American University of Beirut

Faculty of Arts and Sciences — Department of Mathematics

MATH 272
Operating Systems
Final - Fall 1995

Time 2 Hours — *Ahmad Nasri*

Assume that the UNIX commands have the prompt Lucifer>

(A,B) General (12 + 15 = 27points)

A. Answer by True or False each of the follwing questions:

1 In locking protocol, if a transaction T_i can read and write to an item Q, then T_i has obtained a shared lock on Q.

2 In time-based protocols, if a a transaction $TS(T_i) < W - timestamp(Q)$, a **read** operation by T_i is rolled back.

3 A distributed system where processors share a memory is called a tightly coupled system.

4 In a script C shell, expr$var-name is used to perform arithmetic operations on numbers.

5 Processes may never get deadlocked in a system with non preemptive resources

6 In virtual memory, the page size should be large to minimize internal fragmentation

7 A system with one instance only per a resource type is unsafe if a cycle exists.

8 The long term scheduler is invoked when the degree of multiprogramming is reached.

9 In a real-time system, fast response is desirable but not required.

10 One way to reduce the context switch time is to overlap swapping and program execution.

11 The page **Stealer** swaps out memory pages that are no longer part of the working set of a process.

12 In a file system, the Device Directory describes the logical properties of files.

B. Complete each of the following:

1 Setting the actual address used by each nonrelocatable address of a program is called:

2 The time needed to switch from one job to another is called:

3 The difference between an interupt and a trap is:

4 Two advantages of distributed systems are:

5 Given a UNIX session consisting of the following commands:

```
Lucifer> cat *.* > silly1 &
Lucifer> cp *.* > silly2 &
```

the following command resumes the first command:

6 The output of the following command is:

```
Lucifer> cpio -it < devicefiles
```

7 Using the following session on a Unix OS:

```
Lucifer> who | sort
```

```
good      tty03     Jan 26 12:50
notgood   tty06     Jan 26 12:30
silly     console   Jan 26 11:40
sleepy    tty02     jan 26: 07:20
```

complete the commands below to list the user sleepy:

```
Lucifer> who |
```

8 To print the third and the first fields (in that order) of each selected line of a file silly, the following **awk** command is used

9 The following command:

```
Lucifer> cp /home/jenny/memo .
```

10 If silly is a shell script, all users can execute it if we change the mode of silly by the following command:

(C) Job Scheduling (15 points)

(C.1) Consider the following set of processes with their arrival, processing time, and their priorities:

job	Arrival Time	Processing Time	Priority
A	0	4	2
B	1	100	4
C	2	3	5
D	3	100	1

a. Draw a Gantt chart to illustrate the execution of these jobs using a preemptive priority scheduling algorithm. *A large value means higher priority.*

b. What is the average waiting time over all jobs?

c. What is the turnaround time of each jobs if an aging technique is used where each non-executing process gets its priority increased by 1 after each interval of time.

(D) Process Syncronization (20 points)

(D.1) In the implementation of the conditional-region construct, assume that a process p_2 and p_1 are waiting behind *second-delay* (p_1 is at the head of the queue) and p_3 is attempting to execute the instruction *wait(first-delay)*. Aassume that semaphores are used without busy waiting and that no other processes are accessing the region, answer each of the following questions:

(i) Give the value of each of first-delay, second-delay, first-count, and second-count, just after p_3 executed the instruction *wait(first-delay)* successfully.

Answer: first-delay second-delay

Answer: first-count second-count

(ii) Assume that the condition B becomes true for p_2 only, what are the values of the semaphores and count of (i), just after p_2 execute S.

Answer: first-delay second-delay

Answer: first-count second-count

(iii) If the condition B becomes true for all processes, indicate the order in which the processes leave the region.

(D.2) Consider a system with three printers that can be allocated to processes with one condition to keep one printer free at least. Write a monitor *AllocatePrinters* to coordinate the use of these printers. Explain how to modify your solution if the system has two lazer printers and one dot matrix printer where one lazer printer is to be left free at all time.

(E) Deadlocks (18 points)

(E.1) Show that a deadlock cannot occur in a system of r resources and p processes where each processes p_i cannot use more than r resources. The sum of all maximum needs is less than $r + p$ and the resources can be released and reserved only one at a time.

(E.2) Consider a system with 4 resources $(r_i)_{1 \leq 4}$ of instances 6, 7, 11, and 12, respectively. The following tables show a snapshot of the cuurent allocation and the maximum needs of the processes:

	Allocation				Maximum			
Process	r_1	r_2	r_3	r_4	r_1	r_2	r_3	r_4
1	0	0	1	2	0	0	1	2
2	2	0	0	0	2	7	5	0
3	0	0	3	4	6	6	5	6
4	0	3	3	2	0	6	5	2

a. Give the vector *available* ane the matrix *Need* and use the Safety algorithm to determine if the system is in a safe state.

b. If p_3 issues a request of $(0, 1, 0, 0)$, can that request be granted? If not indicate the processes that are deadlocked.

(F) Memory Management (8 points)

(F.1) Assume that the logical address space is mapped to a physical adress space of n locations per a frame starting from frame 0. Given a logical address l (starting from 0) answer each of the following using the contents of the associated page tabe T_1:

a. To which logical page l belongs? Answer:

b. To which frame l belongs? Answer:

c. Find an expression of the physical address of l Answer:

(E) Virtual Memory (12 points)

(E.1) Assume that a 2-D array B[1..10,1..10] is stored contiguously in a memory that can contain five elements per a frame starting at frame 1. What is the reference string generated by the following piece of code :

```
For i := 1 to 10 do
    For j := 1 to 10 do B[j,i] := 0
```

(E.2) A process references 5 pages $(p_i)_{1 \leq i \leq 5}$ in the following order:

$$p_0, p_1, p_2, p_3, p_0, p_1, p_4, p_0, p_1, p_2, p_3, p_4$$

Find the number of page faults in each of the *Least Recently Used* and *Optimal* algorithms starting with an empty memory of 3 frames.

Good Work