UNIVERSITY OF DUNDEE

B.Sc. EXAMINATION
School of Computing
2 Hours

May 2013

Computer Systems 2B
Computer Architecture and Operating Systems (AC22005)

This examination paper contains **SIX** questions.

Attempt **TWO** questions from **Section A** and **TWO** questions from **Section B**.

Only calculators approved by the School of Computing for exam use may be used in this exam.

SECTION A
Attempt TWO questions from this Section.

Question 1

(a) (i) Describe the **general principles** which make the use of **caches** common in microprocessor and microcomputer architecture. **[4 Marks]**

(ii) Name and describe ***three*** specific **types of cache** which can be found in modern microprocessors; include a description of what is stored in the cache in each case.

[9 Marks]

(b) A particular 32-bit computer has 4GB of main memory, segmented into 128KB frames. A paged, byte-addressable virtual memory is being used, and the processor is executing a program which is segmented into eight pages.

(i) How many bits are required to store the frame number in the page translation table?

[1 Mark]

(ii) Pages 1, 2 and 5 of the program are in memory frames 12, 5 and 25 respectively; the other pages are in virtual memory. Draw the relevant section of the page translation table to reflect the current state of this program. **[5 Marks]**

(iii) Consequently, if the CPU needs to access the following (hexadecimal) **logical addresses** in this order, what corresponding **physical addresses** or **page faults** will be generated?

```
$000B754A
$000F00D6
$0005F2CB
```

[6 Marks]

Question 2

(a) Describe the **programmer's model** of a typical CPU, giving a brief description of its main elements. **[6 Marks]**

(b) The width of the **data bus** in microprocessors has increased over the years. Describe and explain the effect which this has had on both machine code **instructions** and their **operands**. **[4 Marks]**

(c) **(i)** Explain how microprocessor **addressing modes** have changed over the years. **[3 Marks]**

(ii) Give an example of an addressing mode from a modern processor which an older 8-bit processor would not have, explaining how it works. **[3 Marks]**

(iii) What potential benefits have these addressing mode changes given to the programmer, and have these been realised in practice? **[3 Marks]**

(d) State how the **power consumption** of a processor relates to the number of transistors it contains, and the implications for future processors. **[6 Marks]**

Question 3

(a) (i) Mention **three differences** and **three similarities** between programming in C# in Visual Studio and programming in C / C++ in a command-line environment.

[6 Marks]

(ii) name **three** user interface components available from the Toolbox when building a C# graphical user interface in Visual Studio Design View; for **each** component, give an example of how it is typically used. **[3 Marks]**

(b) Describe the **bus hierarchy** within the architecture of a modern PC and the reasons why it has developed. Name and briefly describe ***three*** of the standard PC buses.

[8 Marks]

(c) Describe the operation of I/O using **Direct Memory Access (DMA)**, noting any advantages and disadvantages of this method. Give an appropriate example of its use.

[8 Marks]

SECTION B
Attempt TWO questions from this Section.

Question 4

(a) Explain what **Resource Allocation Denial** is, and what role it plays in an Operating System, including its main advantage relative to **Process Initiation Denial**.

[8 Marks]

(b) A certain system has three types of non-pre-emptible resource, named **A**, **B** and **C**. There are five processes **P0**, **P1**, **P2**, **P3** and **P4** needing to use these resources, and at a certain instant of time the resource allocation is as shown in the table below.

Claim Matrix (Total Resources Required)						**Allocation Matrix (Current Resource Allocation)**						**Available Vector**	
	P0	**P1**	**P2**	**P3**	**P4**		**P0**	**P1**	**P2**	**P3**	**P4**		
A	1	4	0	0	2	**A**	0	2	0	0	1	**A**	2
B	3	2	4	3	1	**B**	1	2	2	0	0	**B**	0
C	2	0	3	2	3	**C**	1	0	1	0	1	**C**	1

(i) Show that this allocation of resources is "safe". Explain carefully how your calculation proceeds. **[8 Marks]**

(ii) Explain what "safe" means in this context. **[4 Marks]**

(c) If process **P2** requests the use of **1** more unit of resource **C**, should this be allowed immediately? Justify your answer. **[5 Marks]**

Question 5

(a) Describe, using appropriate diagram(s), the structure of the **Microsoft Windows™** Operating System. Amongst other aspects, your answer should highlight features that:

- facilitate the portability of the Operating System between different hardware platforms;
- promote the modularity of the Operating System and associated applications.

[9 Marks]

(b) Describe the **CPU scheduling objectives** of Microsoft® Windows™, and explain how its scheduling system attempts to address these objectives. Use diagrams in your answer. **[8 Marks]**

(c) Imagine that you are commissioned to modify the Microsoft® Windows™ **scheduling** system so that it contains a new scheduling mode for supporting scientific computation, i.e. the scheduler needs to give more Run time to **CPU-bound** (compute-intensive) applications at the expense of **I/O-bound** (interactive or user-oriented) processes. Describe how you would approach this project, and show the design that you would develop in order to achieve this new scheduling mode. **[8 Marks]**

Question 6

(a) (i) Explain what a **thread** is and how it relates to the concept of a **process**. Note advantages that threads offer and instances where they would be used. **[6 Marks]**

(ii) Explain what a **critical section of program code** is, and the problems that it can cause. Outline a method of combating these problems and illustrate this in pseudo-code. **[7 Marks]**

(b) (i) Describe briefly how the **FIFO (First-In-First-Out)** disk scheduling algorithm works, and note one advantage and one disadvantage of the algorithm. **[4 Marks]**

(ii) The heads on a hard disk drive are currently reading cylinder number 20, and the current queue of required cylinders is:

31, 78, 11, 66, 179, 13, 14, 37, 141.

Write down the order in which these cylinders will be accessed, assuming that no further requests arrive, and that the **FIFO** algorithm is used. **[6 Marks]**

(iii) Compute the total number of cylinders that have to be traversed in order to service the above requests using the **FIFO** algorithm, starting from cylinder 143. **[2 Marks]**

[End of Examination Paper]