Ollscoil Mhá Nuad
Maynooth University

Semester 2
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CS240FZ
Operating Systems, Communications and Concurrency

Dr. Bi Ting, Dr. Lo Fook-Loong, Dr. Joseph Timoney, Dr. Michael English

Time allowed: 2 hours

Answer ***four*** questions
Complete question 1, which is worth 40 marks. Choose 3 from the remaining 4 questions, each of which is worth 20 marks.

	Yes	No
Log Books allowed		X
Formula Tables allowed		X
Other allowed *(enter details)* Scientific calculator	X	

General *(Enter Details)* Calculator used cannot be programmable.

QUESTION 1

(a) An operating system for a single user machine, like a PC, and for a multi-user computer, like a mainframe, will not have the same process scheduling algorithms. Briefly explain the reason for this. (5 marks)

(b) What is the difference between a process and a computer program? (5 marks)

(c) A user will interact with the operating system of a computer through a command-line or graphical user interface. What is the difference between them? (5 marks)

(d) A user of a computer with just one CPU, which can execute only one instruction at a time, may run several apps on it, like Word, Excel and Firefox, at the same time. How does the operating system make this possible? (5 marks)

(e) A hard-disk with tracks numbered 0 to 200 has the following track requests in its queue:
43, 95, 134, 12, 49, 38, 185, 78, 23.
The read head is right now on track 65.
(i) How would the requests be serviced if the First Come First Served algorithm is used? (3 marks)
(ii) How would the requests be serviced if the SCAN algorithm is used? (3 marks)
(iii) How would the requests be serviced if the LOOK algorithm is used? (4 marks)

(f) When messages are passed between two processes running on different hosts, the bits making up the messages travel through copper wires, optical fibres, or through space using microwaves or satellite links from one location to another. Messages may become lost or errors may occur. Explain three different ways TCP/IP can use to help overcome this and make messaging more reliable. (5 marks)

(g) Processes often use threads to carry out different tasks, rather than create child processes to carry out these tasks. Give two advantages of using threads instead of spawning child processes. (5 marks)

(h) (i) Does the OS have control over the CPU cache memory? If not, briefly explain why. (5 marks)
(ii) What is virtual memory? When does the OS need to create it, and where is it created?

QUESTION 2

(a) Briefly explain the difference between running processes, blocked processes and zombie processes. (4 marks)

(b) Blocked processes can be divided into two main groups. What is the difference between them? (4 marks)

(c) Explain the difference between preemptive and non-preemptive scheduling algorithms. (4 marks)

(d) Four jobs (A, B, C, D) arrive at times: (8 marks)

0 TASK A has a CPU burst requirement of 6

3 TASK B has a CPU burst requirement of 9

10 TASK C has a CPU burst requirement of 3

11 TASK D has a CPU burst requirement of 5

Calculate the metrics of waiting time, response time, and turnaround time for the First Come First Served (FCFS) scheduling algorithm.

QUESTION 3

The arrival of customers at a fast-food restaurant is Poisson with the parameter λ of 2.5 every minute. There are two workers at the service counter, each of whom can provide a service rate of μ = 1.5 per minute.

Given: The probability of *k* customers coming into the restaurant in 1 minute is

$$P(k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

(a) What is the probability that there are exactly 3 customers entering the restaurant in a minute? (4 marks)

(b) If the queues are formed separately and randomly at each worker, and nobody changes queue, what will be the mean turnaround time T? (5 marks)

(c) If only one queue is formed, with the front customer going to whichever server is free, what is the mean turnaround time T? (5 marks)

(d) What is the probability that there are more than 3 customers coming into the restaurant in a minute? (6 marks)

QUESTION 4

When a process creates several threads to process data in parallel, different problems can arise.

(a) State the Mutual Exclusion Problem. (4 marks)

(b) One attempt to solve this problem is to use a flag. Only when the flag is zero can a thread enter the section of code. The thread will set the flag to one to indicate it is executing the code, and clear the flag when it has finished, as shown in the code below: (5 marks)

```
int flag = 0; /* Shared variable between the threads*/
while (flag == 1) {} /*Do nothing while flag=1 */

flag = 1;
Enter the Pass
...
Leave the Pass
flag = 0;
```

Explain why this approach may not work.

(c) A second attempt is to use 2 flags, one for each thread. When thread 0 wants to enter critical section, it sets its own flag and checks if flag of (5 marks)

thread 1 is set. If it is, it will wait. Otherwise, it enters the critical section. After finishing, it clears its own flag.

```
/* Shared variable between threads*/
boolean[] flag = {false,false};

Thread 0                    Thread 1

flag[0] = true;             flag[1] = true;
while (flag[1]) { }         while (flag[0]) { }
.....                       ......
flag[0] = false;            flag[1] = false;
```

Explain why this approach also will not work all the time.

(d) Briefly explain how the mutual exclusion problem can be solved for two threads using flags and an extra common integer variable, turn. Also explain why this method also ensures that the two threads can always have access to the critical code section. (6 marks)

QUESTION 5

The dining philosopher problem is used to illustrate a problem that operating systems often face. Five philosophers are at a round table with a plate of noodles in front of each, and a chopstick in between every philosopher.

(a) What does each of the following stand for in relation to an OS: (8 marks)
(i) chopsticks
(ii) philosophers
(iii) philosophers thinking
(iv) philosophers eating
(v) philosophers starving

(b) Explain deadlock as experienced by an OS in terms of the dining philosophers. (6 marks)

(c) (i) Briefly describe two methods of preventing deadlocks using the dining philosopher example. (3 marks)
(ii) List the disadvantages of each of the above methods. (3 marks)