PPE Topic List Computer Science Paper 1 March 2023:

1.2.3 Units	
☐ The units of data storage: ○ Bit ○ Nibble (4 bits) ○ Byte (8 bits) ○ Kilobyte (1,000 bytes or 1 KB) ○ Megabyte (1,000 KB) ○ Gigabyte (1,000 MB) ○ Terabyte (1,000 GB) ○ Petabyte (1,000 TB) ☐ How data needs to be converted into a binary format to be processed by a computer ☐ Data capacity and calculation of data capacity requirements	**Required** ✓ Why data must be stored in binary format ✓ Familiarity with data units and moving between each ✓ Data storage devices have different fixed capacities ✓ Calculate required storage capacity for a given set of files ✓ Calculate file sizes of sound, images and text files ▪ sound file size = sample rate x duration (s) x bit depth ▪ image file size = colour depth x image height (px) x image width (px) ▪ text file size = bits per character x number of characters

1.2.4 Data storage	
Numbers ☐ How to convert positive denary whole numbers to binary numbers (up to and including 8 bits) and vice versa ☐ How to add two binary integers together (up to and including 8 bits) and explain overflow errors which may occur ☐ How to convert positive denary whole numbers into 2-digit hexadecimal numbers and vice versa ☐ How to convert binary integers to their hexadecimal equivalents and vice versa ☐ Binary shifts	**Required** ✓ Denary number range 0 – 255 ✓ Hexadecimal range 00 – FF ✓ Binary number range 00000000 – 11111111 ✓ Understanding of the terms 'most significant bit', and 'least significant bit' ✓ Conversion of any number in these ranges to another number base ✓ Ability to deal with binary numbers containing between 1 and 8 bits ▪ e.g. 11010 is the same as 00011010 ✓ Understand the effect of a binary shift (both left or right) on a number ✓ Carry out a binary shift (both left and right)

1.1.1 Architecture of the CPU	
☐ The purpose of the CPU: ○ The fetch-execute cycle ☐ Common CPU components and their function: ○ ALU (Arithmetic Logic Unit) ○ CU (Control Unit) ○ Cache ○ Registers ☐ Von Neumann architecture: ○ MAR (Memory Address Register) ○ MDR (Memory Data Register) ○ Program Counter ○ Accumulator	**Required** ✓ What actions occur at each stage of the fetch-execute cycle ✓ The role/purpose of each component and what it manages, stores, or controls during the fetch-execute cycle ✓ The purpose of each register, what it stores (data or address) ✓ The difference between storing data and an address

1.3.1 Networks and topologies	
☐ Types of network: ○ LAN (Local Area Network) ○ WAN (Wide Area Network) ☐ Factors that affect the performance of networks ☐ The different roles of computers in a client-server and a peer-to-peer network ☐ The hardware needed to connect stand-alone computers into a Local Area Network: ○ Wireless access points ○ Routers ○ Switches ○ NIC (Network Interface Controller/Card) ○ Transmission media ☐ The Internet as a worldwide collection of computer networks: ○ DNS (Domain Name Server) ○ Hosting ○ The Cloud ○ Web servers and clients ☐ Star and Mesh network topologies	**Required** ✓ The characteristics of LANs and WANs including common examples of each ✓ Understanding of different factors that can affect the performance of a network, e.g.: ▪ Number of devices connected ▪ Bandwidth ✓ The tasks performed by each piece of hardware ✓ The concept of the Internet as a network of computer networks ✓ A Domain Name Service (DNS) is made up of multiple Domain Name Servers ✓ A DNS's role in the conversion of a URL to an IP address ✓ Concept of servers providing services (e.g. Web server → Web pages, File server → file storage/retrieval) ✓ Concept of clients requesting/using services from a server ✓ The Cloud: remote service provision (e.g. storage, software, processing) ✓ Advantages and disadvantages of the Cloud ✓ Advantages and disadvantages of the Star and Mesh topologies ✓ Apply understanding of networks to a given scenario

1.3.2 Wired and wireless networks, protocols and layers	
☐ Modes of connection: ○ Wired • Ethernet ○ Wireless • Wi-Fi • Bluetooth ☐ Encryption ☐ IP addressing and MAC addressing ☐ Standards ☐ Common protocols including: ○ TCP/IP (Transmission Control Protocol/Internet Protocol) ○ HTTP (Hyper Text Transfer Protocol) ○ HTTPS (Hyper Text Transfer Protocol Secure) ○ FTP (File Transfer Protocol) ○ POP (Post Office Protocol) ○ IMAP (Internet Message Access Protocol) ○ SMTP (Simple Mail Transfer Protocol) ☐ The concept of layers	**Required** ✓ Compare benefits and drawbacks of wired versus wireless connection ✓ Recommend one or more connections for a given scenario ✓ The principle of encryption to secure data across network connections ✓ IP addressing and the format of an IP address (IPv4 and IPv6) ✓ A MAC address is assigned to devices; its use within a network ✓ The principle of a standard to provide rules for areas of computing ✓ Standards allows hardware/software to interact across different manufacturers/producers ✓ The principle of a (communication) protocol as a set of rules for transferring data ✓ That different types of protocols are used for different purposes ✓ The basic principles of each protocol i.e. its purpose and key features ✓ How layers are used in protocols, and the benefits of using layers; for a teaching example, please refer to the 4-layer TCP/IP model

Sub topic	Guidance
1.6.1 Ethical, legal, cultural and environmental impact	
☐ Impacts of digital technology on wider society including: ○ Ethical issues ○ Legal issues ○ Cultural issues ○ Environmental issues ○ Privacy issues ☐ Legislation relevant to Computer Science: ○ The Data Protection Act 2018 ○ Computer Misuse Act 1990 ○ Copyright Designs and Patents Act 1988 ○ Software licences (i.e. open source and proprietary)	**Required** ✓ Technology introduces ethical, legal, cultural, environmental and privacy issues ✓ Knowledge of a variety of examples of digital technology and how this impacts on society ✓ An ability to discuss the impact of technology based around the issues listed ✓ The purpose of each piece of legislation and the specific actions it allows or prohibits ✓ The need to license software and the purpose of a software licence ✓ Features of open source (providing access to the source code and the ability to change the software) ✓ Features of proprietary (no access to the source code, purchased commonly as off-the-shelf) ✓ Recommend a type of licence for a given scenario including benefits and drawbacks
1.4.1 Threats to computer systems and networks	
☐ Forms of attack: ○ Malware ○ Social engineering, e.g. phishing, people as the 'weak point' ○ Brute-force attacks ○ Denial of service attacks ○ Data interception and theft ○ The concept of SQL injection	**Required** ✓ Threats posed to devices/systems ✓ Knowledge/principles of each form of attack including: ▪ How the attack is used ▪ The purpose of the attack
1.4.2 Identifying and preventing vulnerabilities	
☐ Common prevention methods: ○ Penetration testing ○ Anti-malware software ○ Firewalls ○ User access levels ○ Passwords ○ Encryption ○ Physical security	**Required** ✓ Understanding of how to limit the threats posed in 1.4.1 ✓ Understanding of methods to remove vulnerabilities ✓ Knowledge/principles of each prevention method: ▪ What each prevention method may limit/prevent ▪ How it limits the attack

Characters ☐ The use of binary codes to represent characters ☐ The term 'character set' ☐ The relationship between the number of bits per character in a character set, and the number of characters which can be represented, e.g.: ○ ASCII ○ Unicode **Images** ☐ How an image is represented as a series of pixels, represented in binary ☐ Metadata ☐ The effect of colour depth and resolution on: ○ The quality of the image ○ The size of an image file **Sound** ☐ How sound can be sampled and stored in digital form ☐ The effect of sample rate, duration and bit depth on: ○ The playback quality ○ The size of a sound file	**Required** ✓ How characters are represented in binary ✓ How the number of characters stored is limited by the bits available ✓ The differences between and impact of each character set ✓ Understand how character sets are logically ordered, e.g. the code for 'B' will be one more than the code for 'A' ✓ Binary representation of ASCII in the exam will use 8 bits **Not required** × Memorisation of character set codes **Required** ✓ Each pixel has a specific colour, represented by a specific code ✓ The effect on image size and quality when changing colour depth and resolution ✓ Metadata stores additional image information (e.g. height, width, etc.) **Required** ✓ Analogue sounds must be stored in binary ✓ Sample rate – measured in Hertz (Hz) ✓ Duration – how many seconds of audio the sound file contains ✓ Bit depth – number of bits available to store each sample (e.g. 16-bit)
1.2.5 Compression	
☐ The need for compression ☐ Types of compression: ○ Lossy ○ Lossless	**Required** ✓ Common scenarios where compression may be needed ✓ Advantages and disadvantages of each type of compression ✓ Effects on the file for each type of compression **Not required** × Ability to carry out specific compression algorithms
1.2.1 Primary storage (Memory)	
☐ The need for primary storage ☐ The difference between RAM and ROM ☐ The purpose of ROM in a computer system ☐ The purpose of RAM in a computer system ☐ Virtual memory	**Required** ✓ Why computers have primary storage ▪ How this usually consists of RAM and ROM ✓ Key characteristics of RAM and ROM ✓ Why virtual memory may be needed in a system ✓ How virtual memory works ▪ Transfer of data between RAM and HDD when RAM is filled

PPE Topic List Computer Science Paper 2 March 2023:

Sub topic	Guidance
2.2.1 Programming fundamentals	
☐ The use of variables, constants, operators, inputs, outputs and assignments ☐ The use of the three basic programming constructs used to control the flow of a program: ○ Sequence ○ Selection ○ Iteration (count- and condition-controlled loops) ☐ The common arithmetic operators ☐ The common Boolean operators AND, OR and NOT	**Required** ✓ Practical use of the techniques in a high-level language within the classroom ✓ Understanding of each technique ✓ Recognise and use the following operators: **Comparison operators**: == Equal to; != Not equal to; < Less than; <= Less than or equal to; > Greater than; >= Greater than or equal to **Arithmetic operators**: + Addition; – Subtraction; * Multiplication; / Division; MOD Modulus; DIV Quotient; ^ Exponentiation (to the power)

2.1.1 Computational thinking

- ☐ Principles of computational thinking:
  - Abstraction
  - Decomposition
  - Algorithmic thinking

Required

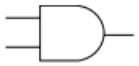
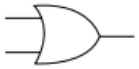
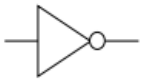
- ✓ Understanding of these principles and how they are used to define and refine problems

2.4.1 Boolean logic

- ☐ Simple logic diagrams using the operators AND, OR and NOT
- ☐ Truth tables
- ☐ Combining Boolean operators using AND, OR and NOT
- ☐ Applying logical operators in truth tables to solve problems

Required

- ✓ Knowledge of the truth tables for each logic gate
- ✓ Recognition of each gate symbol
- ✓ Understanding of how to create, complete or edit logic diagrams and truth tables for given scenarios
- ✓ Ability to work with more than one gate in a logic diagram

Boolean Operators	Logic Gate Symbol
AND *(Conjunction)*	
OR *(Disjunction)*	
NOT *(Negation)*	

Truth Tables

AND			OR			NOT	
A	B	A AND B	A	B	A OR B	A	NOT A
0	0	0	0	0	0	0	1
0	1	0	0	1	1	1	0
1	0	0	1	0	1		
1	1	1	1	1	1		

2.1.2 Designing, creating and refining algorithms

- ☐ Identify the inputs, processes, and outputs for a problem
- ☐ Structure diagrams
- ☐ Create, interpret, correct, complete, and refine algorithms using:
  - Pseudocode
  - Flowcharts
  - Reference language/high-level programming language
- ☐ Identify common errors
- ☐ Trace tables

Required

- ✓ Produce simple diagrams to show:
  - The structure of a problem
  - Subsections and their links to other subsections
- ✓ Complete, write or refine an algorithm using the techniques listed
- ✓ Identify syntax/logic errors in code and suggest fixes
- ✓ Create and use trace tables to follow an algorithm

Flowchart symbols

	Line		**Input/ Output**
	Process		**Decision**
	Sub program		**Terminal**

2.2.2 Data types

- ☐ The use of data types:
  - Integer
  - Real
  - Boolean
  - Character and string
  - Casting

Required

- ✓ Practical use of the data types in a high-level language within the classroom
- ✓ Ability to choose suitable data types for data in a given scenario
- ✓ Understand that data types may be temporarily changed through casting, and where this may be useful

2.1.3 Searching and sorting algorithms	
☐ Standard searching algorithms: ○ Binary search ○ Linear search ☐ Standard sorting algorithms: ○ Bubble sort ○ Merge sort ○ Insertion sort	**Required** ✓ Understand the main steps of each algorithm ✓ Understand any pre-requisites of an algorithm ✓ Apply the algorithm to a data set ✓ Identify an algorithm if given the code or pseudocode for it **Not required** × To remember the code for these algorithms × To remember Exam Reference Language for Merge Sort

Sub topic	Guidance
2.3.1 Defensive design	
☐ Defensive design considerations: ○ Anticipating misuse ○ Authentication ☐ Input validation ☐ Maintainability: ○ Use of sub programs ○ Naming conventions ○ Indentation ○ Commenting	**Required** ✓ Understanding of the issues a programmer should consider to ✓ Authentication to confirm the identity of a user ✓ Practical experience of designing input validation and simple authentication (e.g. username and password) ✓ Understand why commenting is useful and apply this appropriately
2.2.3 Additional programming techniques	
☐ The use of basic string manipulation ☐ The use of basic file handling operations: ○ Open ○ Read ○ Write ○ Close ☐ The use of records to store data ☐ The use of SQL to search for data ☐ The use of arrays (or equivalent) when solving problems, including both one-dimensional (1D) and two-dimensional arrays (2D) ☐ How to use sub programs (functions and procedures) to produce structured code ☐ Random number generation	**Required** ✓ Practical use of the additional programming techniques in a high-level language within the classroom ✓ Ability to manipulate strings, including: ▪ Concatenation ▪ Slicing ✓ Arrays as fixed length or static structures ✓ Use of 2D arrays to emulate database tables of a collection of fields, and records ✓ The use of functions ✓ The use of procedures ✓ Where to use functions and procedures effectively ✓ The use of the following within functions and procedures: ▪ local variables/constants ▪ global variables/constants ▪ arrays (passing and returning) ✓ SQL commands: ▪ SELECT ▪ FROM ▪ WHERE ✓ Be able to create and use random numbers in a program