Question 1  

a) Give a detailed explanation of the concept of a process in operating systems that do not support multithreading. You should concentrate on the relationship between programs, processes and the processor. Do not discuss policies, algorithms and data structures.

(13 marks)

b) Suppose that two processes, P and Q, have been admitted to a system, but have not yet run. Suppose that there are two devices, D and E, that can accept I/O requests from processes. List the contents of the single “ready queue” and the two “blocked queues” (one per device) after each stage in the following scenario:

i) Process P is dispatched.

ii) Process P makes an I/O request to D.

iii) Process Q is dispatched.

iv) Process P’s I/O request is satisfied (without pre-empting Q).

v) Process Q makes an I/O request to E.

vi) Process P is dispatched.

vii) Process P makes an I/O request to E.

(7 marks)

Question 2  

a) Give a detailed explanation of the three alternative approaches to the implementation of a threads library on an operating system. You should cover the advantages and disadvantages of each approach.

(13 marks)

b) In the dining-philosophers problem, five philosophers dine at a round table laid out with five forks. A philosopher repeatedly thinks, sits down, picks up two forks, eats, puts down both forks, and gets up. Deadlock can be avoided by employing a footman to ensure that at most four philosophers are seated at a time. Explain how this solution corresponds to the use of a semaphore to limit the number of processes in their critical section.

(7 marks)
Question 3

a) Give an overview of the fixed and dynamic memory partitioning schemes that have now been superseded by paging and segmentation, respectively. You should discuss fragmentation and placement issues, but there is no need to describe the Buddy system.

(13 marks)

b) Suppose there are three (initially free) frames available to a process in a virtual-memory paging system.

i) What happens (under all page-replacement policies) when the page-address stream begins 4, 1, 4, 2?

ii) If the next page address is 7, which page is replaced under an LRU policy and which page is replaced under a FIFO policy? Also, which page is replaced under the optimal policy if the stream is known to continue 6, 1, 4, 2, 7?

(7 marks)

Question 4

a) Give a detailed explanation of the following three non-preemptive short-term scheduling algorithms: First-Come, First-Served (FCFS); Shortest-Process-Next (SPN); Highest-Response-Ratio-Next (HRRN). You must define the quantities that determine which process is selected and state the advantages and disadvantages of each algorithm.

(13 marks)

b) Measure the effectiveness of FCFS, given that initially the processor is available and the ready queue is empty, and that

- process P0 arrives at time 0 ms and executes for 10 ms
- process P1 arrives at time 6 ms and eventually executes for 2 ms
- process P2 arrives at time 7 ms and eventually executes for 1 ms.

You may assume that time spent executing instructions on behalf of the operating system is negligible.

(7 marks)

END OF EXAMINATION