# Activity: Midterm Exam Review

## Midterm Monday Oct 26

The Midterm Exam will be next Monday, October 26, from 6:25 to 7:25.

Roughly 30 min on material since Quiz 2, 30 min on Quiz 1 & Quiz 2 material.

### Outcomes To Study

In addition to the outcomes covered on Quiz 1 and Quiz 2, we have:

- Know what a verification proof is.
- Know the proof rules for the textbook's system PD (Partial correctness of Deterministic programs).
- Be able to fill in a proof outline for short programs.
- Be able to write a short proof of correctness for simple programs involving a sequence of assignments and if-else.

### A. Questions

1. What is the proof outline for an assignment statement given its postcondition? I.e., what do we fill in for { ______ } $u := t$ $\{p\}$?
   p[u:=t]
2. What about a sequence of assignments { ______ } $u_1 := t_1$ { ______ } $u_2 := t_2$ $\{p\}$

$p[u_2 := t_2][u_1 := t_1]$

$p[u_2 := t_2]$

3. What is the proof outline for $\{x > 1\}$ $y := 0$; $z := y+1$ $\{x > z = y+1 = 1\}$?

$\{x > 1\}$ $\{x > 0+1 = 0+1 = 1\}$ $y := 0$;
$\{x > y+1 = y+1 = 1\}$ $z := y+1$ $\{x > z = y+1 = 1\}$

What is the predicate logic proof obligation?

$x > 1 \rightarrow (x > 0+1 = 0+1 = 1)$

4. Fill in { $p$______ } **skip** $\{p\}$. Repeat, for $\{p\}$ **skip** { $p$ ______ }

5. Fill in

   $\{p\}$ **if** $B$ **then**

   $\{\ p \wedge B$ ________ $\}\ S_1\ \{\ q$ _____ $\}$

   **else**

   $\{\ p \wedge \neg B$ ______ $\}\ S_2\ \{\ q$ _____ $\}$

   **fi** $\{q\}$

6. Fill in

   $\{$**inv** $p\}$ **while** $B$ **do**

   $\{\ p \wedge B$ ________ $\}\ S\ \{\ p$ ________ $\}$

   **od** $\{\ p \wedge \neg B$ ________ $\}$

7. Is the proof outline for an **if-then** statement

   $\{p\}$ **if** $B$ **then** $\{$ ________ $\}\ S_1\ \{$ ________ $\}$ **fi** $\{q\}$ ?

   No, because an if-then is really an **if-else** with **else skip fi**.

   The proof outline for an if-then is:

   {p} **if** $B$ **then**

   $\{p \wedge B\}\ S_1\ \{q\}$

   **else**

   $\{p \wedge \neg B\}$ **skip** {p ∧ ¬B} $\{q\}$

   **fi** $\{q\}$

   We get an obligation of $p \wedge \neg B \rightarrow q$.

8. What is a proof outline for a loop $\{$**inv** $p\}$ **while** $B$ **do** $S$ **od** ?

[Oops; same as Question 6]

9. Add more conditions to complete the proof outline for

   $\{$**true**$\}$ **if** $y > 1$ **then** $x := y$ **else** $x := 1$ **fi** $\{x = min(1,\ y)\}$.

$\{$**true**$\}$

**if** $y > 1$ **then**

$\{$**true** $\wedge$ y > 1$\}$

$\{y = min(1,\ y)\}\ x := y\ \{x = min(1,\ y)\}$

**else**

$\{$**true** $\wedge\ y \le 1\}$

$\{1 = min(1,\ y)\}\ x := 1\ \{x = min(1,\ y)\}$

**fi**

$\{x = min(1,\ y)\}$.

What are the predicate logic proof obligations?

**true** $\wedge$ y > 1 $\rightarrow y = min(1,\ y)$

$\textbf{true} \wedge y \leq 1 \rightarrow 1 = min(1, y)$

Turns out these are false! (The specification has a bug: replace *min* by *max* everywhere!)

10.Add more conditions to complete the proof outline for

$\{\textbf{true}\}\ x := 1;\ \{x = 1\}$ **if** $y > 1$ **then** $x := y$ **fi** $\{x = min(1, y)\}$.

$\{\textbf{true}\}\ \{1 = 1\}\ x := 1;\ \{x = 1\}$

**if** $y > 1$ **then**

$\{x = 1 \wedge \mathrm{y} > 1\}\ \{y = min(1, y)\}\ x := y\ \{x = min(1, y)\}$

**else**

$\{x = 1 \wedge \mathrm{y} \leq 1\}\{x = min(1, y)\}$ **skip** $\{x = min(1, y)\}$

**fi**

$\{x = min(1, y)\}$.

What are the predicate logic proof obligations?

$x = 1 \wedge \mathrm{y} > 1 \rightarrow y = min(1, y)$

$x = 1 \wedge \mathrm{y} \leq 1 \rightarrow x = min(1, y)$

Are these valid???? [hmm]