CS 477: Formal Software Development Methods  
Fall 2016  
Homework 2  
Released: Thursday, October 27  
Due by 12:30pm, Wednesday, November 2, in class before lecture begins.

1. [30 points]  
Consider the following program.

@pre: $m > 0$

$x := 0;$

$y ::= 1;$

$z ::= 1;$

While ($x \neq m$) {

$z := 2 \times z;$

$y := y + z;$

$x := x + 1;$

}

@post: $y = 2^{m+1} - 1$

Prove the program satisfies its pre-post condition by giving a proof using Hoare logic.  
You can assume any valid logical statement that is expressed purely in arithmetic as an axiom.

2. [8*5=40 points]  
For each of the following Hoare triples, write down  
(a) the weakest pre-condition of the post condition with respect to the program,  
(b) write down the verification condition using the weakest pre-condition, and  
(c) formulate the negation of the verification condition in Z3 and report whether it found the verification condition to be valid or not.

[1] \{ x > 0 \} y := x+1; y:=y*2; \{ y > 0 \}

[2] \{ x = y * y \} x:= 4*x \{ x > y \}

[3,4,5] The three verification conditions that result from your annotation of the program in your solution for Problem 1 with an inductive loop invariant.

[6,7,8] The three verification conditions of the program LinearSearch in Fig.5.15 in the book “Calculus of Computation” by Bradley and Manna.  
Note that this requires using the array constraints in Z3.