Level 6 Advanced Diploma in Computer Science (907)
203 Credits

Unit: Computer Systems Architecture **Exam Paper No.:** 1	**Guided Learning Hours:** 280 **Number of Credits:** 28
Prerequisites: Good computing knowledge	**Corequisites:** A pass or better in Diploma in System Design or equivalence.
Aim: The unit covers how programs are represented and executed by modern computers, low-level machine representations of programs and data; an understanding of how computer components influence program performance, assembly level machine organisation, memory system organisation and architecture, functional organisation, multiprocessing and alternative architectures. Fundamental concepts of the architectural structure and organisation of computers are reviewed, including fundamental execution cycle, central processing unit, input/output unit and memory management unit. The unit reviews key abstractions supported at the architectural level such as virtual memory, micro-architecture, I/O controllers and processors. An analysis of the evolution of the major architectures from Complex Instruction Set Computers (CISC) to Reduced Instruction Set Computers (RISC) is carried out. Conceptual development and implementation of data structures including arrays, records, linear lists, stacks, queues and binary trees. Operating system structures, concurrent processes, resource scheduling, memory management, file system and protection and distributed systems are analysed in detail.	
Required Materials: Recommended learning resources.	**Supplementary Materials:** Lecture notes and tutor extra reading recommendations.
Special Requirements: A thorough understanding of computer organisation, operating systems and data structures is required to enable learners pass the examination.	
Intended Learning Outcomes:	**Assessment Criteria:**
1 Computer system; understanding the major characteristics that make the computer system such a powerful machine; capabilities and limitations.	1.1 Describe Input-Process-Output-Storage model 1.2 Analyse computer architecture components 1.3 Describe hardware components – CPU, memory and software components 1.4 Describe communications components 1.4 Describe protocols, standards and history of computers.
2 Describe numbering system computation; conversion between binary, decimal, octal, hexadecimal and bits, data types and operations.	2.1 Define why binary is important 2.2 Define decimal, binary, octal and hexadecimal number systems 2.3 Demonstrate binary arithmetic (addition, subtraction and multiplication) 2.4 Demonstrate how to compute fractions. 2.5 Define how data is represented in a computer 2.6 Define ASCII characters
3 How integer data is represented; the concept of signed magnitude; value/magnitude and sign (plus or minus); floating point numbers; how floating point numbers are used in computers when the number is outside the integer range of the computer or contains a decimal fraction.	3.1 Describe sources of data 3.2 Identify common data representation types 3.3 Define character and control codes 3.4 Define image data. 3.5 Describe different data format specifications for converting data into computer usable form, 3.6 Analyse the different ways human data may be represented, stored and processed by a computer. 3.7 Define a 16, 32 and 64-bit word 3.8 Define unsigned numbers

	3.9 Define sign and magnitude 3.10 Define data overflow 3.11 Describe the exponential notation 3.12 Describe overflow and underflow 3.13 Describe normalisation 3.14 Examine floating point arithmetic issues and limitations
4 The components of the CPU and the von Neumann Computer Model; communication between Memory and Processing Unit.	4.1 Describe the fetch execute cycle 4.2 Define bus characteristics 4.3 Describe general registers 4.4 Describe special-purpose registers 4.5 Identify memory operations and the relationship between memory address registers, memory data register and memory 4.6 Describe memory capacity 4.7 Define Random Access Memory (RAM) 4.8 Define Read Only Memory (ROM) 4.9 Define Point-to-point vs multipoint 4.10 Describe the motherboard layout 4.11 Describe the instruction set format
5 The creation and analysis of efficient data structures, the formation, layout and their functions.	5.1 Describe linear lists; stacks; queues; arrays and binary trees 5.2 Explain the process of traversing data 5.3 Describe how to add and delete data 5.4 Describe how to sort data 5.5 Define the process of searching for a specific item of data
6 Assembly as a low level language and why it lacks high-level conveniences such as variables and functions.	6.1 Explain low-level language basics 6.2 Describe how assembler reads a sample program, and converts each line of code into one CPU-level instruction. 6.3 Describe how assembly language is compiled. 6.4 Define assembly language instruction format.
7 The differences between CISC (Complex Instruction Set Computer) and RISC (Reduced Instruction Set Computer).	7.1 Describe the CISC architecture 7.2 Describe the limitations of CISC architecture 7.3 Define RISC features 7.4 Describe Very Long Instruction Word (VLIW) architecture 7.5 Describe EPIC (Explicitly Parallel Instruction Computer) architecture 7.6 Define how paging is managed by the operating system. 7.7 Differentiate logical vs physical addresses 7.8 Define cache memory. Describe the difference between cache and virtual memory
8 Understand how the processing speed or program execution is determined primarily by the ability of Input/Output (I/O) operations to stay ahead of the processor.	8.1 Describe I/O speed and coordination issues 8.2 Describe I/O device interface issues 8.3 Describe Input/output module functions.

	8.4 Define the CPU interrupts. Explain the use of interrupts. 8.5 Define Direct memory access (DMA) 8.6 Define data bus configuration architecture 8.7 Describe different external bus and port interfaces. 8.8 Explore the structure of an operating system's I/O subsystem 8.9 Discuss the principles of I/O hardware and its complexity 8.10 Provide details of the performance aspects of I/O hardware and software
9 Computer peripherals, their classifications, how they are connected, the characteristics and features of Real-Time systems.	9. Describe storage devices and their data access time 9.2 Describe the hard disk layout format. 9.3 Describe the CD-ROM layout. 9.4 Explain the timing requirements of real-time systems 9.5 Distinguish between hard and soft real-time systems 9.6 Discuss the defining characteristics of real-time systems 9.7 Describe scheduling algorithms for hard real-time systems
10 The difference in layout between PC, mini, and mainframe systems, including clustering, mass-storage systems and distributed system structures implementation.	10.1 Differentiate PC and mainframe components 10.2 Describe multiprocessing symmetrical processing 10.3 Describe cluster models 10.4 Describe the client-server architecture 10.5 Define parallel computing 10.6 Describe the physical structure of secondary and tertiary storage devices and the resulting effects on the uses of the devices 10.7 Explain the performance characteristics of mass-storage devices 10.8 Discuss operating-system services provided for mass storage, including RAID and HSM 10.9 Provide a high-level overview of distributed systems and the networks that interconnect them 10.10 Discuss the general structure of distributed operating systems 10.11 Explain the naming mechanism that provides location transparency and independence 10.12 Describe the various methods for accessing distributed files 10.13 Contrast stateful and stateless distributed file servers 10.14 Show how replication of files on different machines in a distributed file system is a useful redundancy for improving availability 10.15 Introduce the Andrew file system (AFS)

	as an example of a distributed file system
11 Overview of operating systems concept, architecture, structure and the fundamental model.	11.1 Describe the services provided by an operating system 11.2 Describe the relationship between hardware and the operating system 11.3 Describe single job processing 11.4 Compare and contrast multitasking vs multiprocessing 11.5 Compare and contrast concurrent processing vs simultaneous processing 11.6 Describe file management features 11.7 Describe scheduling 11.8 Describe the different types of operating systems 11.9 Describe the services an operating system provides to users, processes, and other systems 11.10 Discuss the various ways of structuring an operating system 11.111 Explain how operating systems are installed and customised and how they boot
12 The process of loading and executing a program, including the number of different methods for preventing or avoiding deadlocks in a computer system.	12.1 Develop a description of deadlocks, which prevent sets of concurrent processes from completing their tasks 12.2 Describe basic scheduling concepts 12.3 Describe CPU scheduling decisions 12.4 Examine the several steps users' go through before scheduling is run 12.5 Define process swapping 12.6 Identify the characteristics of multimedia data 12.7 Examine several algorithms used to compress multimedia data 12.8 Explain the operating system requirements of multimedia data, including CPU; disk scheduling and network management 12.9 Define how virtual memory is implemented 12.10 Define demand paging
13 The file system structure, file operations, block allocation; free-block algorithms and trade-offs.	13.1 Explain the purpose of file systems 13.2 Describe the interfaces to file systems 13.3 Discuss file-system design tradeoffs, including access methods, file sharing, file locking, and directory structures 13.4 Explain file-system protection 13.5 Describe the details of implementing local file systems and directory structures 13.6 Describe the implementation of remote file systems
14 How to protect the system resources and the external environment of a system.	14.1 Discuss security threats and attacks 14.2 Explain the fundamentals of encryption, authentication, and hashing 14.3 Examine the uses of cryptography in

	computing 14.4 Describe the various countermeasures to security attacks

Recommended Learning Resources: Computer Systems Architecture

Text Books	• Introduction to Computing Systems: From Bits and Gates to C and Beyond 2nd Edition. ISBN 10: 0072467509 • Computer Organisation and Design Fundamentals by David Tarnoff ISBN: 978-1-4116-3690-3 • Principles of Computer Architecture Miles Murdocca and Vincent Heuring ISBN-10: 0201436647 • Operating System Concepts, 8th Edition Abraham Silberschatz. ISBN 978-0-470-12872-5
Study Manuals	BCE produced study packs
CD ROM	Power-point slides
Software	None