

Where an algorithm is asked for, you may write in any suitable pseudocode. Correct syntax for any computer language is not expected.

Answer 3 questions.

1.

a) Define the terms *deadlock* and *safe state*. Show that a system that is always in a safe state can never become deadlocked. [8]

b) Three processes share four resource units that can be reserved and released only one at a time. Each process needs a maximum of two units. Show that a deadlock cannot occur. [4]

c) Consider the following snapshot of a system. There are no outstanding unsatisfied requests:

Process	Current allocation				Maximum demand				Still needs			
	r1	r2	r3	r4	r1	r2	r3	r4	r1	r2	r3	r4
p1	0	0	1	2	0	0	1	2				
p2	2	0	0	0	2	7	5	0				
p3	0	0	3	4	6	6	5	6				
p4	2	3	5	4	4	3	5	6				
p5	0	3	3	2	0	6	5	2				

Available			
r1	r2	r3	r4
2	1	0	0

i) Is this system in a safe or unsafe state? Show your working. [7]

ii) A request arrives from p3 for (0,1,0,0). In what state would this request leave the whole system (deadlocked, safe, unsafe) if it were satisfied? Which processes, if any, are or may become deadlocked? [7]

d) Discuss the practicability of deadlock detection and deadlock prevention. Why is neither commonly employed? [7]

[TURN OVER]

2.

a) Define the terms *memory management unit* and *translation lookaside buffer*. [4]

b) Describe how a virtual address generated by the CPU is translated into a physical main memory address. You should assume:

- that the memory management unit uses a multi-level scheme, but you are free to choose which so long as the lowest level is demand paged.
- that a translation lookaside buffer is used.

Illustrate your answer with an example. [18]

c) Using the system you described in answer to part (b) explain what happens when a context switch occurs. [7]

d) Consider a page reference string for a process with a working set of M frames, initially all empty. The page reference string is of length P with N distinct page numbers in it. For any page replacement algorithm:

i) What is a lower bound on the number of page faults?

ii) What is an upper bound on the number of page faults? [4]

3.

a) Name five major activities of an operating system that relate to process management and briefly describe why each is required. [10]

b) Describe the operation of a semaphore and comment on the notion of fairness. [5]

c) The Dasney corporation are proposing to build a new attraction: Computer Science World. In this, a small part of the park will be allocated to the illustration of process coordination. This feature will consist of a display area and a room full of single-user PCs for surfing the Internet. Assume that there are m users and n PCs. Users wander around the display area for a while, then line up to use a PC. When a PC is available, the one user it can take is allowed to use it for as long as they want. If all n PCs are all occupied, then a user who wants to surf must wait; if a PC is available, but there are no users, then the PC powers down and waits until it is woken up. Write and explain a program to simulate this environment, using semaphores to synchronise the m user processes and the n PC processes. [18]

[CONTINUED]

4.

- a) Passwords are the most common method of authenticating a user to a system. Discuss the advantages and deficiencies of an authentication scheme that relies on user name and passwords alone. What safeguards should be employed in deciding when to accept a password, how to hold passwords on the system, etc.? [8]
- b) The National Health Service (NHS) is a very large, highly dispersed, organisation, responsible for maintaining a wide variety of health services from hospitals and specialist treatment centres to local general practitioners (GPs), midwifery services, and so forth. There is currently a proposal to cause all medical records to be held online to allow easier access by health professionals. Analyse in detail the security implications of such a move by examining the range of possible threats and possible countermeasures. [25]

5.

- a) What is a *name service*, and why might it be important in the construction of distributed systems? [4]
- b) When a procedure is remotely invoked across a network, arguments (parameters) may need to be transferred. Explain how this may be accomplished. [6]
- c) With reference to the answers you have given for parts (a) and (b), and an example of your choice, outline how Java RMI operates. In what ways is it similar to local procedure call and in what ways is it different? [18]
- d) In a mobile system, disconnection of mobile devices from the network is common and unpredictable. Do you believe that Java RMI would make a good mechanism for remote communication in such an environment? Justify your answer briefly. [5]

[END OF PAPER]