2008 Paper 7 Question 7

Advanced Systems Topics

A computer system provides a compare-and-swap (CAS) operation which is used in the following manner:

$$\text{seen = CAS (address, old, new)}$$

It loads the contents of `address`, compares the value against `old` and if it matches stores the value `new` at the same address. All of this is performed atomically and the value read from the address is returned as `seen`.

(*a*) What does it mean for a processor instruction to be *atomic*?　　[2 marks]

(*b*) Write pseudocode for a simple spin lock using `CAS`.　　[4 marks]

Consider a singly-linked list of `QNode` objects, each with a Boolean field `value` and a reference `next` to its successor (holding `null` at the tail of the queue). A shared location `l` refers to the tail node (or is `null` if the queue is empty).

(*c*) Define the following concurrent operations using `CAS`:

```
// Append a new node q to the tail of the list, returning
// the previous tail
QNode pushTail (QNode q);

// Remove q, the current head of the list, returning
// the new head
QNode popHead (QNode q);
```

[8 marks]

(*d*) Define a *queue-based spin lock* based on these operations.　　[6 marks]