

## Computing Science: National 5 and Higher skills, knowledge and understanding 2018–19

Software design and development		
	National 5	Higher
Development methodologies	Describe and implement the phases of an iterative development process: analysis, design, implementation, testing, documentation, and evaluation, within general programming problem-solving.	Describe and compare the development methodologies: <ul style="list-style-type: none"> <li>◆ iterative development process</li> <li>◆ agile methodologies</li> </ul>
Analysis	Identify the purpose and functional requirements of a problem that relates to the design and implementation at this level, in terms of: <ul style="list-style-type: none"> <li>◆ inputs</li> <li>◆ processes</li> <li>◆ outputs</li> </ul>	Identify the: <ul style="list-style-type: none"> <li>◆ purpose</li> <li>◆ scope</li> <li>◆ boundaries</li> <li>◆ functional requirements</li> </ul> of a problem that relates to the design and implementation at this level, in terms of: <ul style="list-style-type: none"> <li>◆ inputs</li> <li>◆ processes</li> <li>◆ outputs</li> </ul>
Design	Identify the data types and structures required for a problem that relates to the implementation at this level, as listed below.  Describe, identify, and be able to read and understand: <ul style="list-style-type: none"> <li>◆ structure diagrams</li> </ul>	Identify the data types and structures required for a problem that relates to the implementation at this level.  Read and understand designs of solutions to problems at this level using the following design techniques: <ul style="list-style-type: none"> <li>◆ structure diagrams</li> <li>◆ pseudocode</li> </ul>

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	<ul style="list-style-type: none"> <li>◆ flowcharts</li> <li>◆ pseudocode</li> </ul> <p>Exemplify and implement <b>one</b> of the above design techniques to design efficient solutions to a problem.</p> <p>Describe, exemplify, and implement user-interface design, in terms of input and output, using a wireframe.</p>	<p>Exemplify and implement efficient design solutions to a problem, using a recognised design technique, showing:</p> <ul style="list-style-type: none"> <li>◆ top level design</li> <li>◆ the data flow</li> <li>◆ refinements</li> </ul> <p>Describe, exemplify, and implement user-interface design, in terms of input and output, using a wireframe.</p>
Implementation (data types and structures)	<p>Describe, exemplify, and implement appropriately the following data types and structures:</p> <ul style="list-style-type: none"> <li>◆ character</li> <li>◆ string</li> <li>◆ numeric (integer and real)</li> <li>◆ Boolean</li> <li>◆ 1-D arrays</li> </ul>	<p>Describe, exemplify and implement appropriately the following structures:</p> <ul style="list-style-type: none"> <li>◆ parallel 1-D arrays</li> <li>◆ records</li> <li>◆ arrays of records</li> </ul>
Implementation (computational constructs)	<p>Describe, exemplify, and implement the appropriate constructs in a high-level (textual) language:</p> <ul style="list-style-type: none"> <li>◆ expressions to assign values</li> <li>◆ expressions to return values using arithmetic operations (addition,</li> </ul>	<p>Describe, exemplify, and implement the appropriate constructs in a procedural high-level (textual) language:</p> <ul style="list-style-type: none"> <li>◆ parameter passing (formal and actual)</li> <li>◆ the scope of local and global variables</li> </ul>

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	<p>subtraction, multiplication, division, and exponentiation)</p> <ul style="list-style-type: none"> <li>◆ expressions to concatenate strings</li> <li>◆ selection constructs using simple conditional statements with &lt;, &gt;, ≤, ≥, =, ≠ operators</li> <li>◆ selection constructs using complex conditional statements</li> <li>◆ logical operators (AND, OR, NOT)</li> <li>◆ iteration and repetition using fixed and conditional loops</li> <li>◆ pre-defined functions (with parameters):                             <ul style="list-style-type: none"> <li>— random</li> <li>— round</li> <li>— length</li> </ul> </li> </ul> <p>Read and explain code that makes use of the above constructs.</p>	<ul style="list-style-type: none"> <li>◆ sub-programs/routines, defined by their name and arguments (inputs and outputs):                             <ul style="list-style-type: none"> <li>— functions</li> <li>— procedures</li> </ul> </li> <li>◆ pre-defined functions (with parameters) to:                             <ul style="list-style-type: none"> <li>— create substrings</li> <li>— convert from character to ASCII and vice versa</li> <li>— modulus</li> <li>— convert floating-point numbers to integers</li> </ul> </li> <li>◆ file handling                             <ul style="list-style-type: none"> <li>— sequential CSV and txt files (open, create, read, write, close)</li> </ul> </li> </ul> <p>Read and explain code that makes use of the above constructs.</p>
Implementation (algorithm specification)	<p>Describe, exemplify, and implement standard algorithms:</p> <ul style="list-style-type: none"> <li>◆ input validation</li> <li>◆ running total within loop</li> <li>◆ traversing a 1-D array</li> </ul>	<p>Describe, exemplify, and implement standard algorithms using 1D arrays or arrays of records:</p> <ul style="list-style-type: none"> <li>◆ linear search</li> <li>◆ find minimum and maximum</li> <li>◆ count occurrences</li> </ul>

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Testing	<p>Describe, identify, exemplify, and implement normal, extreme, and exceptional test data for a specific problem, using a test table.</p> <p>Describe and identify syntax, execution, and logic errors.</p>	<p>Describe, exemplify and implement a comprehensive final test plan to show that the functional requirements are met.</p> <p>Identify syntax, execution, and logic errors at this level.</p> <p>Describe and exemplify de-bugging techniques:</p> <ul style="list-style-type: none"> <li>◆ dry runs</li> <li>◆ trace tables/tools</li> <li>◆ breakpoints</li> <li>◆ watchpoints</li> </ul>
Evaluation	<p>Describe, identify, and exemplify the evaluation of a solution in terms of:</p> <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> <li>◆ efficient use of coding constructs</li> <li>◆ robustness</li> <li>◆ readability: <ul style="list-style-type: none"> <li>— internal commentary</li> <li>— meaningful identifiers</li> <li>— indentation</li> <li>— white space</li> </ul> </li> </ul>	<p>Describe, identify, and exemplify the evaluation of a solution in terms of:</p> <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> <li>◆ efficient use of coding constructs</li> <li>◆ usability</li> <li>◆ maintainability</li> <li>◆ robustness</li> </ul>

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<b>Computer systems</b>		
	<b>National 5</b>	<b>Higher</b>
Data representation	<p>Describe and exemplify the use of binary to represent positive integers.</p> <p>Describe floating-point representation of positive real numbers using the terms mantissa and exponent.</p> <p>Convert from binary to denary and vice versa.</p> <p>Describe extended ASCII code (8-bit) used to represent characters.</p> <p>Describe the vector graphics method of graphic representation for common objects:</p> <ul style="list-style-type: none"> <li>◆ rectangle</li> <li>◆ ellipse</li> <li>◆ line</li> <li>◆ polygon</li> </ul> <p>with attributes:</p> <ul style="list-style-type: none"> <li>◆ co-ordinates</li> <li>◆ fill colour</li> <li>◆ line colour</li> </ul> <p>Describe the bit-mapped method of graphics representation.</p>	<p>Describe and exemplify the use of binary to represent positive and negative integers using two's complement, including the range of numbers that can be represented using a fixed number of bits.</p> <p>Conversion of two's complement numbers from binary to denary and vice versa.</p> <p>Describe and exemplify floating-point representation of positive and negative real numbers using the terms mantissa and exponent.</p> <p>Describe the relationship between the number of bits assigned to the mantissa/exponent, and the range and precision of floating-point numbers.</p> <p>Describe Unicode used to represent characters and its advantage over extended ASCII code (8-bit) in terms of numbers of characters.</p> <p>Describe the relative advantages and disadvantages of bit-mapped graphics versus vector graphics.</p>

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Computer structure	<p>Describe the purpose of the basic computer architecture components and how they are linked together:</p> <ul style="list-style-type: none"> <li>◆ processor (registers, ALU, control unit)</li> <li>◆ memory locations with unique addresses</li> <li>◆ buses (data and address)</li> </ul> <p>Explain the need for interpreters and compilers to translate high-level program code to binary (machine code instructions).</p>	<p>Describe the concept of the fetch-execute cycle.</p> <p>Describe the factors affecting computer system performance:</p> <ul style="list-style-type: none"> <li>◆ number of processors (cores)</li> <li>◆ width of data bus</li> <li>◆ cache memory</li> <li>◆ clock speed</li> </ul>
Environmental impact	<p>Describe the energy use of computer systems, the implications on the environment and how these could be reduced through:</p> <ul style="list-style-type: none"> <li>◆ settings on monitors</li> <li>◆ power down settings</li> <li>◆ leaving computers on stand-by</li> </ul>	<p>Describe the environmental impact of intelligent systems:</p> <ul style="list-style-type: none"> <li>◆ heating systems</li> <li>◆ traffic control</li> <li>◆ car management systems</li> </ul>

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Security risks and precautions	<p>Describe the role of firewalls.</p> <p>Describe the use made of encryption in electronic communications.</p>	<p>Describe and identify the implications for individuals and businesses of the Computer Misuse Act 1990:</p> <ul style="list-style-type: none"> <li>◆ unauthorised access to computer material</li> <li>◆ unauthorised access with intent to commit a further offence</li> <li>◆ unauthorised modification of programs or data on a computer</li> </ul> <p>Describe and identify the security risks of:</p> <ul style="list-style-type: none"> <li>◆ tracking cookies</li> <li>◆ DOS (Denial of Service) attacks: <ul style="list-style-type: none"> <li>— symptoms <ul style="list-style-type: none"> <li>○ slow performance, inability to access</li> </ul> </li> <li>— effects <ul style="list-style-type: none"> <li>○ disruption to users and business</li> </ul> </li> <li>— costs <ul style="list-style-type: none"> <li>○ lost revenue, labour in rectifying fault</li> </ul> </li> <li>— type of fault <ul style="list-style-type: none"> <li>○ bandwidth consumption, resource starvation, Domain Name Service(DNS)</li> </ul> </li> <li>— reasons <ul style="list-style-type: none"> <li>○ financial, political, personal</li> </ul> </li> </ul> </li> </ul> <p>Describe how encryption is used to secure transmission of data:</p> <ul style="list-style-type: none"> <li>◆ use of public and private keys</li> <li>◆ digital certificates</li> <li>◆ digital signatures</li> </ul>

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Database design and development		
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Analysis	Identify the end-user and functional requirements of a database problem that relates to the implementation at this level.	Identify the end-user and functional requirements of a database problem that relates to the implementation at this level.
Design	<p>Describe and identify the implications for individuals and businesses of the General Data Protection Regulation (GDPR) — Regulation (EU) 2016/679 that data must be:</p> <ul style="list-style-type: none"> <li>◆ processed lawfully, fairly and in a transparent manner in relation to individuals</li> <li>◆ used for the declared purpose only</li> <li>◆ limited to the data needed for the declared purpose</li> <li>◆ accurate</li> <li>◆ not kept for longer than necessary</li> <li>◆ held securely</li> </ul> <p>Describe and exemplify entity relationship diagrams with two entities indicating:</p> <ul style="list-style-type: none"> <li>◆ entity name</li> <li>◆ attributes</li> <li>◆ relationship (one-to-many)</li> </ul>	<p>Describe and exemplify entity relationship diagrams with three or more entities, indicating:</p> <ul style="list-style-type: none"> <li>◆ entity name</li> <li>◆ attributes</li> <li>◆ name of relationship</li> <li>◆ cardinality of relationship (one-to-one, one-to-many, many-to-many)</li> </ul> <p>Describe and exemplify an instance using an entity-occurrence diagram.</p> <p>Describe and exemplify a compound key.</p> <p>Describe and exemplify a data dictionary with three or more entities:</p> <ul style="list-style-type: none"> <li>◆ entity name</li> <li>◆ attribute name</li> <li>◆ primary and foreign key</li> <li>◆ attribute type: <ul style="list-style-type: none"> <li>— text</li> <li>— number</li> <li>— date</li> </ul> </li> </ul>

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	<p>Describe and exemplify a data dictionary:</p> <ul style="list-style-type: none"> <li>◆ entity name</li> <li>◆ attribute name</li> <li>◆ primary and foreign key</li> <li>◆ attribute type:               <ul style="list-style-type: none"> <li>— text</li> <li>— number</li> <li>— date</li> <li>— time</li> <li>— Boolean</li> </ul> </li> <li>◆ attribute size</li> <li>◆ validation:               <ul style="list-style-type: none"> <li>— presence check</li> <li>— restricted choice</li> <li>— field length</li> <li>— range</li> </ul> </li> </ul> <p>Exemplify a design of a solution to the query:</p> <ul style="list-style-type: none"> <li>◆ multiple tables</li> <li>◆ fields</li> <li>◆ search criteria</li> <li>◆ sort order</li> </ul>	<ul style="list-style-type: none"> <li>— time</li> <li>— Boolean</li> <li>◆ attribute size</li> <li>◆ validation:               <ul style="list-style-type: none"> <li>— presence check</li> <li>— restricted choice</li> <li>— field length</li> <li>— range</li> </ul> </li> </ul> <p>Exemplify a design of a solution to a query:</p> <ul style="list-style-type: none"> <li>◆ tables and queries</li> <li>◆ fields</li> <li>◆ search criteria</li> <li>◆ sort order</li> <li>◆ calculations</li> <li>◆ grouping</li> </ul>

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Implementation	<p>Implement relational databases with two linked tables, to match the design with referential integrity.</p> <p>Describe, exemplify and implement SQL operations for pre-populated relational databases, with a maximum of two linked tables:</p> <ul style="list-style-type: none"> <li>◆ SELECT: <ul style="list-style-type: none"> <li>— from</li> <li>— where: <ul style="list-style-type: none"> <li>○ AND, OR, &lt;, &gt;, =</li> <li>○ order by with a maximum of two fields</li> </ul> </li> </ul> </li> <li>◆ INSERT</li> <li>◆ UPDATE</li> <li>◆ DELETE</li> <li>◆ equi-join between tables</li> </ul> <p>Read and explain code that makes use of the above SQL.</p>	<p>Describe, exemplify and use SQL operations for pre-populated relational databases with three or more linked tables:</p> <ul style="list-style-type: none"> <li>◆ UPDATE, SELECT, DELETE, INSERT statements making use of: <ul style="list-style-type: none"> <li>— wildcards</li> <li>— aggregate functions (MIN, MAX, AVG, SUM, COUNT)</li> <li>— computed values, alias</li> <li>— GROUP BY</li> <li>— ORDER BY</li> <li>— WHERE</li> </ul> </li> </ul> <p>Read and explain code that makes use of the above SQL.</p>
Testing	<p>Describe and exemplify testing:</p> <ul style="list-style-type: none"> <li>◆ SQL operations work correctly at this level</li> </ul>	<p>Describe and exemplify testing:</p> <ul style="list-style-type: none"> <li>◆ SQL operations work correctly at this level</li> </ul>
Evaluation	<p>Evaluate solution in terms of:</p> <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> <li>◆ accuracy of output</li> </ul>	<p>Evaluate solution at this level in terms of:</p> <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> <li>◆ accuracy of output</li> </ul>

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<b>Web design and development</b>		
	<b>National 5</b>	<b>Higher</b>
Analysis	Identify the end-user and functional requirements of a website problem that relates to the design and implementation at this level.	Identify the end-user and functional requirements of a website problem that relates to the design and implementation at this level.
Design	<p>Describe and exemplify the website structure with a home page, a maximum of four linked multimedia pages, and any necessary external links.</p> <p>Describe, exemplify and implement, taking into account end-user requirements, effective user-interface design (visual layout and readability) using wire-framing:</p> <ul style="list-style-type: none"> <li>◆ navigational links</li> <li>◆ consistency across multiple pages</li> <li>◆ relative vertical positioning of the media displayed</li> <li>◆ file formats of the media (text, graphics, video, and audio)</li> </ul> <p>Describe and identify the implications for individuals and businesses of the Copyright, Designs and Patents Act 1988 relating to:</p>	<p>Describe and exemplify the website structure of a multi-level website with a home page and two additional levels, with no more than four pages per level.</p> <p>Describe, exemplify and implement, taking into account end-user requirements and device type, an effective user-interface design (visual layout and readability) using wire-framing:</p> <ul style="list-style-type: none"> <li>◆ horizontal navigational bar</li> <li>◆ relative horizontal and vertical positioning of the media</li> <li>◆ form inputs</li> <li>◆ file formats of the media (text, graphics, video, and audio)</li> </ul> <p>Describe, exemplify and implement prototyping (low fidelity) from wireframe design at this level.</p>

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Web design and development		
	<ul style="list-style-type: none"> <li>◆ web content (text, graphics, video, and audio)</li> </ul> <p>Compare a range of standard file formats:</p> <ul style="list-style-type: none"> <li>◆ audio standard file formats WAV and MP3 in terms of compression, quality, and file size</li> <li>◆ bit-mapped graphic standard file formats JPEG, GIF, and PNG in terms of compression, animation, transparency, and colour depth</li> </ul> <p>Describe the factors affecting file size and quality, relating to resolution, colour depth, and sampling rate.</p> <p>Describe the need for compression.</p> <p>Describe, exemplify and implement prototyping (low fidelity) from wireframe design at this level.</p>	
Implementation (CSS)	<p>Describe, exemplify and implement internal and external Cascading Style Sheets (CSS):</p> <ul style="list-style-type: none"> <li>◆ selectors, classes and IDs</li> <li>◆ properties               <ul style="list-style-type: none"> <li>— text:                   <ul style="list-style-type: none"> <li>○ font (family, size)</li> </ul> </li> </ul> </li> </ul>	<p>Describe, exemplify and implement efficient inline, internal and external Cascading Style Sheets (CSS) using grouping and descendant selectors to:</p> <ul style="list-style-type: none"> <li>◆ control appearance and positioning:               <ul style="list-style-type: none"> <li>— display (block, inline, none)</li> <li>— float (left, right)</li> </ul> </li> </ul>

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Web design and development		
	<ul style="list-style-type: none"> <li>○ color</li> <li>○ alignment</li> <li>— background colour</li> </ul> <p>Read and explain code that makes use of the above CSS.</p>	<ul style="list-style-type: none"> <li>— clear (both)</li> <li>— margins/padding</li> <li>— sizes (height, width)</li> <li>◆ create horizontal navigation bars:               <ul style="list-style-type: none"> <li>— list-style-type:none</li> <li>— hover</li> </ul> </li> </ul> <p>Read and explain code that makes use of the above CSS.</p>
Implementation (HTML)	<p>Describe, exemplify and implement HTML code:</p> <ul style="list-style-type: none"> <li>◆ HTML</li> <li>◆ head</li> <li>◆ title</li> <li>◆ body</li> <li>◆ heading</li> <li>◆ paragraph</li> <li>◆ DIV</li> <li>◆ link</li> <li>◆ anchor</li> <li>◆ IMG</li> <li>◆ audio</li> <li>◆ video</li> <li>◆ lists — ol, ul and li</li> </ul>	<p>Describe, exemplify and implement HTML code:</p> <ul style="list-style-type: none"> <li>◆ nav</li> <li>◆ header</li> <li>◆ footer</li> <li>◆ section</li> <li>◆ main</li> <li>◆ form</li> <li>◆ id attribute</li> </ul> <p>Describe, exemplify and implement form elements:</p> <ul style="list-style-type: none"> <li>◆ form element: input               <ul style="list-style-type: none"> <li>— text</li> <li>— number</li> <li>— textarea</li> <li>— radio</li> <li>— submit</li> </ul> </li> </ul>

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Web design and development		
	<p>Describe and implement hyperlinks (internal and external), relative and absolute addressing.</p> <p>Read and explain code that makes use of the above HTML.</p>	<ul style="list-style-type: none"> <li>◆ form element: select</li> </ul> <p>Describe, exemplify and implement form data validation:</p> <ul style="list-style-type: none"> <li>◆ length</li> <li>◆ presence</li> <li>◆ range</li> </ul> <p>Read and explain code that makes use of the above HTML.</p>
Implementation (JavaScript)	<p>Describe and identify JavaScript coding related to mouse events:</p> <ul style="list-style-type: none"> <li>◆ onmouseover</li> <li>◆ onmouseout</li> </ul>	<p>Describe, exemplify and implement coding of JavaScript functions related to mouse events:</p> <ul style="list-style-type: none"> <li>◆ onmouseover</li> <li>◆ onmouseout</li> <li>◆ onclick</li> </ul>
Testing	<p>Describe and exemplify testing:</p> <ul style="list-style-type: none"> <li>◆ matches user-interface design</li> <li>◆ links and navigation work correctly</li> <li>◆ media (such as text, graphics, and video) display correctly</li> <li>◆ consistency</li> </ul>	<p>Describe, exemplify and implement usability testing using personas, test cases and scenarios based on low fidelity prototypes.</p> <p>Describe and exemplify testing:</p> <ul style="list-style-type: none"> <li>◆ input validation</li> <li>◆ navigational bar works</li> <li>◆ media content displays correctly</li> </ul> <p>Description and exemplification of compatibility testing including:</p> <ul style="list-style-type: none"> <li>◆ device type:</li> </ul>

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Web design and development		
		<ul style="list-style-type: none"> <li>— tablet, smart phone, desktop</li> <li>◆ compatibility with the operating system and browser</li> </ul>
Evaluation	Evaluate solution in terms of: <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> </ul>	Evaluate solution at this level in terms of <ul style="list-style-type: none"> <li>◆ fitness for purpose</li> <li>◆ usability</li> </ul>