Assignment 4
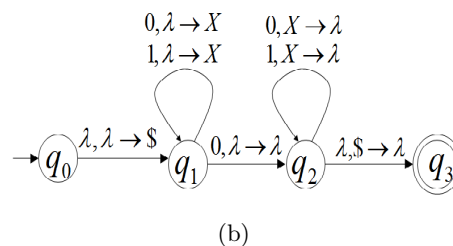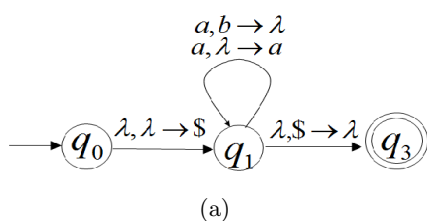**Submission through Moodle due on Tuesday November 21 at 23:55**

1. (10 points) Construct an NPDA that accepts the language generated by the following grammar.

$S \rightarrow aABB \mid aAA$
$A \rightarrow aBB \mid a$
$B \rightarrow bBB \mid A$

2. (10 points) Give concise descriptions of the languages accepted by each of the following PDAs. (Note: $ is the bottom of stack marker/stack start symbol.)

(a)

(b)

3. (15 points) Construct PDAs that accept the following languages.

   (a) $\{a^n b^m : m \geq n\}$
   (b) $\{a^i b^j a^k d^l : i + j = k + l\}$
   (c) $\{a^i w c^k : i \geq 0, w \in \{a, b\}^* \text{ and } k = n_a(w)\}$

4. (15 points) For each of the following languages, say whether it is a DCFL. Justify your answers.

   (a) $\{a^n b^m : n \leq m \leq 2n\}$
   (b) $\{a^n b^n : n \geq 1\} \cup \{b\}$
   (c) $\{a^m b^n c^p : m < n \text{ or } n < p\}$