



THE UNIVERSITY OF
**WESTERN
AUSTRALIA**

DESK No.

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SEMESTER 2, 2021 EXAMINATIONS

Physics, Mathematics & Computing

Department of Computer Science & Software
Engineering

This paper contains: **6 Pages (including title page)**

CITS2002

Systems Programming

Programming and Systems

Time Allowed: **2:00** hours

INSTRUCTIONS:

This is a CLOSED BOOK examination.

You may bring to the examination and use 1 page (2 sides) of notes of your own handwritten or typed notes.

The paper contains 6 pages and 5 questions.

Each question is worth 10 marks.

You are required to attempt ALL 5 questions

THIS IS A CLOSED BOOK EXAMINATION (SEE ALLOWABLE ITEMS)

SUPPLIED STATIONERY

1 x Answer booklet 10 pages

ALLOWABLE ITEMS

Student Notes Only. Please Specify Below.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a supervisor finds, during the examination, that you have unauthorised material, in whatever form, in the vicinity of your desk or on your person, whether in the examination room or the toilets or en route to/from the toilets, the matter will be reported to the head of school and disciplinary action will normally be taken against you. This action may result in your being deprived of any credit for this examination or even, in some cases, for the whole unit. This will apply regardless of whether the material has been used at the time it is found. Therefore, any candidate who has brought any unauthorised material whatsoever into the examination room should declare it to the supervisor immediately. Candidates who are uncertain whether any material is authorised should ask the supervisor for clarification.

Candidates must comply with the Examination Rules of the University and with the directions of supervisors.

No electronic devices are permitted during the examination.

All question papers and answer booklets are the property of the University and remain so at all times.

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Q1.

An essential shell environment variable used in Unix-based operating systems is named “PATH”, which defines a colon-separated list of directory names that the shell searches to find executable programs. A typical value of “PATH” is

```
“/Users/chris/bin:/usr/local/bin:/usr/bin:/bin.”
```

If the user of the shell wishes to execute, say, a program named “ls”, the shell will search for each of the files “/Users/chris/bin/ls”, “/usr/local/bin/ls”, and so on, until it locates the file “/bin/ls”, which it then attempts to execute.

A common tactic of cyber criminals who successfully break into computer systems, is to create “trojan-horse” programs - malicious programs with common names that will be incorrectly located via a user’s “PATH” environment variable.

You are asked to write a C11 function to locate and print all potential trojan-horse programs found via a user’s “PATH” environment variable. The C11 function should have the prototype:

```
int find_potential_trojans(char *testpath);
```

If there are 3 executable programs named “ls” and 2 named “cp” that can be found via a “PATH” environment variable, then the function will print the full pathnames of all 5 programs, and return the integer 5 to indicate the number of suspicious programs found.

If your function allocates dynamic memory, it must deallocate all allocated memory before it returns.

(10)

Q2.

(i)

What is the primary interface between the C11 programming language and an operating system kernel?

With respect to parameter passing, the return of results, and error handling, explain how the interface has been designed to be as consistent as possible.

(5)

(ii)

With respect to support for file input and output, provided by both the C11 standard library and an operating system, explain the relationship between file pointers and file descriptors.

Explain why, or why not, it is possible to mix the use of file pointers and file descriptors within the same C11 program.

(5)

Q3.

What is the primary motivation for developing an application using threads?

List 4 characteristics that differentiate between processes and threads.

With respect to the support provided by operating systems and programming languages, if you could develop and test an application using either multiple processes, or multiple threads, which do you think would be easier to develop, and why?

(10)

Q4.

(i)

Explain the importance of the memory hierarchy in a computer system.

Explain how the principle of referential locality is important for utilising the memory hierarchy.

(5)

(ii)

With respect to process scheduling, explain the process state transition from 'running' to 'blocked'.

Why is this transition necessary?

What is the difference between the 'blocked' and 'suspended' states?

What circumstances enable the state of a process to change from 'blocked' to 'ready'?

(5)

Q5.

(i)

A computer system employing 32-bit addresses implements virtual memory using a two-level page table.

The right-most 10 bits of each virtual address are used to specify the required offset within a page. The left-most 8 bits are used to index the primary (or root) page table, and the remaining 'middle' 14 bits are used for the secondary page tables.

- (a)** What is the page size in this machine?
- (b)** What is the size of the primary page table?
- (c)** What is the number of secondary page tables?
- (d)** Explain why it is sufficient to keep only the primary page table in the RAM.

(5)

(ii)

What is a resident set in a virtual memory machine?

Explain why a small resident set for each process allows efficient utilization of the CPU.

Explain whether there is any drawback in keeping a small resident set.

(5)

—————END OF PAPER—————