SENG 5811 HW#6

Q1.

a) See attached .lus files

b) The safety property that I chose is that the traffic light shall not be GREEN while the pedestrian light is WALK. This makes sense because the pedestrian light should not signal to pedestrians while traffic is passing by. The safety property was the following:

```
    safety_prop = not (traffic_light = GREEN and pedestrian_light = WALK);
    --%PROPERTY safety_prop;
```

Here is the jkind output:

```
PS C:\Users\anthonycamano\source\repos\seng-5811\HW-6\jkind> .\jkind .\trafficLightStarving.lus
Warning at line 27:30 unguarded pre expression
Warning at line 27:62 unguarded pre expression
Warning at line 27:90 unguarded pre expression
Warning at line 28:16 unguarded pre expression
Warning at line 29:16 unguarded pre expression
Warning at line 32:16 unguarded pre expression
Warning at line 35:13 unguarded pre expression
Warning at line 38:27 unguarded pre expression
Warning at line 38:55 unguarded pre expression
Warning at line 38:87 unguarded pre expression
Warning at line 39:16 unguarded pre expression
Warning at line 40:16 unguarded pre expression
Warning at line 40:46 unguarded pre expression
Warning at line 43:16 unguarded pre expression
Warning at line 44:16 unguarded pre expression
Warning at line 47:13 unguarded pre expression
Warning at line 50:26 unguarded pre expression
Warning at line 50:53 unguarded pre expression
Warning at line 51:16 unguarded pre expression
Warning at line 52:16 unguarded pre expression
Warning at line 52:45 unguarded pre expression
Warning at line 55:16 unguarded pre expression
Warning at line 56:13 unguarded pre expression
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  JKind 4.5.2
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There are 1 properties to be checked.
PROPERTIES TO BE CHECKED: [safety_prop]

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```

```
VALID PROPERTIES: [safety_prop] || k-induction || K = 1 || Time = 0.107s
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    --^^--        SUMMARY          --^^--
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VALID PROPERTIES: [safety_prop]

```

c) A desirable state that may never get reached is {WAIT, RED, SET}. This is due to the possibility of getting stuck at {WAIT, AMBER, SET}. The transition of AMBER -> RED is dependent on the arbitrary input value (“toggle” in my code) that is selected by jkind. If the value of the input is never switched to true, then the transition is never going to go from AMBER to RED. To fix this, we can add a constraint on toggle by adding a new toggle variable and adding the following:

```
 assert(toggle ->  new_toggle);
 new_toggle  = (toggle <> pre toggle);
```

This constraint then ensures that the input value switches to the opposite of the previous value at every step.

d) A test case that would be really simple to test is to check if the pedestrian light ever transitions to flash. We have logic that says that it should be possible so simply adding the following prop should show us a counter example:

```
    test_case_prop = pedestrian_light <> FLASH;
 --%PROPERTY test_case_prop;
```

The output would be the following, indicating that the pedestrian_light does in fact transition to FLASH at some point

```
PS C:\Users\anthonycamano\source\repos\seng-5811\HW-6\jkind> .\jkind
.\trafficLightStarving.lus
Warning at line 27:30 unguarded pre expression
Warning at line 27:62 unguarded pre expression
Warning at line 27:90 unguarded pre expression
Warning at line 28:16 unguarded pre expression
Warning at line 29:16 unguarded pre expression
Warning at line 32:16 unguarded pre expression
Warning at line 35:13 unguarded pre expression
Warning at line 38:27 unguarded pre expression
```

```
Warning at line 38:55 unguarded pre expression
Warning at line 38:87 unguarded pre expression
Warning at line 39:16 unguarded pre expression
Warning at line 40:16 unguarded pre expression
Warning at line 40:46 unguarded pre expression
Warning at line 43:16 unguarded pre expression
Warning at line 44:16 unguarded pre expression
Warning at line 47:13 unguarded pre expression
Warning at line 50:26 unguarded pre expression
Warning at line 50:53 unguarded pre expression
Warning at line 51:16 unguarded pre expression
Warning at line 52:16 unguarded pre expression
Warning at line 52:45 unguarded pre expression
Warning at line 55:16 unguarded pre expression
Warning at line 56:13 unguarded pre expression
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  JKind 4.5.2
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There are 2 properties to be checked.
PROPERTIES TO BE CHECKED: [safety_prop, test_case_prop]

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INVALID PROPERTY: test_case_prop || bmc || K = 7 || Time = 0.206s
                          Step
variable                     0     1     2     3     4    5     6

INPUTS
toggle                   false false false false false true false

OUTPUTS
button_state             RESET RESET   SET   SET   SET  SET RESET
pedestrian_light          WAIT  WAIT  WAIT  WAIT  WAIT WALK FLASH
traffic_light              RED GREEN GREEN AMBER   RED  RED   RED

LOCALS
new_button_state         RESET RESET   SET   SET   SET  SET RESET
new_pedestrian_light     FLASH  WAIT  WAIT  WAIT  WAIT WALK FLASH
new_traffic_light        AMBER GREEN GREEN AMBER   RED  RED   RED
test_case_prop            true  true  true  true  true true false

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VALID PROPERTIES: [safety_prop] || k-induction || K = 1 || Time = 0.221s
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    --^^--        SUMMARY          --^^--
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VALID PROPERTIES: [safety_prop]
```

INVALID PROPERTIES: [test_case_prop]
```

Q2.

| ?X? | Predicate |
|---|---|
| ?1? | r x n! = N! |
| ?2? | r x (n-1)! = N! |
| ?3? | r x n! = N! |
| ?4? | r = N! |
```