COL 830	**August 13, 2018**

Homework 2

Instructor: Subodh Sharma	**Due: August 23, 23:55 hrs**

Problem 1: Formal Modeling of Distributed Systems

1. The operator $||_H$ defines the handshaking between two transition systems. Show that handshaking is commutative, but not associative in general. That is, for $H \neq H'$

$$TS_1||_H(TS_2||'_H TS_3) \neq (TS_1||_H TS_2)||'_H TS_3$$

2. Consider the following mutual exclusion algorithm that uses the shared variables $y1$ and $y2$ (initially both 0).

```
Process P1:
while true do
  ... noncriticalsection ...
  y1 :=y2 +1;
  wait until (y2 =0) \/ (y1 <y2)
  ... critical section ...
  y1 :=0; od
```

```
Process P2:
while true do
  ... noncriticalsection ...
  y2 :=y1 +1;
  wait until (y1 =0) \/ (y2 <y1)
  ... critical section ...
  y2 :=0; od
```

   (a) Give the program graph representations of both processes. (A pictorial representation suffices.)

   (b) Give the reachable part of the transition system of $P1||P2$ where $y1 \leq 2$ and $y2 \leq 2$.

   (c) Check whether the algorithm indeed ensures mutual exclusion.

   (d) Check whether the algorithm never reaches a state in which both processes are mutually waiting for each other.

   (e) Is it possible that a process that wants to enter the critical section has to wait ad infinitum?

3. You have to model the elevator system of your building in Promel and verify in SPIN. The system consists of an elevator that services 3 floors of the building and a controller that communicates with the elevator (using message passing) and schedules its moves. Each floor has a request button that a user presses to get the elevator to come to that floor and open its door. Inside the elevator, there is one request button for each of the 3 floors; passengers press these buttons to get the elevator to go to a particular floor and open its doors. To go from floor i to floor k, the elevator must visit floors i+1 through k-1, although it does not have to open doors there. If there are no requests to service, an elevator stays put with its doors open. Check for the following properties:

   - The elevator never moves with its doors open.
   - The elevator visits every floor infinitely often.
   - Requests to use the elevator are eventually serviced.
   - Requests to be delivered to a particular floor are eventually serviced.

   (**This question will take time; so start early!**)

Problem 2: Logical Time and Clocks

1. Assume you have implemented the vector clock algorithm, however, your application needs Lamport's clock. Write a function `convert` that takes as input a vector timestamp and outputs a logical clock timestamp.

2. Give a proof of strong clock consistency in Vector clocks using induction. That is, show $\forall e_i, e_j \in H, i \neq j : e_i \rightarrow e_j \iff VC_{e_i} < VC_{e_j}$.