CISC/CMPE 223 - Assignment 6 (Winter 2018)
Due: Thursday March 8 by 2:30 PM
(in the locked CISC 223 drop-off box on Goodwin 2nd floor)

One bonus mark for neatly written student information: Papers that have all the names and student numbers written exactly as requested in the regulations (found at the end), will receive one bonus mark.

1. (5 marks) Consider the context-free grammar with the following rules (S, A, B are non-terminals, S is the start nonterminal and a, b, c are the terminals):

   \[ S \rightarrow cAa \mid aAb \mid bB \]
   \[ A \rightarrow dAb \mid cB \mid \varepsilon \]
   \[ B \rightarrow bB \mid cBa \mid \varepsilon \]

Determine the sets \( \text{FOLLOW}(S) \), \( \text{FOLLOW}(A) \), \( \text{FOLLOW}(B) \), as well as the sets \( \text{FIRST}(\alpha) \) where \( \alpha \) is any of the right sides of the productions.

For each element \( z \) belonging to a set \( \text{FOLLOW}(X) \), \( X \in \{S, A, B\} \), give a derivation starting from \( S \) of a string \( w \) where \( z \) occurs directly after \( X \). If \( z \) is EOS, give a derivation of \( w \) where \( X \) is the last symbol of \( w \).

Does the grammar allow the use of recursive-descent parsing? Justify your answer.

2. (5 marks) What should the pre-condition \( P \) be in each of the following ten correctness statements for the statement to be an instance of Hoare’s axiom scheme? All variables are of type int.

   (a) \( P \{ x = 1; \} \ x == 1 \)
   (b) \( P \{ x = 1; \} \ x == 2 \)
   (c) \( P \{ x = y + z; \} \quad 0 < x + y + z \)
   (d) \( P \{ x = x*z + 3; \} \ x*x > y + 2 \)
   (e) \( P \{ x = x*y*z + 1; \} \ y*y > x + 5 \)
   (f) \( P \{ z = y + 1; \} \quad \text{Exists}(y = 0; y < 10) \ x + y == 50 \)
   (g) \( P \{ x = y + 1; \} \quad \text{ForAll}(z = 1; z < 100) \ x + 2*z > w + 2 \)
   (h) \( P \{ x = z + 1; \} \quad \text{ForAll}(z = 1; z < x) \ x + y + z < 100 \)
   (i) \( P \{ x = x + y; \} \quad \text{Exists}(x = 0; x < 10) \ x*x + z == 10 \)
   (j) \( P \{ x = x + y \} \quad \text{Exists}(y = 0; y < 100)(x + y == 15 \ || \ z*x + y < 100) \)
Regulations on assignments

- The assignments may be done in groups consisting of one, two, three or four students. If more than one student are collaborating on an assignment, they must submit a single joint solution.

- At the top of the first page, for each student collaborating on the assignment, type or write in clear capital letters the following information:
  
  - LAST-NAME, FIRST-NAME (name as it appears on solus, e.g., “SMITH, NANCY”)
  - the student number (e.g., “1234 4321”)
  - “CISC 223” or “CMPE 223” (depending on which course you are in)
  - signature (the signature need not be easily readable)

  The information for each one student should be written on one line and in the order specified above.

- **Bonus mark:** Papers that have the above information, for all the participants, written exactly correctly and perfectly clearly and legibly will receive one bonus mark. The assignment is worth 10 marks. Papers that receive the bonus mark, may get more than 10 marks. For the bonus mark there is no partial credit for incomplete information or unclear handwriting.

- The assignment should be put into the locked CISC 223 drop-off box on the 2nd floor of Goodwin hall by the due date. The assignments must be submitted in hardcopy. Assignments sent by email are not accepted.

- If the submission consists of more than one page, the pages must be stapled together.

- **Note:** You are asked to write your solutions using non-erasable pen (or to type the solutions). Solutions written in pencil or erasable ink will be marked, but they will not be considered for remarking after the assignments are returned.