UNIVERSITY OF EDINBURGH

COLLEGE OF SCIENCE AND ENGINEERING

SCHOOL OF INFORMATICS

INFR09015 OPERATING SYSTEMS

Tuesday 9$\underline{^{th}}$ August 2016

14:30 to 16:30

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

CALCULATORS MAY NOT BE USED IN THIS EXAMINATION

Year 3 Courses

Convener: C. Stirling
External Examiners: A. Cohn, T. Field

THIS EXAMINATION WILL BE MARKED ANONYMOUSLY

1. (a) Requests for data on a disk are placed into a request queue and serviced by moving the head appropriately. If the current position of the head is known, algorithms known by the acronyms FCFS, SSTF, SCAN, C-SCAN, C-LOOK can be used.

   Describe briefly each of the five mentioned algorithms. [*5 marks*]

   (b) Assume a slow single-platter disk with the following characteristics. It has 200 tracks (number 1 at the inside, 200 at the outside). Assume that the time taken to move the head from standstill at track m to standstill at track m+n (or mn) is approximately (4+n/10) ms. At the current time, the head is stationary at track 100, after moving there from an inner track. The disk request queue contains requests for tracks 55 (front), 58, 39, 90, 160, 38, and 184 (back).

   For each of the five mentioned algorithms (FCFS, SSTF, SCAN, C-SCAN, C-LOOK), show the sequence of moves made to service the request queue, and calculate approximately the time taken to service the whole queue. Ignore the time taken to read the data from the track. [*20 marks*]

2. (a) What is a pre-emptive process scheduler? Describe the first come first served, shortest job first, round-robin (RR) and feedback/priority queue approaches. [*8 marks*]

(b) Suppose that the usual description of the RR algorithm is modified so that a single process can have two (or more) independent entries in the algorithm's data structures, so that a process can be doubly, triply, etc. scheduled.

   i. What is the effect of having two entries for the same process? Does it depend on how they are placed? [*4 marks*]

   ii. Under what circumstances would you consider it appropriate to give a process multiple entries? [*4 marks*]

(c) In a scheduling system known as preemptive priority scheduling, the priority of each process is a (positive or negative) number that changes dynamically, at a rate α when it is on the ready queue, and at a rate β when it is actually running. Processes are initialised with priority 0, and reset to priority 0 when they return from a blocked state. (Positive α means increasing priority.) What happens if the algorithm is run with the following settings? Explain your answers.

   i. $\beta > \alpha > 0$ [*4 marks*]

   ii. $\beta < \alpha < 0$ [*5 marks*]

3. (a) State the criteria to be satisfied for correct critical sections [*5 marks*]

   (b) Consider the following algorithm intended to ensure correct critical section access by two similar processes, where $i = 0, 1$ is the process identifier.

```
flag[i] = true;
while ( flag[1-i] == flag[i] ) {}

/* critical section */

flag[i] = false;
```

      i. Does this algorithm enforce mutual exclusion. Explain your answer? [*4 marks*]

     ii. Can the algorithm result in deadlock? Explain your answer? [*4 marks*]

   (c) Give Peterson's algorithm for mutual exclusion, and justify informally its correctness (namely, that it enforces mutual exclusion and does not deadlock or livelock). [*8 marks*]

   (d) Your system supports an atomic `test_and_set` instruction:

```
bool test_and_set(bool *flag) {
 bool old = *flag;
 *flag = True;
 return old;
}
```

   Write two functions, `acquire()` and `release()`, that use `test_and_set` to implement spinlocks, in C or pseudo-code. [*4 marks*]