COMP 2320 Operating Systems
1st Semester, 2006-2007
Mid-term Examination

Time Allowed: 50 Minutes

Answer all <u>SIX</u> questions (total 63 marks)

Questions are printed on both side.

This is a closed book examination

Student's Name: _____

Student's ID: _____

Question Number	Full Mark	Score
1	8	
2	8	
3	6	
4	18	
5	10	
6	15	
	Total	

1.a   What are the **<u>FOUR</u>** typical elements in a process image?   (2 marks)

Process Control Block or PCB
User Program or Program
User Data or Data
Stack

1.b   What are the **<u>FOUR</u>** typical elements in the Process Control Block?   (2 marks)
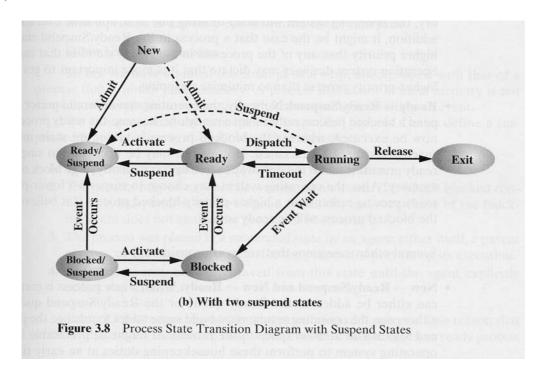
Identifiers – like pid, ppid
Registers
Stack Pointers
State Information
(Refer to Table 3.5, Any 4 will do)

1.c   In order to manage processes and resources, an operating system usually refers to **<u>FOUR</u>** tables for the current information and status. What are these tables?   (2 marks)

Memory Table
I/O Table
File Table
Process Table

2.a Draw a process state transition diagram with the following states: i) New; ii) Ready; iii) Running; iv) Exit; v) Blocked; vi) Blocked Suspend; vii) Ready Suspend. Please also indicate the interactions between the states. (6 marks)

Figure 3.8(b)

Figure 3.8 Process State Transition Diagram with Suspend States

2.b Under what condition will a process be blocked? (1 mark)

Wait for I/O request

2.c What is a typical application that will suspend a running process and examine its content? (1 mark)
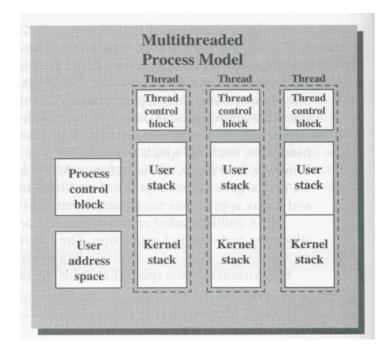
debugger

3.a   What are the advantages of using Threads instead of using Processes?   (2 marks)

Less time to create
Less time to terminate
Less time to switch between two threads
Enhance efficiency in communication (pp. 156-157)

3.b   Use a diagram to show a Multithreaded Process Model.

(4 marks)

4.a Construct an example such that if mutual exclusion is not enforce in a system. More than one process accessing the same data object at the same time will produce comutation/transaction errors. (4 marks)

Account A = $2000
Deposit $1000 to Account A   Withraw $500 from Account A
Read Account A /* A = 2000 */

                                                        Read Account A /* A = 2000 */
                                                        A = A – 500 /* A = 1500 */
                                                        Write $1500 to Account A
A = A + 1000 /* A = 3000 */
Write $3000 to Account A

The withraw transaction is lost because mutual exclusion is not enforced.

4.b Other than Dekker's software approach and the use of semaphores, name **FOUR** more ways to implement mutual exclusion in a computer system.   (2 marks)

Peterson's algorithm
Test and Set instruction
Exchange Instruction
Special Machine Instructions
Disable interrupts
Monitors
Message Passing
(Any 4 will do)

4.c What are the **FOUR** conditions for Deadlock to happen in a computing system?   (4 marks)

1. Mutual exclusion: Only one process may use a resource at a time.
2. Hold-and-wait: A process may hold allocated resources while awaiting assignment of others.
3. No preemption: No resource can be forcibly removed from a process holding it.
4. Circular wait: A closed chain of processes exists, such that each process holds at least one resource needed by the next process in the chain.

(Just the names are OK)

4.d   Answer the following questions with the pseudo-code below:

```
program produce_consumer;
semaphore a = 1;
semaphore b = 0;
semaphore c = 0;
semaphore d = 5;

producer()                                consumer()
{                                         {
 for (I = 0; I < 50; I++){                 for (I = 0; I < 50; I++){
   wait(d);                                  wait(c);
   wait(a);                                  wait(a);
   produce                                   consume;
   signal(a);                                signal(a);
   signal(c);                                signal(d);
 } // end of for loop                      } // end of for loop
 wait(b);                                  signal(b);
 remove all semaphores
}                                         }

main()
{
 parbegin
   producer();
   consumer();
 parend
}
```

i) What is the purpose of semaphore a?   (2 marks)

Guard against critical section or
Enforce mutual exclusion

ii) What is the purpose of semaphore b?   (2 marks)

The producer will wait until the consumer is done then remove all semaphores or
Synchronization between the producer and consumer to remove the semaphores.

iii) What is the purpose of semaphore c?   (2 marks)

Synchronization between the producer and consumer (produce first then consume).

iv) What is the purpose of semaphore d?   (2 marks)

To enforce a limited buffer of 5 for storing the data.

5.

	Maximum Claim			
	R1	R2	R3	R4
P1	0	1	1	0
P2	2	2	1	1
P3	1	1	2	1
P4	2	1	1	0
P5	0	1	1	1

	Current Allocation			
	R1	R2	R3	R4
P1	0	1	1	0
P2	0	0	1	0
P3	0	1	0	1
P4	1	1	0	0
P5	0	0	0	0

	Request (Still Need)			
	R1	R2	R3	R4
P1	0	0	0	0
P2	2	2	0	1
P3	1	0	2	0
P4	1	0	1	0
P5	0	1	1	1

Resource Vector			
R1	R2	R3	R4
2	3	2	1

Available Vector			
R1	R2	R3	R4
1	0	0	0

5.a   Given the Maximum Claim Matrix, the Current Allocation Matrix, and the Resource Vector, fill-in the Request Matrix, and the Available Vector above.   (6 marks)

(1 mark for each correct row)

5.b   Use the deadlock detection algorithm to find out whether the above system is deadlock or not. (Please show your steps in deriving your answer)   (4 marks)

Q = Available Vector (1 0 0 0)

Mark P5 because it does not have any resource allocated
Mark P1 because it does not need any resource and will finish
Q = (1 1 1 0) after P1 finished
Since Q > P4 (1 0 1 0), mark P4 and update Q to (2 2 1 0)
No more row can be marked, hence P2 and P3 are involved in a deadlock.

6.a   What are the names of the **FOUR** Placement Algorithms used for Dynamic Partitioning.

(2 marks)

First-Fit
Best-Fit
Worst-Fit
Next-Fit

6.b   For a 32-bit Operating System. If each memory address can hold 1 byte, how much memory can this operating system addressed?   (1 mark)
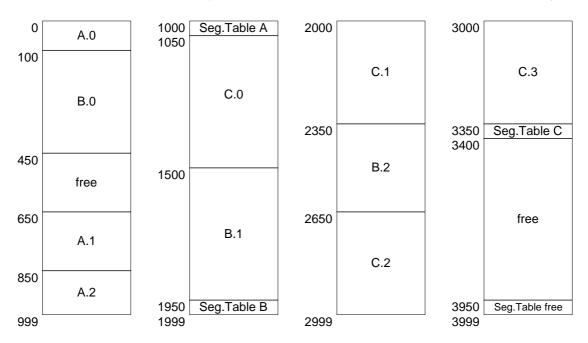
2^{32} X 1 byte = 4 Gbyte

6.c   Assuming a paging system using 32-bit for addressing with 16 Kbyte per page. How many bits will be used for the Offset and how many bits will be used for the page number?   (2marks)

16 Kbyte = 2^4 X 2^{10} = 14 bit
32 bit – 14 bit = 18 bit

So we have 18 bit for page number and 14 bit for the offset

6.d   Consider the following a snap shot of the main memory for a simple segmentation system. Fill-in the following Base address Registers, and the entries in the Process Segment Tables. (All the addresses listed below are in decimal – base 10).   (8 marks)

Base Address Registers:

Process A	Process B	Process C	Free-list
1000	1950	3350	3950

Segment Process Table:

Process A

Seg.#	Address	Length
0	0	100
1	650	200
2	850	150

Process B

Seg.#	Address	Length
0	100	350
1	1500	450
2	2350	300

Process C

Seg.#	Address	Length
0	1050	450
1	2000	350
2	2650	350
3	3000	350

Free-list

Seg.#	Address	Length
0	450	200
1	3400	550

6.e   What is the percentage of the memory that is NOT used due to external fragmentation for the above system?   (2 marks)

Free memory not due to external fragmentation / total memory
750 / 4000
= 18.75%