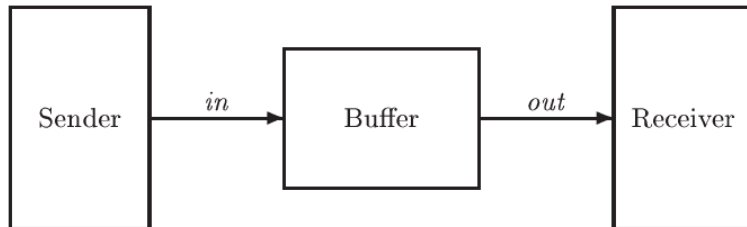**BCS2213 – Formal methods**

Teaching assignment 3. Specification of FIFO Protocol.

1. Model of FIFO (First In First Out).

- Sender and Receiver interact by messages passing (like in Async Interface);

- they communicate not directly, but via Buffer by ***In*** and ***Out*** lines;

- Buffer has a queue inside, storing finite number of messages.

2. Specification of FIFO.

- specification of FIFO **Extends** modules **Naturals** and **Sequences**.

- the **Sequences** module defines operations on finite sequences (tuples).

- TLA tuple is represented in ASCII with $<< >>$

- the basic operations of the sequences are:

$Seq(S)$ The set of all sequences of elements of the set S.

$Head(s)$ The first element of sequence s.

For example, $Head(\langle 3, 7 \rangle)$ equals 3.

$Tail(s)$ The tail of sequence s.
For example, $Tail(\langle 3, 7 \rangle)$ equals $\langle 7 \rangle$.

$Append(s, e)$ The sequence obtained by appending element e to the tail of sequence s.

For example, $Append(\langle 3, 7 \rangle, 3)$ equals $\langle 3, 7, 3 \rangle$.

3. Run TLA+ Toolbox and create new module with name lab_3_<your_ID>.tla

4. Define as a tuple variable Buf and apply to it all the considered above operations on sequences.

Don't forget to define initial, next state predicates and combining it specification.

5. To understand the sense of the operations print the resulted *Buf* (for it, extend your module by TLC).

6. Write TLA specification of FIFO protocol.

In action appends a message to *Buf*, *Out* action deletes a message from *Buf*.

For implementation, please also define the constant Messages.

7. You have specified an unbounded FIFO, that can hold any number of messages.

But any real system has a finite amount of resources, so FIFO can contain only a bounded number of messages. So action *In* is enabled if there are fewer than *N* messages in the buffer, i.e. Len(Buf) is less than N, where N is some constant.

8. Write comments in your TLA module, explaining your ideas.

9. Please upload your labsheet into Moodle. It will be evaluated in max 3% of your general marks.