

Monash University

Semester Two 2007 Examination Period

Faculty of Information Technology

EXAM CODES: CSE/FIT

TITLE OF PAPER: FIT2022 Computer Systems II

EXAM DURATION: 3 hours writing time

READING TIME: 10 minutes

THIS PAPER IS FOR STUDENTS STUDYING AT: Clayton, Malaysia

During an exam, you must not have in your possession, a book, notes, paper, calculator, pencil case, mobile phone or other material/item which has not been authorised for the exam or specifically permitted as noted below. Any material or item on your desk, chair or person will be deemed to be in your possession. You are reminded that possession of unauthorised materials in an exam is a discipline offence under Monash Statute 4.1.

No examination papers are to be removed from the room.

AUTHORISED MATERIALS

CALCULATORS: NO

OPEN BOOK: NO

SPECIFICALLY PERMITTED ITEMS: NO

Candidates must complete this section if required to write answers within this paper

STUDENT ID

DESK NUMBER

SECTION A: Multiple Choice (20 marks total)

Each question in this section is worth *2 marks*. Circle the one alternative (a,b,c,d,e) that you think is the **best** answer to the question. If you make a mistake, draw a single stroke “/” through your incorrect answer, then circle your revised answer.

- 1) Operating systems are all about:
 - a) managing memory
 - b) managing processes
 - c) managing people
 - d) managing computer resources
 - e) all of the above

- 2) The kernel of the operating system:
 - a) is written in Python
 - b) manages all interrupt activity in the system
 - c) schedules I/O
 - d) keeps the memory partitioned
 - e) recovers the system from deadlock

- 3) A process scheduler:
 - a) is a kernel process
 - b) is a user process
 - c) is an application process
 - d) is an operating system process
 - e) is not a process at all, since it schedules them

- 4) Process synchronization involves:
 - a) deadlocks
 - b) graphical user interfaces
 - c) non-atomic operations
 - d) all of the above
 - e) none of the above

- 5) An interrupt
 - a) is a faster way of transferring large blocks of data
 - b) improves the scheduling of waiting processes
 - c) is caused by an atomic instruction
 - d) is generated whenever deadlock occurs
 - e) none of the above

- 6) The limit register in memory protection systems
- defines the starting address of a process image
 - controls the size of a process image
 - allows access to any location in memory
 - defines the address of a page table
 - causes an interrupt on page faults
- 7) Dispatch latency is
- the time a process waits before being executed by the dispatcher
 - the time it takes for the dispatcher to start a waiting process
 - the time a process executes before being pre-empted by the dispatcher
 - the time a process waits before being terminated by the dispatcher
 - the time it takes for the dispatcher to switch between processes
- 8) Indexed allocation in file system organization is where
- each file is represented by an i-node
 - the file sectors are linked in a list
 - pointers to the file sectors are stored in an indexed hash table
 - each file has its own block of pointers to the sectors of the file
 - none of the above
- 9) Starvation in disk scheduling may occur in the algorithms:
- FCFS (First Come First Served) and SCAN
 - FCFS and LOOK
 - SSTF (Shortest Seek Time First) and C-SCAN
 - SSTF and FCFS
 - none of the above
- 10) Suppose $D_1 = \{ \langle O_1, rw \rangle, \langle O_2, rx \rangle \}$, $D_2 = \{ \langle O_1, rp \rangle, \langle O_2, w \rangle \}$ are two protection domains, where r=read right, w=write right, x=execute right and p=print right. Then
- In D_1 , O_1 can be executed
 - In D_1 , O_1 can be printed
 - In D_2 , O_1 can be printed
 - In D_2 , O_2 can be read
 - In D_2 , O_2 can be executed

SECTION B: Answer any FOUR questions in this section (80 marks total)

1)

a) What is the difference between multiprogramming and multiprocessing? [4 marks]

b) What are the advantages and disadvantages of multiprocessing? [4 marks]

c) What are the memory management implications of multiprocessing? In your answer, explain particularly how shared memory affects memory management in the context of multiprocessing. [4 marks]

d) Some computers have three levels of privileged instructions: user, supervisor, and kernel; as opposed to the usual two (user and supervisor). Explain why the kernel mode might be useful. [4 marks]

e) Which of the following instructions should be executable in user mode? (circle all correct answers)

- i) set value of timer
- ii) read the clock
- iii) turn off interrupts
- iv) subroutine call
- v) operating system (or supervisor) call
- vi) switch from user mode to kernel mode

[4 marks]

2) **The Supermarket Checkout Problem:** A supermarket has a row of checkout stations, where customers can present their purchased goods for payment. Customers arrive at random times at the checkouts. There is a queue at each checkout (possibly empty), and when each customer arrives at the head of the queue, they deposit goods on the counter for checkout by the operator. The operator in turn picks up these goods, scans them, and packs them into bags for later collection by the customer. When all goods have been scanned, the customer pays the total amount of money due, and collects their packed goods.

You are to model this activity by writing two pieces of code, one for describing each customer process, and one for describing each checkout operator process. Pay particular attention to the synchronization of the two processes. Assume each customer process is initiated by arrival at the checkout queue, and terminates when goods are collected. There may be more than one of these processes at any one time. The checkout operator process is assumed to run indefinitely, and you need model only one such process. You may use any programming language you choose to write the code. (A bonus of 1 mark applies if you use Python!) Pseudo-code is acceptable. [20 marks]

3)

- a) In Laboratory session 3, you saw how to implement a rudimentary file system. Identify what issues have to be addressed if the file system design allows for Unix-style *links* to be used in identifying files. Give your answer in point form. [8 marks]

b) A disk drive has a total of 100 tracks, with a track-to-track seek time of 0.1mS, and a linear seek time proportional to the number of tracks traversed (so seeking from track 0 to track 100 takes 10mS). The head may be returned from track 100 to track 0 with a “head home” operation that takes only 0.2mS.

Given a set of 5 independently generated disk block addresses [85,60,72,36,91], arrange them in the order that gives the lowest seek time under

- i) shortest seek time first scheduling;
- ii) cyclic scanning, where the head starts at track 0 (the home track) and always moves upward, except when returning from the last track to the home track;

assuming that the head is currently positioned at track 67. You may ignore rotational latency, and assume that seek time is proportional to track distance. Which algorithm gives the better performance?

If the reference to track 85 is changed to track 83, what happens to the seek times and the relative performance?

[12 marks]

4)

a) Write a short program fragment (in any language) that defines the semantics (meaning) of the Test and Set instruction. [5 marks]

b) Why can't you use a test and set instruction in place of a binary semaphore? Explain what additional semantics are required. [5 marks]

c) Write a short program fragment (in any language) that defines the semantics of the blocking `wait(semaphore)` operation, and calls the test and set operation defined in part a) above. You may assume a primitive instruction "block". [5 marks]

d) What is the difference between deadlock prevention, deadlock avoidance, and deadlock detection? [5 marks]

5)

- a) Consider a demand-paged computer system where the degree of multiprogramming is currently fixed at 4. The system was measured to determine utilization of the CPU and the paging disk. The results on three different occasions were
- i) CPU utilization 13%, disk utilization 97%
 - ii) CPU utilization 87%, disk utilization 3%
 - iii) CPU utilization 13%, disk utilization 3%

On each occasion, what was happening and why? Can the degree of multiprogramming be increased to improve the CPU utilization? Is the paging helping? [10 marks]

- b) Explain the “working set model” of virtual memory. On a given system, the following measurements were made:

Number of instructions	Working Set size (pages)
1000	6
2000	10
4000	12
6000	13
8000	18
10000	26
12000	27

Sketch the shape of this curve and explain what is happening as the number of instructions in the working set window increases

- i) from 2000 through to 6000
- ii) from 6000 to 10000
- iii) from 10000 to 12000

[10 marks]

- a) List the three characteristics that any solution to the critical section problem must address.

[6 marks]

- b) Instead of a password consisting of a sequence of characters to be entered, it is proposed to use a sequence of arithmetic operators (+, −, ×, ÷). When the user wants to authenticate to a system, they type their username, and then the computer responds with a sequence of numbers. The user applies their operators to the digits, and then enters the result, which must match to authenticate.

For example, suppose your password is −, ×, +, +, and the computer tells you 23, 34, 9, 16, 12. You compute the expression $((((23 - 34) \times 9) + 16) + 12)$ and get −71, which you enter to authenticate yourself.

Discuss the advantages and disadvantages of such a scheme.

[14 marks]

END OF EXAMINATION QUESTIONS