Autumn Examinations 2020/2021

Declaration

In submitting this work I confirm that it is entirely my own. I acknowledge that I may be invited to online interview if there is any concern in relation to the integrity of my exam submission, and I am aware that any breach will be subject to the University's Procedures for dealing with breaches of Exam Regulations.

Exam Code(s)	2BMS1, 2BPT1, 2BS1
Exam	2nd Science.
Module Code	CS211
Module	Programming and Operating Systems
Paper No.	1
Repeat paper	No
External Examiner(s)	Dr Detta Dickinson
Internal Examiner(s)	Prof. Graham Ellis
	⋆ Dr Niall Madden
Contact person	Dr Niall Madden (`Niall.Madden@NUIGalway.ie`)
Instructions:	**Answer all questions**.
Duration	2 Hours + 30 minutes for uploading
Upload deadline	**12.00 (noon), Wednesday, 11 August 2021**
No. of Pages	4 pages (including this page)
Discipline	Mathematics

Online Examination Procedures and Rules

This is an OPEN BOOK exam: you may use any online resource you wish, including the lecture notes, text-book, C compiler, etc, providing you list all such resources. You may **not** consult with any person, or share work with anyone else.

Scan your answers, convert your scan to a single PDF file, and upload the PDF to EXAM section of the 2021-CS211 module on Blackboard. Each page of the PDF should include your ID number.

If you encounter difficulties uploading your PDF, email a copy to Niall Madden (`Niall.Madden@NUIGalway.ie`) by the deadline before continuing to upload it to Blackboard.

If you have LENS report that allows extra time to complete the exam, this should be added onto the upload deadline. Indicate the amount of extra time in the uploaded PDF.

During the period of the examination you are not permitted to communicate with anyone else, other than the invigilator, about the examination.

Q1. [**5 Marks**] Which of these expressions describe an operating system? (Select all that apply).

(a) Software for editing documents and spreadsheets.

(b) Software that provides an interface between users and the computer's hardware.

(c) Software that allocates resources: it gives access to the CPU, RAM, mass storage, etc., and makes efficient use of resources.

(d) Software for writing and compiling other programmes.

Q2. [**5 Marks**] In Operating Systems theory, which of the following best describes **a process**?

(a) A unit of memory.

(b) An algorithm for solving a problem.

(c) A program that is being executed.

Q3. [**5 Marks**] Which of the following pairs of symbols are used to delemit a program block in C?

(a) { and } (b) `(` and `)` (c) `[` and `]` (d) `<` and `>`

Q4. [**5 Marks**] Which of the following common C functions are declared in the `stdio.h` header? (Select all that apply).

(a) `scanf()` (b) `rand()` (c) `pipe()` (d) `open()`

Q5. [**5 Marks**] Which of the following are data types in C? (Select all that apply).

(a) `dict` (b) `unsigned int` (c) `unsigned double`
(d) `tripple` (e) `string` (f) `character`

Q6. [**5 Marks**] Which of the following gives the correct syntax for a `for`-loop in C? (Select all that apply. Note that the answer may be case-sensitive).

(a) `for(int count=0; count<=10); count++)`
(b) `for(int i=0; i<=10; i=i+1)`
(c) `for(count int=0; int<=10; int++)`
(d) `for i in range(11):`
(e) `for(int i=0; i=10; i++)`
(f) `for(int i=0..10)`

Q7. [**5 Marks**] Suppose a programme has two integer variables, `a` and `b`. Which of the following gives the correct syntax for outputting a message if they are equal. (Select all that apply).

(a) `if (a = b) printf("a and b are equal");`
(b) `if (a == b) printf("a and b are equal");`
(c) `if ( !(a>b) && !(a<b) ) printf("a and b are equal");`
(d) `if ( !( (a>b) || (a<b) ) printf("a and b are equal");`

Q8. [**5 Marks**] Match each of these data types with its conversion character, as used by, e.g., `printf()`.

Data type:	(i) `int`	(ii) `char *`	(iii) `double`	(iv) `char`
Conversion characters:	(a) `%s`	(b) `%c`	(c) `%e`	(d) `%d`

Q9. [**5 Marks**] Which of the following functions returns the PID of the calling process?

(a) `whatpid()` (b) `mypid()` (c) `getpid()` (d) `returnpid()`

Q10. [**5 Marks**] A C program contains the line

```
fileptr = fopen("data.txt", "w");
```

Which of the following statements is true?

(a) A new file named `data.txt` is opened for writing. If it already exists, its contents are overwritten.

(b) A new file named `data.txt` is opened for writing. If it already exists, any new data will be appended to the end of the file.

(c) A new file named `data.txt` is opened for writing. If it already exists, a `NULL` pointer is returned.

(d) A file called `data.txt` is opened for reading. If it does not exist, a `NULL` pointer is returned.

Q11. [**6 Marks**] Which of the following CPU scheduling algorithms is *non-preemptive*? (Select all that apply).

(i) *First-Come-First-Served* (FCFS),

(ii) *Shortest-Job-First* (SJF),

(iii) *Round-Robin* (RR).

Q12. [**12 Marks**] The table below shows the CPU burst times (in seconds) of four processes submitted in the given order, all at time $t = 0$.

Process	P_1	P_2	P_3	P_4
Burst Time	20	10	15	5

Assuming context switching requires no time, calculate the average wait time for each of:

(a) First-Come-First-Served (FCFS),

(b) Shortest-Job-First (SFJ), and

(c) Round Robin with a time quantum of q = 5 seconds

Note: "time quantum" is also referred to as a "time slice" and as "scheduling quantum".

Q13. [**8 Marks**]

(a) Six (6) processes, all requiring 2 seconds of CPU time are submitted at the same time. If Round Robin scheduling, with a time quantum of 1 second, is used, and context switching requires 0s, what is the average response time?

(b) What is the average response time for the scenario in Part (a) if context switching actually requires 1 second?

Q14. [**6 Marks**] The "Dining Philosophers Problem" model for process synchronisation supposes that there are five philosophers seated around a circular table. They spend their time alternating between periods of eating, and periods of thinking. They each have a plate of rice in front of them, from which they will eat. There are five chopsticks on the table, one between each pair of philosophers. When a philosopher decides to eat, they must pick up both the chopsticks to their immediate left and right. They pick up the chopsticks one at a time. If a philosopher picks up just one chopstick, they will wait indefinitely for the other. Only when they get it, and have finished eating, will the philosopher put down both chopsticks. They then commence thinking for a period of time, before eventually getting hungry again, and repeating the process.

For each of the following statements, state if it is true or false, and explain your answer.

(a) If all diners reach for the chopstick to their left, before trying to pick up the one on their right, then the system **may** reach deadlock.

(b) If all diners reach for the chopstick to their left, before trying to pick up the one on their right, then the system **must** reach deadlock.

(c) If one of the philosphers were to leave, the system could **never** reach a deadlocked state.

(d) If one of the philosphers were to always reach first for the chopstick on their right, while all others first reach for the one on their left first, the system could **never** reach a deadlocked state.

Q15. [**8 Marks**] Suppose a system has two free memory partitions, of size **400k** and **600k**, in that order.

Four jobs requiring (contiguous) memory space of various sizes are submitted at the same time, and in the following order:

Process	Order submitted	Size
P_1	1st	320k
P_2	2nd	200k
P_3	3rd	280k
P_4	4th	200k

(a) Would all these processes be allocated memory if the First-Fit (FF) scheme is employed? If not, which one(s) would be omitted?

(b) Would all these processed be allocated memory if the Worst-Fit (WF) scheme is employed? If not, which one(s) would be omitted?

Q16. [**10 Marks**] Suppose a system has $F = 4$ available frames, and executes a process that has the following "page reference string"

$$\{1, 2, 3, 1, 4, 5, 1, 4, 2, 4, 3, 4\}.$$

(a) Calculate the **Frame Hit rate** using the First-In-First-Out algorithm.

(b) Calculate the **Frame Hit rate** using the Least Recently Used algorithm.

(c) What would be **Frame Hit rate** be for both these algorithms if we increase the number of frames (i.e., $F \geq 5$)?

Q17. [**0 Marks**] What resources, other than lectures notes, did you use when answering the questions on this exam?