Topics in Concurrency (JMH)

(a) Define the *token game* for basic Petri nets. [3 marks]

(b) When is a basic Petri net *safe* from an initial marking? [2 marks]

(c) An LB-net is a basic Petri net \((B, E, \text{pre, post})\) accompanied by

- a labelling function \(\lambda : E \rightarrow \text{Act}\) from its events to a set of actions \(\text{Act}\)
- subsets of conditions \(I \subseteq B\) and \(T \subseteq B\). The initial conditions \(I\) are marked when the process starts and the terminal conditions \(T\) are marked when the process has terminated.

LB-nets are drawn with labels inside events and boxes surrounding the initial and terminal conditions.

(i) Draw the labelled transition system of the following LB-net. The initial state should correspond to the initial conditions \(I\) being marked and labels on the transitions should correspond to actions, not events. [4 marks]

(ii) Ignoring the particular sets that states represent, is there an LB-net with an injective labelling function \(\lambda\) that gives rise to the same labelled transition system? Justify your answer briefly. [2 marks]

(iii) A simple process language has the following syntax.

\[
p ::= \alpha | p + p' | p \parallel p' | p; p'
\]

where \(\alpha \in \text{Act}\). As in CCS, + represents the nondeterministic sum of processes and \(\parallel\) represents the parallel composition. The process \(p; p'\) represents the sequential composition of \(p\) and \(p\).

Draw diagrams to describe the inductive definition of an LB-net semantics for this fragment. [7 marks]

(iv) An iteration operator \(p^*\) is proposed with LB-net semantics such that its sets of initial and terminal conditions are equal: \(I = T\). Discuss briefly how this affects the semantics you gave in part (c)(iii). [2 marks]