1998 Paper 3 Question 2

Concurrent Systems

An n-process mutual exclusion algorithm has entry and exit protocols given below. In order to express the algorithm concisely we use a lexicographic "less than" relation on ordered pairs of integers, so that:

$$(a, b) < (c, d) \text{ if } a < c \text{ or if } a = c \text{ and } b < d.$$

Entry protocol for the critical region for process i:

$taking[i] := true;$
$ticket[i] := max(ticket[0], ticket[1], \ldots, ticket[n-1]) + 1;$
$taking[i] := false;$
for $j := 0$ **to** $n - 1$ **do**
  begin
    while $taking[j]$ **do** *no-op*;
    while $ticket[j] \neq 0$ **and** $(ticket[j], j) < (ticket[i], i)$ **do** *no-op*;
  end

Exit protocol for the critical region for process i:

$ticket[i] := 0;$

(a) Illustrate fully the operation of the algorithm by showing, for a small value of n, successive values of the arrays *taking* and *ticket* under a variety of concurrent executions. Explain by means of short comments on the values. [14 marks]

(b) Is it possible or likely that a value in the array *ticket* might overflow? Why? [2 marks]

(c) A RISC processor has an atomic *read-and-clear-memory* instruction. Give pseudo-code for the entry and exit protocols using the instruction. [4 marks]