



FACULTY OF SCIENCE

ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE	CSC3B10 COMPUTER SYSTEMS ARCHITECTURES
CAMPUS	APK
EXAM	EXAMINATION SSA — DECEMBER 2014

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ASSESOR(S)

DR ID ELLEFSEN
MR M CILLIERS

EXTERNAL MODERATOR

DR WJC VAN STADEN (UNISA)

DURATION 3 HOURS

MARKS 150

NUMBER OF PAGES: 5 PAGES

INSTRUCTIONS: ANSWER ALL THE QUESTIONS

REQUIREMENTS: NON-PROGRAMMABLE CALCULATORS MAY BE USED

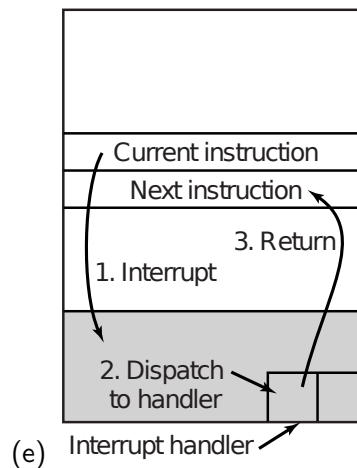
SURNAME AND INITIALS _____

STUDENT NUMBER _____

CONTACT NR _____

SECTION A**QUESTION 1**

- (a) Provide an exact and concise definition of what the **operating system** is and how the operating system works. [3]
- (b) Discuss the management of hardware devices in terms of the **operating system** and the **user**. Provide a diagram to aid in your explanation. [3]
- (c) Operating systems have evolved quite dramatically over time. Discuss the evolution of operating systems of their early days to modern operating systems. [2]
- (d) Superscalar CPUs attempt to make computation more efficient. Explain how superscalar CPUs are structured to allow for faster computation, and also discuss some of the problems that can occur with these designs. [2]



Discuss what this figure is illustrating and for each of the labels provide a short discussion of that is being illustrated.

[15]

QUESTION 2

- (a) What are the four conditions that are required to avoid race conditions? [4]
- (b) You have been asked by your company to rewrite a critical piece of single-threaded software into a multi-threaded platform. Based on the content of the course, discuss the approaches that you would take to do this, the considerations (other than race conditions) that have to be made, and the techniques that you can use. [5]
- (c) In terms of scheduling, would you prefer to run process that are **IO-Bound** or **CPU-Bound**? Explain your answer. [1]
- (d) Consider a queue of jobs that must be run on a batch system that makes use of the **Shortest Job First Algorithm**. Discuss the benefit of using this scheduling algorithm taking into account the scheduling goals for a batch system. [5]

[15]

QUESTION 3

- (a) In the course we discussed memory management in terms of **Bitmaps** and **Linked Lists**. Provide an explanation and advantage of each. [4]
 - (b) Explain how the Memory Management Unit works and what it is used for. [4]
 - (c) The TLB is important to speed up paging. Provide a brief explanation of how the TLB can speed up paging. [2]
 - (d) The effective use of page replacement algorithms is important to ensure that page replacement is efficient. Provide a brief discussion on **WSClock Page Replacement** and **Working Set Page Replacement** and how each of these algorithms contribute to the efficiency of the operating system. [5]
- [15]
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QUESTION 4

- (a) There are three essential requirements for the long term storage of data. List and discuss these three requirements by referring to mechanism that a file system can use to realise these requirements. [6]
 - (b) The Virtual File System plays an important role in the functionality the the Operating System provides. Provide a discussion on the Virtual File System and elaborate how the Virtual File system works. You may include a diagram to aid in your explanation. [5]
 - (c) You have been asked to discuss the types of system backups that can be done. Elaborate on the types of system back and reasons for system backups. [3]
 - (d) What are we refering to when we talk about a **double indirect block**? [1]
- [15]
-

QUESTION 5

- (a) List and explain the four (4) factors that can effect the performance of a disk. [4]
 - (b) Which disk performance factor is effected by a **Disk Arm Scehduling Algorithm**? Discuss why this is the case and elaborate on two possible algorithms can can be used to perform **Disk Arm Scheduling**. [4]
 - (c) What is the use of the clock hardware on a machine, and what effect does the clock hardware have on process scheduling? [2]
 - (d) Sector interleaving and cylinder skew are two methods that can physically improve performance of a hard disk drive. Discuss what sector interleaving and cylinder skew are and how they can improve the performance of a disk drive. [5]
- [15]
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QUESTION 6

- (a) The idea of a deadlock is an important one for the operating system. Discuss what a deadlock is with reference to the resources in a system. [2]
- (b) When performing deadlock modeling, how can resource allocation be modelled in such a way that deadlocks can be detected? [2]
- (c) List and explain the four conditions required having the potential for deadlock. [8]
- (d) Discuss deadlock detection and recovery as a method of dealing with deadlocks. In your discussion include an outline of methods that can be used to detect and recovery from deadlock. [4]
- (e) Deadlocks and communication deadlocks are closely related problems. Provide a complete discussion of what a communication deadlock is, how it could occur, and how it can be prevented. [4]

[20]

QUESTION 7

- (a) Explain the characteristics of a UMA or NUMA-based machine type. [4]
- (b) Explain what Binary Translation is and how it is used to allow Type-2 Hypervisors to work correctly. [3]
- (c) RPC mechanisms often rely on different types of middleware to communicate. Elaborate on the possible different types of middleware that can be used by an RPC mechanisms. [3]
- (d) Explain how Gang Scheduling works when scheduling threads on multiple processors. [2]
- (e) Provide an explanation of how a Master-Slave arrangement works to control multiple processors. [3]

[15]

QUESTION 8

- (a) Security models can be use to define how objects and entities interact on a secure level. With this in mind, provide a discussion that compares the **Bell-La Padula Model** with the **Biba Model**. [5]
- (b) File systems can implement **Access Control Lists** or **Capabilities Lists** to allow files to be protected. Provide a discussion on the use of Access Control Lists and Capabilities Lists in the context of the File System. In your discussion outline which you believe is better and justify your answer. [5]

[10]

SECTION B**QUESTION 9**

- (a) Explain how pointers can be realised in an Assembly Language for global variables, local variables, and function parameters. Include in your discussion how the pointers can be dereferenced for each of the above types. [5]
- (b) Modern machines contain a Floating Point Unit to work with floating point numbers. In terms of an Intel machine, discuss how the Floating Point Unit work and how the CPU communicates with the Floating Point Unit. [5]
- (c) You must create a function that makes use of the Floating Point Unit and recursively performs the following operation on each element of an array: $(p + 1)/n$, where p is the current element, and n is the size of the array. You should have the user read in 5 integer values from the keyboard that you store in an array, the function should then accept an array as a parameter as well as the size of the array. The original array should be modified to store the new values in the function. Your function should be recursive. Your function should make use of the Floating Point Unit. Provide the **pseduocode** to realise this function. [5]
- (d) Complete the assembly language code that can be used to realise algorithm outlined in the previous question making use of the skeleton provided below. Use the following skeleton in your answer: [15]

```
.386
.MODEL flat

ExitProcess      PROTO    NEAR32 stdcall , dwExitCode: DWORD

.DATA

; CODE GOES HERE

.CODE

; CODE GOES HERE

_start:

; CODE GOES HERE

PUBLIC _start
END
```

[30]

— End of exam —