

- *The exam is open book and notes.*
- *Results/proofs covered in class/problem sessions/assignments may simply be cited, unless specifically asked for.*
- *Unnecessarily lengthy solutions will be penalized.*
- *Do not copy solutions from others or indulge in unfair means.*

1. Consider the following program with location labels L_i :

```

int func2(int x, int y) {
    int z := 0;

    L1: if (x < y) {
        L2:   while (x < y) {
            L3:       // begin while1
                    x := func1(x, y);
                    y := func1(x, y);
                } // end while1
        } // end if
    L4: else { // x >= y
        L5:   while (x >= y) {
            L6:       // begin while2
                    y := func1(x, y);
                    x := func1(x, y);
                } // end while2
        } // end else

    L7: z := x + y;
    L8: return(z);
} // end func2

```

You are not given the body of the function `func1` except that you are told that it takes two integers m , n as arguments and returns an integer k as result. You are also told that `func1` always terminates, does not alter the values of m and n , and that the following two Hoare triples are valid:

- (a) $\{m \geq n\} \text{func1}(m, n) \{k = m - 2\}$
- (b) $\{m < n\} \text{func1}(m, n) \{k \geq m + n\}$

You are required to find if the Hoare triple $\{x > 3 \wedge y > 10\} \text{func2}(x, y) \{z > 0\}$ is valid.

Use a Hoare style proof to answer the above question. You may choose to construct a Boolean abstraction of the above program if you find Hoare style reasoning on that more convenient, but this is not necessary. You must clearly indicate all steps, inferences, predicates etc. used in your solution.