T-79.179 **Spring 2005**
Parallel and Distributed Digital Systems
Exercise 5
21.3-3.4 2005

Consider two queues, Q_1 and Q_2, of capacity one that are put in sequence (see Section 5.5 p.60 in [Fok00]). Let Δ be a finite set of data elements. Queue Q_1 reads a datum $d \in \Delta$ from a channel 1 and sends this datum into channel 3. Queue Q_2 reads a datum $d \in \Delta$ from a channel 3 and sends this datum into channel 2 (the system is depicted on p.60 in [Fok00]).
The two queues are defined by recursive specifications:

$$Q_1 = \sum_{d \in \Delta} r_1(d) \cdot s_3(d) \cdot Q_1$$

$$Q_2 = \sum_{d \in \Delta} r_3(d) \cdot s_2(d) \cdot Q_2$$

where action $r_i(d)$ represents reading a datum $d \in \Delta$ from channel i, action $s_i(d)$ represents sending datum $d \in \Delta$ into channel i, and $\sum_{d \in \Delta} t(d)$ denotes the alternative composition of process terms $t(d)$, for all elements $d \in \Delta$.
The communication function γ is defined by:

$$\gamma(s_3(d), r_3(d)) = c_3(d)$$

where action $c_3(d)$ represents communication of datum d via channel 3 (all other communications between atomic actions result to δ).
The overall behavior of the system is described as the term

$$\tau_{\{c_3(d) | d \in \Delta\}}(\partial_{\{s_3(d), r_3(d) | d \in \Delta\}}(Q_2 \| Q_1)).$$

1. Give the specification of the two queues with $\Delta = \{d1, d2\}$ as a process declaration in μCRL language.

2. Use μCRL tool set to produce the process graph that belongs to the process declaration from part 1.

3. Use μCRL tool set to show that the system does not contain any deadlocks.