

Programme Code: TU857
Module Code: CMPU 2018
CRN: 22505

TECHNOLOGICAL UNIVERSITY DUBLIN
Grangegorman

TU857 – Computer Science (Infrastructure)
Year 2

SEMESTER 1 EXAMINATIONS 2022/23

CMPU 2018 Operating Systems and System Administration

Internal Examiner(s)

Jack O'Neill
Dr. Paul Doyle

External Examiner(s)

Dr. Charles Markham

Instructions to candidates: Answer Question 1 and any 2 others.
Question 1 is worth 40 marks, all others are worth 30 marks

Exam Duration: 2 hours

Additional Resources Provided: None

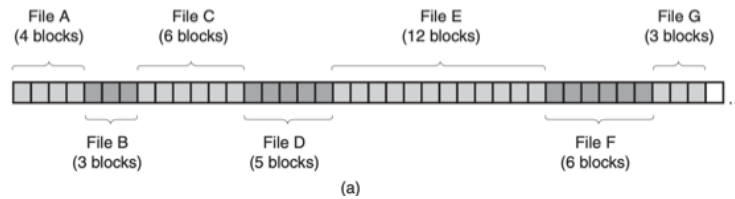
1. (a) *The whole point with "everything is a file" is not that you have some random filename (indeed, sockets and pipes show that "file" and "filename" have nothing to do with each other), but the fact that you can use common tools to operate on different things.* **15 marks**
(Linus Torvalds)

- i. (3 marks) Describe the purpose of a *pipe* in Linux.
- ii. (6 marks) Explain what Torvalds means in the above quote, when he says that "*pipes* show that *file* and *filename*" have nothing to do with each other. Illustrate your answer with an example of how a pipe is used in a Linux shell.
- iii. (3 marks) Explain what the command below would do on a Linux system.

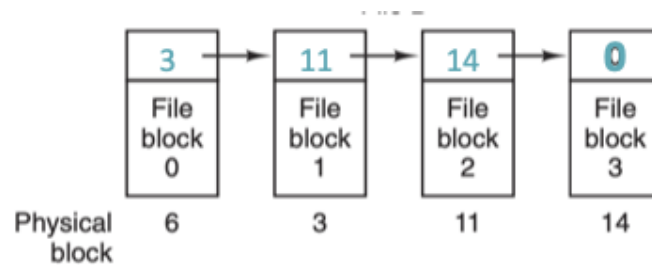
```
> find . -user jack | xargs -d "\n" rm
```

- iv. (3 marks) Modify this command to append all error logs to a log file called *mylog.txt* in the current working directory.

- (b) The images in Figure 1 show examples of the layout of a contiguous (a) and linked-list (b) filesystem. **19 marks**



(a) Contiguous filesystem



(b) Linked-list filesystem

Figure 1: Two possible filesystem layouts

- i. (10 marks) Compare and contrast these approaches to filesystem design, outlining the benefits and drawbacks of each.
- ii. (5 marks) Explain how the File Allocation Table (FAT) filesystem addresses the problems of a linked-list filesystem.
- iii. (4 marks) Discuss how the idea of *i-nodes* improves on the File Allocation Table design.

- (c) The code snippets below are examples of commands which may be run from a Linux shell. **6 marks**

<pre>> sudo rm -rf /</pre>	(a)
<pre>> sudo dd if=/dev/zero of=/dev/sda</pre>	(b)

- i. (3 marks) State the purpose of the **dd** command as shown in (b) and explain each of the command parameters shown.
- ii. (3 marks) Explain the difference between the outcome of running command (a) vs the outcome of running command (b).

2. The listing below shows two possible snippets of the output of an `ls -l` command in the directory containing a standard Linux password file.

```
-rw-r--r-- 1 root root 8160 18 Oct 13:36 passwd (a)
```

```
-rw----- 1 root root 8160 18 Oct 13:36 passwd (b)
```

(a) Explain

15 marks

- i. (2 marks) why listing (a) may appear insecure to such a user unfamiliar with the. `/etc/passwd` file.
- ii. (3 marks) how modern Linux systems address this potential insecurity.
- iii. (6 marks) how a malicious user may circumvent the security provided by listing (b) (give an example).
- iv. (4 marks) what a system administrator can do to further increase the security of Linux passwords (give 2 examples).

- (b) When protecting sensitive resources (such as passwords) stored on disk, operating system designers are faced with a choice between using *symmetric encryption* and *hashing*. **9 marks**

i. (3 marks) Explain the term *symmetric encryption*, and describe how it could be used by the system during the login process, explaining the steps taken when

a) setting a new password

b) checking whether a password matches on login

ii. (3 marks) Explain the term *hashing*, and describe how it could be used by the system during the login process, explaining the steps taken when

a) setting a new password

b) checking whether a password matches on login

iii. (3 marks) State which approach is used on modern Linux and explain why.

- (c) *Physical access is root access*

6 marks

(Lots of people on the internet)

Explain what is meant by the quote above. Illustrate your answer with an example. Describe what a system administrator can do to limit the damage in the event of physical access.

3. (a) *Dependency hell is inevitable*

10 marks

(John Bintz)

- i. (6 marks) Briefly explain the term *dependency hell*, as it relates to software package management. Give an example of the kind of problem it can cause, to illustrate your answer.
- ii. (4 marks) Explain the term *semantic versioning*, and how it helps sys admins and package maintainers to deal with dependency issues.

(b) The code listing, below, shows two commands which must be run to compile a C programme (labelled **a** and **b**). **12 marks**

```
> gcc -c helloworld.c (a)
> gcc -o helloworld.a helloworld.o utils.o (b)
```

- i. (2 marks) Explain what each of the commands (a and b) do.
- ii. (4 marks) Explain the purpose of the *helloworld.a* file and the *utils.o* file in command (b).
- iii. (6 marks) What is the difference between *dynamic linking* and *static linking*. State one benefit and one drawback of each.

- (c) i. (4 marks) A system administrator wants to install the *fish-shell* package from a launchpad ppa and adds the following line to the `/etc/apt/sources.list` file, (having verified that the URL is correct). **8 marks**

```
deb https://ppa.launchpadcontent.net/fish-shell/nightly-master/ubuntu jammy main
```

She then tries to install the fish shell using the following command

```
> sudo apt install fish-shell
```

but gets an error message stating that apt is “unable to locate package *fish-shell*”. Explain what is causing this problem and what the sys admin should do to fix the issue.

- ii. (4 marks) During the process of resolving the previous issue she encounters the following error message:

```
W: ...The following signatures couldn't be verified  
because the public key is not available: NO_PUBKEY  
27557F056DC33CA5  
E: The repository 'https://ppa.launchpadcontent.net/fish-shell/nightly-master/ubuntu jammy InRelease' is not  
signed.  
N: Updating from such a repository can't be done  
securely, and is therefore disabled by default.
```

What steps should she take to rectify the problem?

4. (a) i. (6 marks) Having installed a new version of *python* on a linux server to the */opt/python* directory, describe the steps a system administrator would need to take to permanently be able to run this from any directory. **10 marks**
- ii. (4 marks) The listing below shows two commands, (labelled a and b) which may be used to help troubleshoot booting issues. Explain what each of these commands does and highlight the difference between them.

> dmesg	(a)
> journalctl -b	(b)

- (b) i. (6 marks) Explain the terms *Master Boot Record* and *Volume Boot Record*, stating **12 marks**
- what kind of data each contains
 - where each might be located
 - and how each is used in the boot process
- ii. (6 marks) In older computers, the BIOS was frequently unable to deal with large enough numbers to be able to handle the addresses of very large hard disks, (for example, a 16-bit BIOS could only access the first 65,536 sectors of a disk).

Explain the impact this limitation had on partitioning strategies.

(c) The listing below shows the contents of a bash script.

8 marks

```
1. #!/bin/bash
2.
3. if [ $# -ne 2 ] ; then
4.     exit 2
5. fi
6.
7. if [ $(id -u) -gt 0 ] ; then
8.     exit 1
9. fi
```

Explain what each of the following code segments do in this script

- i. (2 marks) Line 1.
- ii. (3 marks) Lines 3 - 5
- iii. (3 marks) Lines 7 - 9