



# Concurrency Theory WS 2015/2016

## — Series 5 —

Hand in until December 7th before the exercise class.

### Exercise 1 (Value Passing Process Definitions) (2+2 Points)

- (a) Complete the value passing process definition below such that the process `Counter` outputs the sequence of natural numbers, i.e.  $\overline{\text{out}}(0), \overline{\text{out}}(1), \overline{\text{out}}(2), \overline{\text{out}}(3), \dots$ , but where arbitrarily many  $\tau$ 's may occur between the outputs.

`Counter` = ...  
`Adder` = ...  
`Adder'` = ...  
`Buffer` = ...

- (b) Give a value passing process definition for a process `Squarer` such that the process `Squares` =  $(\text{Counter} \parallel \text{Squarer}) \setminus \{\text{sync}\}$  outputs the sequence of *even* square numbers, i.e.  $\overline{\text{square}}(0), \overline{\text{square}}(4), \overline{\text{square}}(16), \overline{\text{square}}(36), \dots$ , but where arbitrarily many  $\tau$ 's may occur between the outputs.

### Exercise 2 (Translation of Value Passing into Pure CCS) (4 Points)

Prove Theorem 8.8 from Lecture 8.

### Exercise 3 (Structural Congruence in the $\pi$ -Calculus) (1+1 Points)

Let  $Q_1$  and  $Q_2$  be two monadic  $\pi$ -calculus processes.

- (a) Prove that  $\text{new } x Q_1 \not\equiv Q_1 \implies x \in \text{fn}(Q_1)$ .  
(b) Prove that  $Q_1 \equiv Q_2 \implies \text{fn}(Q_1) = \text{fn}(Q_2)$ .