

Monash University

EXAMINATIONS 1999
FACULTY OF INFORMATION TECHNOLOGY

TITLE OF PAPER CSE2302 Operating Systems

INSTRUCTIONS TO CANDIDATES

1) CANDIDATES ARE REMINDED THAT THEY SHOULD HAVE NO BOOKS, NOTES PAPER OR OTHER MATERIAL IN THEIR POSSESSION UNLESS THEIR USE IS SPECIFICALLY PERMITTED BY "INSTRUCTIONS TO CANDIDATES" SET OUT BELOW

- 2) READING TIME IS OF 10 MINUTES DURATION
- 3) EXAMINATION TIME IS OF 3 HOURS DURATION
- 4) THERE ARE THREE SECTIONS: A, B, C; EACH SECTION IS WORTH 40 MARKS TOTAL
- 5) ANSWER ALL QUESTIONS IN EACH SECTION
- 6) WRITE ALL ANSWERS ON THE EXAMINATION PAPER
- 7) TOTAL MARKS 120
- 8) CALCULATORS ARE NOT ALLOWED

SECTION A: Multiple Choice (40 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) A kernel is:
 - a) that part of an operating system that is responsible for resource allocation
 - b) that part of an operating system that is always running
 - c) that part of an operating system that is always resident in memory
 - d) all of the above
 - e) some (but not all) of the above

- 2) Early operating systems used punched cards
 - a) for program entry
 - b) for data entry
 - c) for job control
 - d) all of the above
 - e) some (but not all) of the above

- 3) Spooling in an operating system allows
 - a) the overlap of input and output with job execution
 - b) the overlap of multiple processes or jobs
 - c) email to be read offline
 - d) all of the above
 - e) none of the above

- 4) Multiprogramming in an operating system allows
 - a) more than one programming language to be used
 - b) more than one user on the system
 - c) more than one CPU in the system
 - d) all of the above
 - e) none of the above

- 5) Symmetric multiprocessing
 - a) requires multiple processors, all the same
 - b) requires each processor to run identical copies of the operating system
 - c) allows many processes to run at once without performance degradation
 - d) all of the above
 - e) none of the above

- 6) An interrupt
 - a) is essential to the design of operating systems
 - b) improves the scheduling of waiting processes
 - c) is always generated by a software trap
 - d) all of the above
 - e) none of the above

- 7) A direct memory access (DMA) is
 - a) a fast kind of interrupt
 - b) a fast kind of I/O transfer
 - c) a fast translation look-aside buffer
 - d) all of the above
 - e) none of the above

- 8) Supervisor mode
 - a) protects the operating system against damage
 - b) prevents the user from accessing I/O devices
 - c) allows the execution of privileged instructions
 - d) all of the above
 - e) some (but not all) of the above

- 9) The base register in memory protection systems
 - a) allows access to any location in memory
 - b) defines the starting address of a process image
 - c) contains the ORG address from the assembler code
 - d) all of the above
 - e) none of the above

- 10) Privileged instructions are required to
 - a) change the limit register of a memory protection system
 - b) handle a page fault
 - c) load the timer
 - d) all of the above
 - e) none of the above

- 11) A system trap occurs when
 - a) a system call is issued
 - b) a process is waiting
 - c) the interrupt vector overflows
 - d) all of the above
 - e) some (but not all) of the above

- 12) Dispatch latency is
 - a) the time a process waits before being executed by the dispatcher
 - b) the time a process waits before being terminated by the dispatcher
 - c) the time it takes for the dispatcher to start a waiting process
 - d) the time it takes for the dispatcher to switch between processes
 - e) the time a process executes before being pre-empted by the dispatcher

- 13) Memory-mapped I/O is used because it
 - a) reduces the need for interrupts
 - b) improves the speed of the I/O bus
 - c) removes the need for separate I/O instructions
 - d) improves the programming of some I/O transfers
 - e) all of the above

- 14) A demand segmented memory management scheme

- a) has homogeneous units of memory allocation
 - b) suffers from internal fragmentation
 - c) suffers from external fragmentation
 - d) two or more of the above
 - e) none of the above
- 15) Given a request for an area of size n bytes, First-Fit allocation for storage space (memory or disk) searches the list of free areas for
- a) the area that is the smallest possible over all areas on the free list
 - b) the first area that is $< n$
 - c) the first area that is $\geq n$
 - d) the best area that minimizes the wasted space over all areas
 - e) none of the above
- 16) Indexed allocation in file system organization is where
- a) each file is stored in contiguous sectors
 - b) the file sectors are linked in a list
 - c) pointers to the file sectors are stored in an indexed hash table
 - d) each file has its own block of pointers to the sectors of the file
 - e) none of the above
- 17) Starvation in disk scheduling may occur in the algorithms:
- a) FCFS (First Come First Served) and SCAN
 - b) FCFS and LOOK
 - c) SSTF (Shortest Seek Time First) and C-SCAN
 - d) SSTF and FCFS
 - e) none of the above
- 18) 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
- a) In D_1 , O_1 can be executed
 - b) In D_1 , O_1 can be printed
 - c) In D_2 , O_1 can be printed
 - d) In D_2 , O_2 can be read
 - e) In D_2 , O_2 can be executed
- 19) In question 18 above, suppose object O_1 is executing in domain D_1 and calls O_2 which then starts executing in domain D_2 . Then
- a) O_2 can print itself
 - b) O_2 can write to O_1
 - c) O_2 can copy itself
 - d) O_1 can write to O_2
 - e) none of the above
- 20) Login emulation programs that record passwords are a form of the security threat known as
- a) Trojan Horse
 - b) Trap Door
 - c) Worm
 - d) Virus
 - e) XINU

SECTION B: Answer all questions in this section (40 marks total)

1)

- a) Briefly explain what an operating system is, and what its main purpose from a user perspective should be.

[4 marks]

- b) Name and define the five states of a process as managed by an operating system. Draw a state diagram showing the transitions between these states, and label the edges with the events that cause those transitions.

[8 marks]

- 2) *The Cigarette Smokers Problem.* Consider a system with three *smoker* processes and one *agent* process. Each smoker continuously rolls a cigarette and then smokes it. But to roll and smoke a cigarette, the smoker needs three ingredients: tobacco, paper, and matches. Each smoker has a supply of exactly one of these ingredients: one has tobacco, the next paper, and the third matches. The agent has a supply of all three ingredients, and on each cycle places two arbitrarily chosen ingredients on the table. The smoker who has the third ingredient then makes and smokes a cigarette, signalling the agent on completion, who then puts out two more arbitrarily chosen ingredients, and the cycle repeats. Write a program (pseudo code will suffice) to synchronize the agent and the smokers. You may assume the following shared data structures:

```
var a : array [0..2] of semaphore /* initialized to 0 */;  
    agent : semaphore /* initialized to 1 */;
```

3)

a) An operating systems supports a paged virtual memory, using a processor with a cycle time of 1 microsecond. Pages have 1024 words, and the paging device is a drum that rotates at 3000 revolutions per minute and transfers 1 million ($\approx 2^{20}$) words per second. The following statistical measurements were obtained from the system.

- 0.1 percent of all instructions executed access a page other than the current page.
- Of the instructions that accessed another page, 80 percent accessed a page already in memory.
- When a new page was required, the replaced page was modified 50 percent of the time.

Calculate the effective access time on this system, assuming that there is only one process running, and that the processor is idle during drum transfers.

[4 marks]

- b) Consider the following page reference string:
1,2,3,4,2,1,5,6,2,1,2,3,7,6,3,2,1,2,3,6

How many page faults would occur for the following replacement algorithms and physical memory sizes? Assume the memory is initially empty, and include the initial frame filling page faults.

- i) LRU with 3 frames
- ii) FIFO with 3 frames
- iii) Optimal with 3 frames
- iv) LRU with 6 frames
- v) FIFO with 6 frames
- vi) Optimal with 6 frames

[6 marks]

4)

- a) Give three data structures that might be used to represent directory information in a file system, and state the advantages offered by that data structure.

[3 marks]

- b) For each of your three data structures, identify any problems that might arise in implementing directories with that data structure.

[3 marks]

SECTION C: Answer all questions in this section (40 marks total)

1)

a) Name the three queues involved in process scheduling.

[3 marks]

b) Draw a diagram showing the movement of processes between those queues.

[3 marks]

c) What is the difference between short-term and long-term scheduling?

[2 marks]

2) Consider the following solution to the bounded buffer problem:

```
Data:
    int n,in,out;
    ItemType buffer[n],nextp,nextc;

Producer:
    do {
        ...
        produce(nextp);
        ...
        while ((in+1) % n == out) {noop;}
        buffer[in] = nextp;
        in = (in+1) % n;
    } until 0;

Consumer:
    do {
        while (in==out) {noop;}
        nextc = buffer[out];
        out = (out+1) % n;
        ...
        consume(nextc);
        ...
    } until 0;
```

a) This is a valid solution to the problem, but is inefficient in that it only uses $n-1$ slots of the buffer. Explain why.

[2 marks]

b) It also uses busy waiting. Explain what this is, and why it is inefficient.

[4 marks]

- c) Rewrite the bounded-buffer solution, so that it uses all n slots of the buffer, and uses semaphores to avoid the busy waiting.

[8 marks]

3) Consider the following information about an operating system and the allocation of resources within it.

	Allocation				Max				Available			
	A	B	C	D	A	B	C	D	A	B	C	D
P0	0	0	1	2	0	0	1	2	1	5	2	0
P1	1	0	0	0	1	7	5	0				
P2	1	3	5	4	2	3	5	6				
P3	0	6	3	2	0	6	5	2				
P4	0	0	1	4	0	6	5	6				

a) Explain the meaning of the terms *Allocation*, *Max*, and *Available*, as they are used in the Banker's Algorithm.

[6 marks]

b) Show that the system is in an unsafe state.

[4 marks]

c) Show that it is nevertheless possible for the processes to complete execution without deadlock occurring.

[4 marks]

- 4) Suppose a disk drive has 5000 cylinders, numbered 0 to 4999. The disk is currently serving a request at cylinder number 143. The queue of pending requests, in FIFO order, is
86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130

Starting from the current head position, what is the total distance in cylinders that the disk arm moves in order to satisfy all pending requests, assuming the

a) FCFS

b) SSTF

disk-scheduling algorithms?

[4 marks]