

Theory Assignment 1

Question 1

Spin Lock

Safety property:

No.

in θ_1 x is set before a and before checking a so θ_1 must be at the beginning of the loop if $b == 0$ when $b := x$ is executed in θ_2 and in θ_2 , y is set before b and before checking b so θ_2 must be at the beginning of the loop if $a == 0$ when $a := y$ is executed in θ_1 , and since θ_1 cannot set a and also be at the beginning of the loop it is impossible.

Deadlock:

Yes.

because if the programs execute like this:

θ_1	θ_2
$x := 1$	$y := 1$
$a := y$	$b := x$
if $a == 0$	
	if $b == 0$

Then the program would be deadlocked.

Liveness property:

Yes, given that local variables don't automatically reflect shared variables, as each thread checks a local variable, and that variable is not updated it could be possible for θ_1 to enter CS_1 at least once while θ_2 does not:

θ_1	θ_2
x := 1	
a := y	
if a==0	
CS_1	
	y := 1
	b := x
x:= 0	if b == 0
x := 1	
a := y	
if a==0	

Non-Spin Lock

Safety property:

No.

The same argument for Spin Lock applies for Non-Spinlock

Deadlock:

No as when ever the spinlock version would deadlock, the non-spin lock version is able to loop again and check the shared variable again.

Liveness property:

Yes, per below its possible for θ_1 to get access to CS_1 and θ_2 to not get access to CS_2 if the two threads don't execute exactly in the same time.

θ_1	θ_2
x := 1	
a := y	
if a==0	y := 1
CS_1	b := x

θ_1	θ_2
x:= 0	if b == 0
x := 1	y := 0
a := y	
if a==0	y := 1
Repeat	Repeat

Question 2

Methods:

- enqueue (enq)
- dequeue (deq)

States:

- Initial State = $\{\emptyset, \emptyset\}$

Rules:

Enqueue:

- $\{\emptyset, \emptyset\} \xrightarrow{enq(a, true)} \{\{a\}, \emptyset\}$
- $\{\{a, \dots\}, \emptyset\} \xrightarrow{enq(a, true)} \{\{a, \dots\}, \{a\}\}$
- $\{\{b, \dots\}, \{c, \dots\}\} \xrightarrow{enq(a, true)} \{\{a, b, \dots\}, \{c, \dots\}\}$ if $a \neq b$
- $\{\{a, \dots\}, \{b, \dots\}\} \xrightarrow{enq(a, true)} \{\{a, \dots\}, \{a, b, \dots\}\}$ if $a \neq b$
- $\{\{a, \dots\}, \{a, \dots\}\} \xrightarrow{enq(a, false)} \{\{a, \dots\}, \{a, \dots\}\}$

Dequeue:

- $\{\{a, b, \dots\}, \{a, \dots\}\} \xrightarrow{deq(a, head)} \{\{b, \dots\}, \{a, \dots\}\}$
- $\{\{c, \dots\}, \{a, b, \dots\}\} \xrightarrow{deq(a, tail)} \{\{c, \dots\}, \{b, \dots\}\}$

- $\{\{c, \dots\}, \{b, \dots\}\} \xrightarrow{deg(a, false)} \{\{c, \dots\}, \{b, \dots\}\}$ if $b \neq a \neq c$