Time: 2 hours

Default: 1p

1. (3p). Using symbolic heaps, compute the symbolic execution of the following program

```
a := nil;
[x]:=a;
z:=y;
a:= [y];
```

starting with the precondition x|->y * y|->z * z|->nil.

2.(3p). Determine the invariant and prove the partial correctness of the following program:

```
{x>0}
a := x;
y := 0;
while a /= 0 do
begin
y := y + 3 ; a := a – 1;
end
{y=3x}
```

3.(3p). Given the following code, please compute the *available expressions* before and after each instruction:

```
x=a+1;
y=a*b;
b=a+1;
while (y> a+b)  do {
      a=a+1;
      x=a+b;
}
```