Student ID:

CW Exam2

15th November 2019 COMP 3602

1. Draw PDAs for the following languages:

   (a) $\{w \mid w \text{ has balanced brackets}, w \in \{(,)\}^*\}$ [5]

   (b) $\{w \mid w = w^R, |w| \geq 1, w \in \{0,1\}^*\}$ [5]

2. Design the production rules for a context-free grammar that generates the following languages over $\{0, 1\}$

   (a) $\{w \mid w = w^R, |w| \geq 1, w \in \{0, 1\}^*\}$ [5]

   (b) $\{0^n 1^m \mid n, m \geq 1, n \leq m\}$ [5]

3. Show that $\{w \mid w \in \{0,1\}^*, w = w^R\}$ is not a regular language using the Pumping Lemma. [5]

4. Consider the following production rules for a context-free grammar:

$$
\begin{aligned}
&E \to E \wedge T \mid E \vee T \mid T \\
&T \to T \implies F \mid T \iff F \mid F \\
&F \to (E) \mid \neg F \mid \forall F \mid \exists F \mid V \\
&V \to p \mid q \mid r \mid 1 \mid 0
\end{aligned}
$$

   (a) What are the non-terminals of the above grammar? [2]
   (b) What are the terminals of the above grammar? [3]
   (c) Using E as the start symbol, show the parse tree of $\forall(0 \vee 1)$. [3]
   (d) Using E as the start symbol, show the left-most derivation of $\exists p$. [2]