UNIVERSITY OF EDINBURGH

COLLEGE OF SCIENCE AND ENGINEERING

SCHOOL OF INFORMATICS

INFR09015 OPERATING SYSTEMS

Monday 16 th May 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) What is deadlock? [*2 marks*]

   (b) What are the four conditions that must hold for deadlock to occur? [*4 marks*]

   (c) Explain the terms: deadlock prevention, avoidance and detection. [*3 marks*]

   (d) Describe the Bankers algorithm using pseudo-code or otherwise. [*5 marks*]

   (e) Does the Bankers algorithm prevent, avoid or detect deadlock? [*1 mark*]

   (f) Which condition(s) described in (b) does the Banker's algorithm address and how? [*2 marks*]

   (g) There are two resource types: A and B. There are instances of resource A and two instances of resource B. Consider the situation where there are two Processes X and Y. Process X requests at most one instance of A and two instances of B while Process Y requests at most two instances of A and one instance of B

   Describe what happens using the Bankers algorithm with the following request sequences:

      i. X requests A ; Y requests A; Y requests B [*4 marks*]

      ii. X requests A ; Y requests A ; X requests B ; X requests B [*4 marks*]

2. (a) Sketch a diagram showing process states and transitions. Briefly describe each state and transition. [*5 marks*]

(b) Explain round-robin, shortest job first and static priority scheduling. [*3 marks*]

(c) Which is fairer: round-robin, shortest job first or static priority scheduling? Explain your answer. [*3 marks*]

(d) Consider five processes, P1, P2, P3, P4, P5 available to execute at time 0 with associated execution times: P1: 10 cycles, P2: 29 cycles, P3: 3 cycles, P4: 7 cycles, P5: 12 cycles.

Calculate the average waiting of the process when using the following scheduling policies: First-come-first-served, round-robin with quantum =10, shortest job first. [*6 marks*]

(e) Suppose we have multiple producers and a single consumer. The producers produce items and insert them into a FIFO queue, while the consumer consumes items from the queue in FIFO order.

The queue is initially empty. If the queue is empty when the consumer wants to run, the consumer will block until the queue is not empty.

Consider the case when we run three producer processes, P1, P2, and P3, and one consumer process, C1, and all of the processes are runnable starting at time zero. Process P1 takes 3 cycles to execute, process P2 takes 2 cycles to execute, process P3 takes 1 cycle and process C1 takes 1 cycle to execute.

The process priorities are P1>P2>P3>C1 i.e. process P1 has the highest priority and C1 has the lowest priority Assume that the initial run order is P1 , P2 , P3 , C1, and the queue is unbounded in size.

i. If round-robin scheduling is used to execute the processes, with time quanta=1, how many items will each process have produced or consumed at the end of 20 cycles? [*2 marks*]

ii. How does the number of entries in the queue change if we increase the time quanta to 3 cycles for round-robin scheduling? [*2 marks*]

iii. If static priority scheduling is used to execute the processes how many items will each process have produced or consumed at the end of 10 time cycles? [*2 marks*]

iv. If shortest job first scheduling is used, how many items will there be in the queue after 20 time cycles? Compare your answer to (i) and (ii) and comment. [*2 marks*]

3. (a) Give brief definitions of the following terms in memory management: MMU, virtual memory, page table, TLB. *[8 marks]*

(b) A virtual address is 32 bits long and a page is 2KB in size. A single-level page table is used, where each page table entry occupies 8 bytes. How big is the page table? How can its size be reduced? State one drawback of a smaller page table. *[4 marks]*

(c) A process iteratively accesses nine pages sequentially (i.e., from page 1 to page 9). Initially the nine pages are stored only on disk and there are only eight page frames available.

i. If the OS employs the LRU page replacement algorithm how many page faults will there be after

A. 1 iteration? *[1 mark]*

B. 10 iterations? *[1 mark]*

ii. If the OS were able to use the clairvoyant Belady's algorithm, how many page faults will there now be after

A. 1 iteration? *[1 mark]*

B. 10 iterations? *[1 mark]*

iii. What realistic replacement algorithm has the same behaviour, in this example, as Belady's? Describe a case where this replacement algorithm performs poorly. *[3 marks]*

(d) A disk drive has 1024 cylinders, each cylinder contains 16 tracks, each track contains 256 sectors, and each sector contains 512 bytes. It spins at 100 rotations per second. It takes (1000 + N) microseconds for the head to move N cylinders.

i. What is the total storage capacity of the disk drive? *[2 marks]*

ii. If the average seek requires that the head move halfway across the disk, what is the average seek time? *[2 marks]*

iii. If, once the head arrives at the right cylinder, the disk has to rotate 180 degrees on average for the requested block to come under the head, what is the average rotational delay? *[2 marks]*