Name (PRINTED): _____

University ID #: _____

Circle your TA's name: Tommy Tammy Derek Varun

Circle your discussion: 9:00 10:00 11:00 12:00 1:00 2:00

CMSC 330 Quiz #4 Fall 2012

This quiz is 40 points. **Do not start** until you're told you can begin. You must turn in your quiz **immediately** when the end of the quiz is announced.

1. [12 pts.] Consider the following OCaml code, which uses references:

```
let jack = ref "Jack";;
let queen = ref "Queen";;
let king = ref "King";;
let ace = ref "Ace";;

let cards = ref [jack; queen; king; ace];;

let shuffle = function () ->
  match !cards with
    (a::b::c::d::[]) ->
      let tempB = !b in
        b := !d ;
        d := tempB ;
        cards := (c::b::a::d::[]);;

shuffle();;
```

Give the values that the following variables would have after execution of the code:

`jack`: _____

`queen`: _____

`king`: _____

`ace`: _____

2. [18 pts.] Consider the following context–free grammar:

$$
\begin{aligned}
S &\rightarrow TU \mid V \\
T &\rightarrow aTb \mid \epsilon \\
U &\rightarrow cUd \mid \epsilon \\
V &\rightarrow aVd \mid W \\
W &\rightarrow bWc \mid \epsilon
\end{aligned}
$$

   a. What is the set of strings generated by this grammar? (Hint: express it as a union of two sets of strings.)

   b. Give a string that shows that this grammar is ambiguous: _____

c. Now prove that the grammar on the previous page is ambiguous, by constructing **two derivations** for the string that you gave in the previous part, that will demonstrate the ambiguity.

3. [10 pts.] Consider the following context–free grammar: $\mathrm{E} \rightarrow \mathrm{T} + \mathrm{E} \mid \mathrm{E} - \mathrm{T} \mid \mathrm{T} * \mathrm{E} \mid \mathrm{T}$
$\mathrm{T} \rightarrow 1 \mid 2 \mid 3 \mid (\mathrm{E})$

Construct a parse tree for this grammar for the string $1 * 2 - 3$: