UNIT 2: FUNDAMENTALS OF COMPUTER SYSTEMS

Delivery guidance

Approaching the unit

This synoptic unit allows learners to explore how computer systems and their component parts work. Learners will need to understand how hardware and software combine to make a system that can, in turn, form part of a larger system. Learners will need understand how data is represented in digital form and how it is used, stored, processed and transmitted by different parts of a system within vocational contexts. They will also need to be able to analyse the impact of computer systems, evaluate the effectiveness of systems in a range of vocational contexts and, where appropriate, suggest improvements and make justified recommendations.

You should prepare learners to be highly effective and technically fluent users of computer systems. Learners should have both theoretical and practical experience of how to use and combine components and systems to meet vocational needs. Learners should be able to create and interpret systems diagrams and flow charts to plan and/or describe computer systems and associated processes.

This delivery guide does not cover everything that needs to be delivered for completion of this unit but gives examples of delivery methods. You should refer to the specification for full details of all the content that needs to be covered.

In the external assessment, learners may be tested on any of the content in the specification. Learners must practise the correct and full completion of any templates given in sample assessment materials (SAMs) or past papers in preparation for their external assessment task.

Delivering the topics

For topic A, learners should have an understanding of how individual internal computer components and larger hardware devices can be used individually or in combination with other computer systems. Learners should have a sound understanding of how the features of different hardware devices affect their use in an IT system, as well as the implications of the relationship(s) between components, devices and relevant peripherals.

Learners should be aware of the important role that software plays in any system and should understand the roles and functions of different types of software. Learners should be able to analyse how software and hardware make use of data to achieve identified aims and be able to analyse the impact of these on the overall effectiveness of a computer system and the associated implications for individuals and organisations.

For topic B, learners should understand the principles and implications of different computer system architecture and microarchitecture models. Learners should have a strong grasp of the purpose and functions of component parts within microarchitecture models, the factors that affect the performance of

individual and related components, and the resulting implications for systems, individuals and organisations.

For topic C, learners should understand the concept of how data can be represented and stored in digital format. Learners should be able to use and interpret number systems that are used in computer systems to process numerical data and should also be able to perform operations and calculations of data in these forms. Learners should understand the purpose of systems used for representing text in digital form and the associated processes and implications.

Learners should explore how images are captured, represented and stored in digital form. You should give learners opportunities to explore the features of digital images (including colour modes, bit depth and resolutions), and opportunities to investigate how variations in hardware, software and computer processes affect the stored data, and the resulting impact on the quality and accuracy of an image.

For topic D, learners should explore the use of data structures within computer systems. Learners should have a strong grasp of how data is stored within these structures and how these structures affect how a computer system can access and use the data. Learners should be confident in using and exploring matrix representation in computer systems and should be able to perform and interpret processes and calculations using matrices and arrays.

For topic E, learners should explore the ways in which data is transmitted within and between computer systems. Learners should explore the technologies that enable devices and systems to communicate and share data with each other and how the features and characteristics of these technologies affect the system and its effectiveness. Learners should be aware of different connection types and the processes used to transmit data using these connection methods.

Learners should have a strong grasp of the role and implications of protocols used to govern data transmission and issues that relate to using technologies for transmitting data. Learners should be able to describe, apply and justify the use of encryption methods and their role in protecting data. Learners should explore the use and effects of compression on data and have a good understanding of its use by computer systems.

You should give learners opportunities to investigate and apply common techniques and processes for checking and correcting errors in transmitted data. Learners should be able to analyse the uses and implications of error detection and correction systems.

For topic F, learners should be able to use, apply and interpret the use of Boolean logic to identify and analyse the logical structures and computer processes of a computer system. You should supply learners with opportunities to explore the use and interpretation of system diagrams and flow charts to represent systems and processes. This topic is best taught in conjunction with other topics.

You should ensure that learners have opportunities to apply their understanding of all topic areas in vocational contexts and you should help learners to create logical links between different areas of the specification. Learners should be able to recall factual knowledge about computer systems, analyse situations, evaluate decisions and discuss wider considerations of the implementation and use of computer systems. You should deliver content for all topics through a combination of presentations, individual and group learning tasks, visits, guest speakers and detailed case studies.

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Assessment guidance

Learners will be assessed by a written examination paper, which will include short-answer questions, extended tasks and tasks requiring diagrammatical responses. This will assess learners' technical and theoretical understanding as well as their analytical skills.

In preparation for the examination, learners should respond to vocational scenarios to explore the use of computer systems and associated hardware and software. Learners should be able to discuss, analyse and evaluate small- and large-scale computer systems. Learners will need to back up these skills by developing their exam techniques, such as how to identify what specific command words require and how to structure and present answers.

For full details of assessment, refer to the SAMs and the specification.

Getting started

This gives you a starting place for one way of delivering the unit. Activities are suggested in preparation for the external assessment.

Unit 2: Fundamentals of Computer Systems

Introduction

Computer systems are present in almost everything people do. They help support and enable individuals and organisations to achieve their aims. Understanding how the component parts of a system achieve their aims, and the effect that each part has on the whole system, is a valuable skill in all areas of the computing industry and in other vocational areas. This unit should equip learners with strong technical knowledge of how computer systems are formed and how they are implemented in a range of contexts. Learners should be able to apply in-depth technical knowledge when considering the wider implications of computer systems. These transferable skills will equip learners for further study or employment in a range of vocational areas.

Topic A – Hardware and software

- You should emphasise context when delivering this unit, both in terms of the setting in which systems are used and in terms of the types of activity technical staff will engage in when supporting hardware and software.
- You could begin by introducing the aim of the unit: ie to become a highly skilled, technically fluent user of computer systems. You could then go on to explain how understanding computer systems, including their possibilities and limitations, can be applied to plan systems, and to analyse and evaluate outcomes or decisions in many different situations.
- Introduce learners to the concept that a computer system can be anything from a single digital device to a global collection of computers. Explain that even large IT systems are made up of smaller devices that can perform both an isolated individual role or be part of a larger system.
- It might be useful to establish a baseline understanding of learner concepts of digital devices. You should start with common devices, such as computers and mobile devices, before moving to more specialised or less common devices. You could introduce components and devices, along with an overview of the tasks that they can perform, to give the learners examples in context. Learners should explore the capabilities and limitations of this hardware, and understand how external factors such as connection speeds may also impact on the performance of components or systems.
- Through a range of individual and group activities, you should introduce learners to the varying roles that software plays in a computer system. Learners should have a clear understanding of how software controls and/or interacts with hardware and other software to enable systems to function. Learners should be able to analyse the use and features of software and the impact these have on computer systems and the subsequent implications for individuals and organisations.
- As future technical staff, learners should understand the role of utility software, the importance of drivers in maintaining device operation, the role of security software guarding against external threats or managing staff access to systems. Most importantly, learners should understand that technical staff must be pro-active in terms of managing the systems hardware and software to ensure continuity of service.
- Learners should explore the features of computer systems used for data

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processing. Learners should be aware of the way in which systems can collect, process, store and manipulate data. This works well when linked to a real example such as sport. Learners could then consider wearable technologies and the data that is gathered through these devices. The data is captured, downloaded and analysed and this helps users to manage their performance. Learners should understand the functions carried out by such systems and be able to analyse the implications of using and protecting individual and multiple systems that store and manipulate data.

- You should give learners opportunities to explore vocational scenarios that require them to explore different choices of hardware and software and allow them to evaluate the appropriateness of computer systems in a range of contexts.This could include Engineering, Research and Development, Crime, as well as the more traditional contexts of Social Media, Communication, Education and Business.

Learning aim B – Computer architecture

- Learners should understand how the individual components can be connected to form computer systems and how the features and characteristics of each of the components affect the system as a whole.
- Learners should be able to analyse the use of different computer architecture models in a range of contexts and would benefit from exploring the use of different approaches in both theoretical and practical activities. You should expect learners to research developments in this field and give them opportunities to build physical and virtual (emulated) systems to meet different success criteria.
- Health and safety and the correct use of PPE and safety equipment should be covered if learners do practical work with computers. You should make clear the dangers of static and potential for shocks from components even if machines are unplugged.
- Once learners have a solid understanding of the principles of system architecture, and have an overview of how the features and characteristics of components affect a system, they should explore the concepts of processor microarchitecture. Learners should be able to explain how the individual aspects of a processor enable it to perform its role. They should be able to analyse how the features and functions of a processor affect mobile, traditional and server computers, and the implications of this on a larger system and its users.
- Learners should understand how data is used by processors and the role of general and special registers in storing, fetching and executing instructions.

Learning aim C – How data is represented by computer systems

- Learners should explore how numbers, text and images are represented as data on a computer system. Learners should be able to work with units of data and perform calculations for binary representations of whole and decimal numbers. You should give learners opportunities to explore the use of number systems in a range of different contexts.
- Learners should explore the use of character representation systems and have a clear understanding of the purpose and implications of using common character sets such as ASCII, Extended ASCII and Unicode.
- You should supply learners with some initial explanation about the theoretical concepts of digital image representation. You should start with the concept of how the data is stored and how the characteristics of the stored data (and how it is collected) affect the resulting image. Exploring the impact of resolution, sampling etc gives an opportunity for learners to engage in a range of practical tasks – learners could use image manipulation software to alter file format, compression method etc of images to see how these affect the characteristics and usability of

the images. Cover common file formats such as .bmp, .jpeg, .giff and .tif, and learners would benefit from saving the same file in different formats to see the difference it makes to the quality of the image. Note that learners should always save from the original image and not from a saved version, otherwise the comparisons will be meaningless.

- Learners should have a sound understanding of how using different hardware and software, as well as associated tools and settings, affects the final image. You should give learners opportunities to analyse the use of tools and their appropriateness for a range of scenarios. There is also an opportunity here to consider some of the newer technologies such as the Boomstick, which is not yet widely available. How does this work?

Learning aim D – How data is organised on computer systems

- Learners should have a strong grasp of the features and uses of common data types and structures. You should give learners some initial explanation covering the theoretical concepts of data types and structures. Learners could then carry out individual research to expand on this.
- Learners should have a clear understanding of how data types and structures are used by computer systems and how the 'structures' that are seen by the user are represented in the computer system.
- Learners would benefit from exploring the use of data types and structures in a practical setting, including their use in database software and in high-level programming languages. One option is to compare a 2D array with an array of records. They might behave in the same way but they are very different data types and structures.
- Learners should be able to analyse a range of vocational scenarios to identify and justify using different data structures and consider the implications of the choices they make.
- Learners should be able to use and manipulate data stored in matrices. Learners should understand the relationship between matrices and arrays and be confident in using and exploring matrix representation in computers systems. You should supply learners with a range of tasks that require them to be able to perform and interpret processes and calculations using matrices and arrays.

Learning aim E – How data is transmitted by computer systems

- It may be helpful to introduce this topic by first considering different methods of connecting devices and systems together and some of the features and limitations of different connection methods. As well as understanding the types of connection that can be used, learners should be clear about the technical factors that affect connection and transmission methods and the impact these have on their functions, and the resulting implications for individuals and organisations.
- Learners need to understand the potential threats to transmitted data and ways in which data can be protected. A presentation from you might be the best way to introduce the subject content, followed by individual and group research tasks, to allow learners to explore potential threats and the characteristics of these threats. Learners can develop their understanding of the impact and implications through case studies and real-world examples. One example could include the dangers of connecting learners' own devices to unsecured wifi and hotspots. Using MIM (Man in the Middle) and Evil Twin techniques to eavesdrop on transmissions, data such as passwords, where you were born, your recent searches, your emails, social media posts etc can be accessed and/or stolen.
- Learners should explore ways in which data transmission is helped by data compression. Learners should understand how different compression methods

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work, and the implications of using compression when transmitting data.

- Learners should explore the role that protocols play in governing how data is transmitted and the implications of these protocols on users and systems. You might choose to deliver an explanatory presentation of the content to introduce the subject matter, followed by individual research tasks.
- Learners should understand how devices and systems can be connected to form different small- and large-scale systems. Learners should have a strong grasp of how data is transmitted around and between the systems and the format and structure that data takes to ensure effective transmission (including the use of packet data and error detection and correction methods).
- Learners should be aware of how the component parts of a computer system affect data transmission and the impact this has on the function and performance of the system as a whole. The learning for this topic area can be supported by a range of activities including:
  - visits to local employers to see the use of connected systems and how they are used to meet organisational, user and customer needs
  - individual and group research and discussion tasks supported by guest speakers and case studies of real-world examples
  - practical activities involving setting up and using different types of connection.
- You should give learners opportunities to explore using encryption to protect transmitted and stored data. Learners should understand how common encryption methods are used and be able to use and manipulate simple encryption cyphers.
- Learners should be able to consider different scenarios and plan solutions and/or make and evaluate decisions relating to the transmission of data. Learners should be able to consider a wide range of implications and apply them to realistic and varied examples. Where possible, tasks should include a scenario that contextualises the learning. You will need to vary the level of scaffolding you give learners for the devised tasks.
- Due to the integrated nature of many modern systems, and depending on the scenarios used, there will be areas of this topic that you may have already touched upon during previous topics (there are significant links between this topic and topic A). It will be useful for learners if you draw attention to these natural links by giving them learning opportunities (such as visits and case studies) that naturally create links between topic areas.

Learning aim F – The use of logic and data flow in computer systems

- Learners should be able to use, apply and interpret the use of Boolean logic to identify and analyse the logical structures and computer process of a computer system. You should give learners opportunities to explore the use of Boolean logic in diagrammatical and instruction-based formats. There is a natural link between this and many other topic areas, and learners should be able to apply their understanding in conjunction with other knowledge to solve problems.
- Learners should be able to use, interpret and create system diagrams and flow charts to represent computer systems and processes and to solve problems. You should give learners opportunities to explore the use and interpretation of system diagrams and flow charts within vocational contexts and you should help learners to create logical links between this and other areas of the specification.

Details of links to other BTEC units and qualifications, and to other relevant units / qualifications

Pearson BTEC Level 3 Nationals in Computing (NQF):

- *Unit 3: Planning and Management of Computer Projects*
- *Unit 4: Software Design and Development Project*
- *Unit 7: IT Systems Security and Encryption*
- *Unit 9: The Impact of Computing*

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC Nationals in IT. Check the Pearson website (http://qualifications.pearson.com/en/support/published-resources.html) for more information as titles achieve endorsement.

Journals

- www.mdpi.com/journal/computers
  Free, open-access journal that publishes peer-reviewed academic papers for all computing sectors.

Websites

- www.doc.ic.ac.uk/~eedwards/compsys/index.html
  An academic website for computer architecture and data representation in computer systems.
- www.cs.cf.ac.uk/Dave/Multimedia/node189.html
  An academic website for arrays and digital image representation.
- https://sites.google.com/site/dtcsinformation/home
  An independently maintained computer science website giving an introduction to a number of topics.
- http://pippin.gimp.org/image_processing/chap_dir.html
  This site gives an introduction to digital image representation.
- www.cs.cmu.edu/~adamchik/15-121/lectures/
  An academic computer science resource including arrays, stacks and queues.
- www.gchq.gov.uk/Pages/homepage.aspx
  The government website dedicated to data security.
- www.bbc.co.uk/news/technology
  BBC news and information regarding technology and IT.
- www.forbes.com/technology/
  News and information regarding technology and IT.

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