

Two hours - online

**UNIVERSITY OF MANCHESTER
DEPARTMENT OF COMPUTER SCIENCE**

Operating Systems

Date: Thursday 16th January 2020

Time: 14:00 - 16:00

**This is an online examination. Please answer ALL Questions
The examination is worth a total of 60 marks**

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This is a CLOSED book examination

The use of electronic calculators is NOT permitted

- Q1. How does “metadata” differ from “data”? Include a simple example. [2 marks]
- Q2. Briefly define what is revealed by the Unix command "echo \$PATH". [2 marks]
- Q3. Why are mutual exclusion locks sometimes needed in operating systems code? [2 marks]
- Q4. In Unix, lots of things appear in the files tree as “files”. Give four different examples of apparent file “types” which may be found in such a filing system. [2 marks]
- Q5. You are debugging an application by printing out messages when certain points are reached to find the position of a segmentation fault in the source code and the circumstances which preceded it. Because this takes a long time (many messages) you redirect the messages into file. Unfortunately when you look at this the file cuts off abruptly (in the middle of a message!) and you suspect the last few messages before the fault might be missing. Why might this happen and what can you do to fix it? [2 marks]
- Q6. Write a short explanation, suitable for a student at the beginning of a Computer Science degree course, of how a computer with a single processor can appear to be “multitasking”. Include some details on the possible process states, how processes may be scheduled and how relatively slow I/O is accommodated. (As a guide three or four paragraphs should be adequate.) [10 marks]
- Q7. In one to three sentences, describe the general meaning of “exceptions” in computing. [2 marks]
- Q8. In a Linux system a user process may be subject to exceptions -- known as "signals" -- most of which can be trapped in the user application. Give three different examples such exceptions. (The POSIX names are not required if you can give a brief description of the cause.) [3 marks]
- Q9. A typical computer processor (such as an ARM or x86) will support a set of exceptions which will trap into the operating system. Give three different examples such exceptions. [3 marks]
- Q10. Some types of exception are “inexact”. What does this mean? Suggest why some sections of Operating Systems code will disallow inexact exceptions. [2 marks]
- Q11. Assuming each byte has a unique address, how many bytes are addressable in a `32-bit' address space? [1 mark]
- Q12. In a virtual memory system, why is the memory mapped in “pages”? [2 marks]
- Q13. In a virtual memory system, why does each process require a unique page table/set of page tables? [2 marks]
- Q14. In a 64-bit virtual memory space, why is it effectively essential to use a -multi-level- page table structure? Illustrate your answer with some quantitative estimates. [4 marks]

Q15. A Blu-ray disc can hold about 25 GiB of data. Given sufficient budget for buying RAM, could this all be fitted (at the same time) into the virtual address space of:

- i) a 32-bit computer?
- ii) a 64-bit computer?

Full marks require a little justification, not just yes/no answers) [2 marks]

Q16. The MMAP function allows the logical mapping of a file into the addressable memory space. Assuming space is available for a particular file and the MMAP function is available, describe how data from a particular section of the file (somewhere near the middle) would be accessed using:

- i) File reading operations
- ii) MMAP

Exact names and syntax are not required but you should include enough description to make all the operations clear. [9 marks]

Q17. What is meant by "Lazy Loading" and "Eager Loading"? Describe the behaviour of an operating system employing Lazy Loading of pages when a large binary file is executed. [5 marks]

Q18. Explain what is meant by "DMA" in the context of I/O support. Why is DMA often employed when loading data from a hard disk? Briefly describe, in outline, all the processes which occur when setting up and loading a block of data from a disk. [5 marks]

END OF EXAMINATION