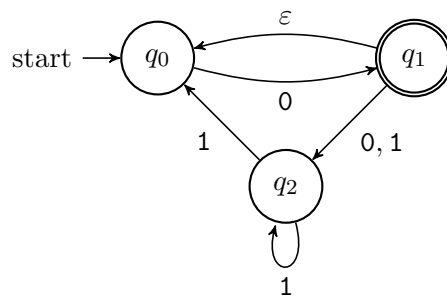
## Problem 1

Give a DFA for the following languages, specified by a transition diagram. For each one of them, give a short and clear description of how the machine works. The alphabet is  $\Sigma = \{0, 1, 2\}$ :

- (a)  $L_1 = \{w \in \Sigma^* : w \text{ begins with } 0 \text{ or ends with } 0 \text{ but not both}\}$ .
- (b)  $L_2 = \{w \in \Sigma^* : w \text{ contains the pattern } 01 \text{ at least twice}\}$ .
- (c)  $L_3 = \{w \in \Sigma^* : \text{the sum of the digits of } w \text{ is odd and is a multiple of } 3\}$ .
- (d)  $L_4 = \{w \in \Sigma^* : w \text{ is **not** in the language of the regular expression } 0^*1^*2^* + 2^*1^*0^*\}$ .

## Problem 2

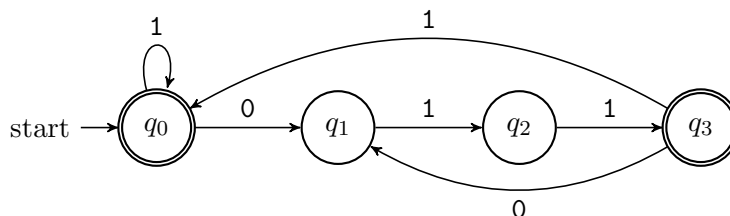
Convert the following NFA to a DFA using the method described in class. Specify the DFA by its transition diagram. The alphabet is  $\Sigma = \{0, 1\}$ .



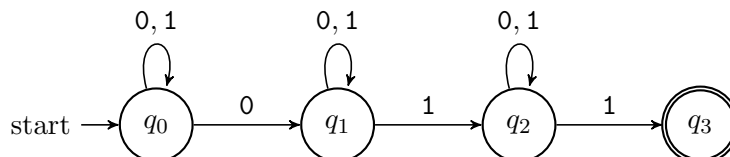
### Problem 3

Consider the following languages over  $\Sigma = \{0, 1\}$ .

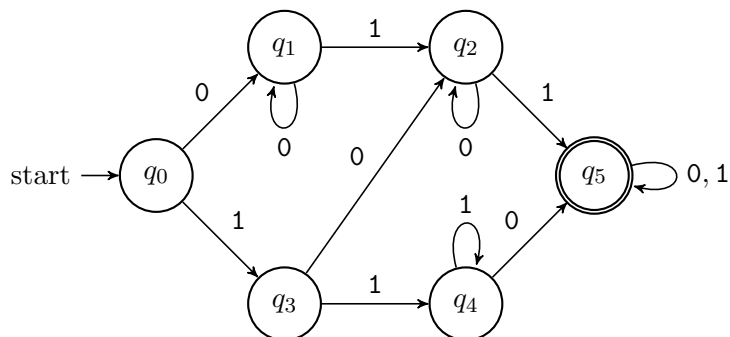
- $L_1$  is the language described by  $1^*(0111^*)^*$ .
- $L_2$  is the language of strings with at least one 0 and at least two 1s.
- $L_3$  is the language of the following NFA:



- $L_4$  is the language described by  $(0 + 1)^*01(0 + 1)^*1$ .
- $L_5$  is the language described by  $(011 + 101 + 110)^*$ .
- $L_6$  is the language of the following NFA:



- $L_7$  is the language of all strings that do **not** contain 00, 010 and do **not** end in 0 or 01.
- **(Optional)**  $L_8$  is the language of the following DFA:



Which of these languages are the same and which are different? To show two languages are the same give a short argument, and to show two languages are different give a string that is in one but not in the other. (You must provide an explanation to get credit.)

## Problem 4

In this problem you will design an NFA that checks if an arithmetic expression is formatted correctly. An arithmetic expression is made up of parans '(', ')', operations '+', '-', '\*' and the digits from 0 to 9. Here are some correctly formatted expressions:

```
1 + 2
(1999 + 75) * (89 - 2036)
(88 + 0) / 1
```

And here are some incorrectly formatted ones:

```
74 +* 0
(7 * 1)(
10 *
```

You may assume the expression does *not* have nested parans like  $(5 * (4 + 6))$ . Feel free to make other simplifying assumptions, but make sure you state all such assumptions in your solution.

When drawing the transition diagram of your NFA, you can use the shorthand notation  $[0-9]$  to describe transitions labeled by all the digits '0', '1', ... '9'. You can also label a single transition by multiple symbols: For instance, a transition labeled by '671' stands for three consecutive transitions labeled by '6', '7', and '1' respectively.

This is a design problem, and part of your job is to figure out a way to distinguish among correct and incorrect description. There may not be a single right answer. You must describe your reasoning clearly in your solution. Solutions that only provide a picture of an NFA with no explanation will get no credit.