1997 Paper 7 Question 12

Communicating Automata and Pi Calculus

Define the concepts of *strong simulation* and *strong bisimulation* between processes. [4 marks]

Here are three vending machines, selling tea for 20p and/or coffee for 40p:

$$\begin{aligned} T &\stackrel{\text{def}}{=} \mathit{20p}.\mathit{tea}.T \\ C &\stackrel{\text{def}}{=} \mathit{20p}.\mathit{20p}.\mathit{coffee}.C \\ CT &\stackrel{\text{def}}{=} \mathit{20p}.(\mathit{tea}.CT + \mathit{20p}.\mathit{coffee}.CT) \end{aligned}$$

"*20p*" is the user's action of inserting a coin; "*tea*", "*coffee*" are the user's actions of selecting a drink. (For simplicity, the delivery of a drink is not represented.)

One might hope that CT can be made to behave like C or T respectively by blocking off (i.e. by restricting by $\boldsymbol{\nu}$) the appropriate select button. But prove, by considering bisimulations or otherwise, that one of the following assertions is true, the other false:

$$(\boldsymbol{\nu}\ \mathit{tea})\, CT \sim C$$
$$(\boldsymbol{\nu}\ \mathit{coffee})\, CT \sim T$$

[8 marks]

In the case which is false, is there a simulation in one direction? Give a precise reason for your answer. [3 marks]

Now redesign T, C and CT, in a way which still has reasonable behaviour for a machine selling tea and/or coffee, but so that *both* of the above assertions hold, and justify the claim. [5 marks]