MATH 4LT/6LT3 Assignment #3
Due: Tuesday, 21 October by 11:59pm.

1. Let $T = (\{q_0, q_1, q_2, q_{accept}, q_{reject}), \{a\}, \{a, \sqcup\}, q_0, q_{accept}, q_{reject}, \delta)$ be the DTM whose transition function is given by the following table:

$Q \times \Gamma$	δ
$(q_0, \sqcup)$	$(q_{accept}, \sqcup, +1)$
(q_0, a)	$(q_1, a, +1)$
$(q_1, \sqcup)$	$(q_2, \sqcup, +1)$
(q_1, a)	$(q_0, \sqcup, +1)$
$(q_2, \sqcup)$	$(q_2, \sqcup, +1)$
(q_2, a)	$(q_2, \sqcup, +1)$

   (a) Show that T accepts the string $aaaa$ by writing down the sequence of configurations that T occupies, after being started in the initial configuration $[q_0, aaaa, 1]$.

   (b) Describe the sequence of configurations that T occupies after being started in the configuration $[q_0, aaa, 1]$. Does T accept aaa?

   (c) For $n \geq 0$, carefully describe what T does when started in the configuration $[q_0, a^n, 1]$.

   (d) Describe the language accepted by T.

2. Consider the language L over the alphabet $\{0, 1\}$ consisting of all words w that contain an equal number of 0's and 1's.

   (a) Describe a halting DTM that accepts L. Your description should describe how your DTM operates on an input word w without going into too much detail.

   (b) Draw a state diagram for the DTM described in part a). To save time and effort you need not include any transitions that do not matter for the operation of your DTM. You may use the JFLAP software or some other Turing Machine simulator for this part of the problem.

3. Exercise 2.10.5.

4. Exercise 2.10.9, part 2.

5. Exercise 2.10.10.

The following questions are for students enrolled in MATH 6LT3. Students in MATH 4LT3 can treat them as bonus questions.

B1 A common definition of a DTM allows for the machine to not move after reading a symbol, instead of always having to move one cell to the left or to the right. Consider a variant DTM whose transition function may also produce a triple $\delta(q, s) = (q', a', 0)$, where the 0 indicates that the read/write head of the DTM does not move.

Describe how a standard DTM can be used to simulate the running of one of these variant machines. More precisely, given a specification $T = (Q, \Sigma, \Gamma, q_s, q_{accept}, q_{reject}, \delta)$ of a variant DTM, give a definition of a standard DTM T' which essentially does the same things that T does.

B2 Exercise 2.10.14, part 1.