

CfE

BrightRED  
PUBLISHING

HIGHER COMPUTING SCIENCE

BrightRED Study Guide

CfE HIGHER

COMPUTING  
SCIENCE



Don't forget to check out  
the BrightRED Digital Zone

NEW  
EDITION

# THE HIGHER COURSE

## SYLLABUS AND ASSESSMENT

### SYLLABUS

This course has four areas of study: Software Design and Development; Computer Systems; Database Design and Development; Web Design and Development.

| Software Design and Development            |  |
|--|--|
| Development methodologies                  | <ul style="list-style-type: none"> <li>Iterative development process, agile methodologies</li> </ul>   |
| Analysis                                   | <ul style="list-style-type: none"> <li>Purpose, scope, boundaries</li> <li>Inputs, processes, outputs</li> </ul>   |
| Design                                     | <ul style="list-style-type: none"> <li>User design using wireframe</li> <li>Structure diagrams</li> <li>Pseudocode</li> <li>Top-level design</li> <li>Data flow</li> </ul>   |
| Implementation (data types and structures) | <ul style="list-style-type: none"> <li>Data types and structures</li> <li>Parallel 1-D arrays, records, arrays of records</li> </ul>   |
| Implementation (computational constructs)  | <ul style="list-style-type: none"> <li>Parameter passing (formal and actual)</li> <li>Local and global variables</li> <li>Subprograms/subroutines, functions, procedures</li> <li>Pre-defined functions: substrings, conversion between character and ASCII, Mod, Int</li> <li>Sequential files: open, create, read, write, close</li> <li>Txt files, CSV files</li> </ul> |
| Implementation                             | <ul style="list-style-type: none"> <li>Standard algorithms using 1-D arrays or arrays of records</li> <li>Linear search, Find minimum and maximum, Count occurrences</li> </ul>  |
| Testing                                    | <ul style="list-style-type: none"> <li>Comprehensive final test plan</li> <li>Types of errors: syntax, execution, logic</li> <li>De-bugging techniques: dry runs, trace tables, breakpoints, watchpoints</li> </ul>  |
| Evaluation                                 | <ul style="list-style-type: none"> <li>Fitness for purpose</li> <li>Efficient use of coding constructs</li> <li>Usability, maintainability, robustness</li> </ul>  |
| Computer Systems                           |  |
| Data representation                        | <ul style="list-style-type: none"> <li>Two's complement</li> <li>Floating-point numbers</li> <li>The range and precision of floating-point numbers</li> <li>Unicode</li> <li>Comparison of Unicode with Extended ASCII code</li> <li>Comparison of bit-mapped and vector graphics</li> </ul>   |
| Computer structure                         | <ul style="list-style-type: none"> <li>The fetch-execute cycle</li> <li>Factors affecting computer system performance: number of processors (cores), width of data bus, cache memory, clock speed</li> </ul>   |
| Environmental impact                       | <ul style="list-style-type: none"> <li>The environmental impact of intelligent systems</li> <li>Heating systems, traffic control, car management systems</li> </ul>  |
| Security risks and precautions             | <ul style="list-style-type: none"> <li>The Computer Misuse Act 1990, unauthorised access, intent to commit a further offence, modification data</li> <li>Tracking cookies</li> <li>DOS (denial-of-service) attacks: symptoms, effects, costs, type of fault, reasons</li> <li>Encryption: public and private keys, digital certificates, digital signatures</li> </ul>     |

contd

| Database Design and Development |  |
|---------------------------------|--|
| Analysis                        | <ul style="list-style-type: none"> <li>Identify end-user and functional requirements</li> </ul>  |
| Design                          | <ul style="list-style-type: none"> <li>Entity-relationship diagrams: entity name, attributes, name of relationship</li> <li>Cardinality of relationship</li> <li>Entity-occurrence diagram</li> <li>Compound key</li> <li>Data dictionary: entity name, attribute name, primary and foreign key</li> <li>Attribute type: text, number, date, time, Boolean</li> <li>Attribute size</li> <li>Validation: presence-check, restricted choice, field length, range</li> <li>Query design: tables and queries, fields, search criteria, sort order, calculations, grouping</li> </ul> |
| Implementation                  | <ul style="list-style-type: none"> <li>SQL (Structured Query Language): UPDATE, SELECT, DELETE, INSERT</li> <li>Wildcards</li> <li>Aggregate functions (MIN, MAX, AVG, SUM, COUNT)</li> <li>Calculated values, alias</li> <li>GROUP BY, ORDER BY, WHERE</li> </ul>   |
| Testing                         | <ul style="list-style-type: none"> <li>Describe testing</li> <li>SQL operations work correctly</li> </ul>  |
| Evaluation                      | <ul style="list-style-type: none"> <li>Fitness for purpose</li> <li>Accuracy of output</li> </ul>  |

| Web Design and Development  |   |
|-----------------------------|---|
| Analysis                    | <ul style="list-style-type: none"> <li>Identify end-user and functional requirements</li> </ul>   |
| Design                      | <ul style="list-style-type: none"> <li>Multi-level website</li> <li>Effective user interface for user and device type</li> <li>Design (visual layout and readability) using wireframe</li> <li>Horizontal navigational bar</li> <li>Relative positioning of the media</li> <li>Form inputs</li> <li>File formats of the media (text, graphics, video, and audio)</li> <li>Prototyping (low fidelity) from wireframe design</li> </ul> |
| Implementation (CSS)        | <ul style="list-style-type: none"> <li>Inline, internal and external Cascading Style Sheets (CSS)</li> <li>Grouping and descendant selectors: display (block, inline, none), float (left, right), clear (both), margins/padding, sizes (height, width)</li> <li>Create horizontal navigation bars, hover</li> </ul>   |
| Implementation (HTML)       | <ul style="list-style-type: none"> <li>HTML code: nav, header, footer, section, main, form, ID attribute</li> <li>Form element: input, text, number, textarea, radio, submit</li> <li>Form element: select</li> <li>Form data validation: length, presence, range</li> </ul>  |
| Implementation (Javascript) | <ul style="list-style-type: none"> <li>Javascript mouse event: onmouseover, onmouseout, onclick</li> </ul>  |
| Testing                     | <ul style="list-style-type: none"> <li>Usability testing using personas, test cases and scenarios based on low-fidelity prototypes</li> <li>Input validation works correctly</li> <li>Navigational bar works correctly</li> <li>Media content displays correctly</li> <li>Compatibility testing including: device type (tablet, smartphone, desktop), browser</li> </ul>  |
| Evaluation                  | <ul style="list-style-type: none"> <li>Fitness for purpose</li> <li>Usability</li> </ul>  |

### THINGS TO DO AND THINK ABOUT

There is an SQA document called "Higher Course Specification" which you can get from your teacher or download from the Computing Science section of the SQA website. Use this document to study the course content, and in particular use the twelve appendices for further clarification and detailed explanation.



ONLINE

This book is supported by the Bright Red Digital Zone. Visit <http://www.brightredbooks.net/Account/Logon> to create an account.



DON'T FORGET

You should use the syllabus as a kind of checklist to make sure that you understand exactly what knowledge is required for assessments in this course. Read it through and ask yourself if you know the topics covered in the table.



DON'T FORGET

In addition to your performance in the exam, your course assessment also includes an assignment practical task. The assignment makes up 50 out of the total 160 marks awarded for the course.

## COMPUTER SYSTEMS

## ENVIRONMENTAL IMPACT OF INTELLIGENT SYSTEMS

## INTELLIGENT SYSTEMS

Intelligent systems are computer systems that use Artificial Intelligence to imitate human intelligence. They are used to perform tasks that would normally require humans, such as autopilots for flying planes, credit-card fraud protection, robotic vacuum cleaners etc.

Increasing processing power and improving AI techniques such as image recognition, touch-sensing and speech recognition are producing new levels of functionality for tasks that until recently were only performed by humans.

Autonomous unmanned vehicles have sensors and AI software that allow them to act independently rather than being remotely controlled by a human operator. Intelligent robots are able to work in environments that are dangerous for humans, such as deep-sea exploration, outer space and war zones. There are enormous ethical questions to be answered about the use of vehicles that act independently as a weapon of war.

## DON'T FORGET



For this course, you must know the environmental impact of intelligent systems that are for heating, traffic control and car management. You do not need to know about the impact of other intelligent systems such as robotics and fraud detection.

This course specifies three areas of the use of intelligent systems and their environmental impact:

- 1 Heating systems
- 2 Traffic-control systems
- 3 Car-management systems.

## Environmental impact

Human activity can have a negative environmental impact through the release of greenhouse gases by burning fossil fuels. Intelligent systems can help to reduce this impact by providing systems that are more efficient in their energy requirements and lead to a reduced fuel consumption and lower emissions.

For example, an intelligent system that is used to plan the distribution of goods by lorries can find routes that minimise the overall journey distance and reduce the environmental impact.

## HEATING SYSTEMS

Early central-heating systems used thermostats that could be set manually to control the heat emitted by individual radiators and offer some control over the efficiency of the system.

Modern heating systems offer more efficient control by intelligently adapting to the day-to-day use of the system. For example, the heating system can learn from previous data what temperatures are preferred in which rooms and at what time of day.

Movement sensors can be fitted in each room which can monitor the amount of activity in each room and increase or reduce the heat accordingly. If nobody has gone into a spare room for three days, then the heating can be switched off in that room until activity resumes.

Smartphones can connect via wi-fi and use an app that allows the heat in each room to be adjusted from the phone and can turn the heating on from a remote location to heat the house in time for returning home.

## TRAFFIC-CONTROL SYSTEMS

The speed of traffic has a big impact on the fuel consumption of vehicles, since free-flowing traffic which is moving between 50 and 60 miles per hour has a much lower fuel consumption than traffic that is starting and stopping because of congestion on busy roads.

Intelligent traffic-control systems use data from sensors and cameras to intelligently control traffic signals to optimise the traffic flow and thereby limit fuel consumption.

Satnav systems can also be used to guide drivers through less congested routes and improve the overall flow of traffic.

In the future, self-driving cars will monitor traffic, weather and road conditions to always take the most efficient (in terms of energy) route to the destination.



## CAR-MANAGEMENT SYSTEMS

Car-management systems are ways of reducing the fuel consumption of cars and lorries and other vehicles by intelligently managing the vehicle's engine through computer control.

For example, the engine can be made to automatically turn off when the car is stopped at traffic lights and to automatically restart when the driver accelerates to move off.

In town, a lot of time is spent stopping and starting at traffic lights, and the fuel that is consumed by cars whose engine is idling when stopped at traffic lights and in traffic jams can be reduced.

Sensors can also be used to optimise engine performance by controlling the air-to-fuel ratio accurately for the best fuel consumption.

In the future, electric cars aim to get as many miles out of the battery as possible to reduce the number of times it needs to be charged and hence reduce the emissions from power stations.

## THINGS TO DO AND THINK ABOUT

Intelligent systems have a positive and/or negative impact on the environment, economy and society.

Office buildings are increasingly using robotic vacuum cleaners to clean the rooms after working hours. List the impact on the environment, economy and society of using robots to do this work instead of humans.

Also, consider if there is any negative environmental impact of using robotic vacuum cleaners. Try to list at least two negative impacts.

## DON'T FORGET

Intelligent traffic-control systems are about having an efficient flow of traffic to reduce fuel consumption, whereas intelligent car-management systems are about efficient fuel consumption by the vehicle's engine.



## ONLINE

Visit YouTube and watch a short video on intelligent heating systems at [www.youtube.com/watch?v=tInC6E8p7R8&t=28s](http://www.youtube.com/watch?v=tInC6E8p7R8&t=28s)



## ONLINE TEST

Take the test on Environmental Impact of Intelligent Systems at [www.brightredbooks.net](http://www.brightredbooks.net)

## DATABASE DESIGN AND DEVELOPMENT

## SQL

## INTRODUCTION

SQL stands for Structured Query Language (pronounced “sequel” or “S-Q-L”).

The language is used to perform tasks such as updating data on a database, or retrieving data from a database. Standard SQL commands such as SELECT, INSERT, UPDATE or DELETE can be used to accomplish most tasks.

## INSERT, DELETE, UPDATE, WHERE

The examples below use a table named “country” which has seven records.



| country    |         |               |             |           |
|------------|---------|---------------|-------------|-----------|
| country_id | name    | continent     | population  | area_kmsq |
| 1          | Italy   | Europe        | 64,762,320  | 301,308   |
| 2          | Algeria | Africa        | 37,100,000  | 2,381,741 |
| 3          | UK      | Europe        | 58,667,840  | 242,900   |
| 4          | Mexico  | North America | 107,027,504 | 1,958,201 |
| 5          | Bhutan  | Asia          | 38,394      | 749,090   |
| 6          | France  | Europe        | 51,495,667  | 551,500   |
| 7          | Canada  | North America | 35,702,707  | 9,984,670 |

## INSERT

The INSERT statement can be used to add records to a table.

In this example, a record for Denmark would be added to the country table.

```
INSERT INTO country (country_id, name, continent, population, area_kmsq)
```

```
VALUES (8, 'Denmark', 'Europe', 5634437, 43094);
```

## UPDATE

The UPDATE statement can be used to change values in rows that already exist.

In this example, the population of France would be updated to a new value.

```
UPDATE country SET population = 54596008 WHERE country_id = 6;
```

## DELETE

The DELETE statement can be used to remove rows from a table.

This example deletes the countries with a population of under 10 million from the Country table.

```
DELETE FROM country WHERE population < 10000000;
```

## SELECT, FROM, WHERE

The SELECT statement can be used to retrieve results from a table.

A WHERE clause is used to select only the rows that meet certain criteria.

## Example:

In this example, the name and population fields are selected for countries which have a population of between 55 million and 65 million.

```
SELECT name, population FROM country
WHERE population > 55000000 AND population < 65000000;
```

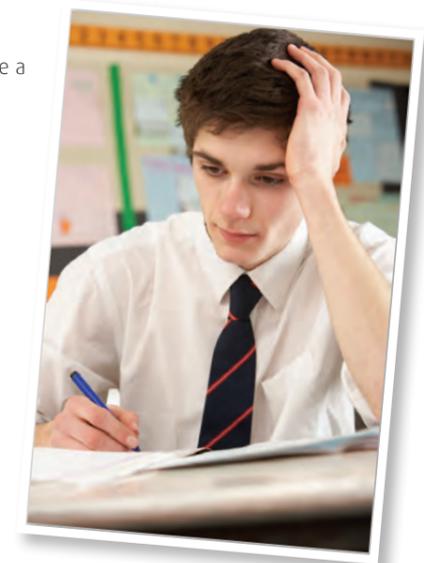
| country |            |
|---------|------------|
| name    | population |
| Italy   | 64,762,320 |
| UK      | 58,667,840 |

In this example, the name and birthday of students are selected from a student table for students who were born between Guy Fawkes Day (5 November) and Christmas Day (25 December) in 2005.

```
SELECT student_name, birthday
FROM student
WHERE birthday >= '2005-11-05' AND birthday <= '2005-12-25';
```

| student    |              |            |              |
|------------|--------------|------------|--------------|
| student_id | student_name | birthday   | school_house |
| 1          | Sam          | 2006-03-28 | Yellow       |
| 2          | Mandy        | 2005-12-02 | Red          |
| 3          | Paul         | 2005-11-21 | Green        |
| 4          | Sophie       | 2006-07-08 | Green        |
| 5          | Frank        | 2005-09-30 | Red          |
| 6          | Rosie        | 2006-05-28 | Blue         |
| 7          | Polly        | 2007-11-02 | Yellow       |
| 8          | David        | 2005-12-16 | Blue         |

| student      |            |
|--------------|------------|
| student_name | birthday   |
| Mandy        | 2005-12-02 |
| Paul         | 2005-11-21 |
| David        | 2005-12-16 |



## DON'T FORGET

Remember that an INSERT statement adds an entirely new record to a table whereas an UPDATE statement amends a record that already exists.

## ONLINE

Visit [www.codeacademy.com](http://www.codeacademy.com), where you can try out the SQL commands used in this topic.

## DON'T FORGET

Some SQL statements (DDL) are used to create and modify the structure of tables and databases, whereas other SQL statements (DML) are used to select and change the actual data in the tables. In this course, you are only being assessed on the DML commands.

## ALIAS

Aliases are created to make the columns selected by SQL statements more readable by giving them a temporary name.

## Example:

To select the student\_name and school\_house of all the students who are in the “Yellow” or “Red” houses.

```
SELECT student_name AS Name, school_house AS House
FROM student
WHERE school_house = 'Yellow' OR school_house = 'Red';
```

In the above query, the field “student\_name” is given an alias of “Name”, and “school\_house” is given an alias of “House”.

| student |        |
|---------|--------|
| Name    | House  |
| Sam     | Yellow |
| Mandy   | Red    |
| Frank   | Red    |
| Polly   | Yellow |

## THINGS TO DO AND THINK ABOUT

Search YouTube for relevant lessons to consolidate the SQL statements covered in this topic. Enter keywords such as “tutorial” or “beginner”, as well as the SQL command words, to obtain search results that are not too complex and are best suited to learning the fundamentals.

## ONLINE TEST

Take the test on SQL at [www.brightredbooks.net](http://www.brightredbooks.net)

## IMPLEMENTATION (JAVASCRIPT)



## JAVASCRIPT MOUSE EVENTS

Scripts can contain instructions to be executed in response to certain mouse actions such as clicking a command button, moving the mouse pointer over or away from an image, or selecting an item from a drop-down list.

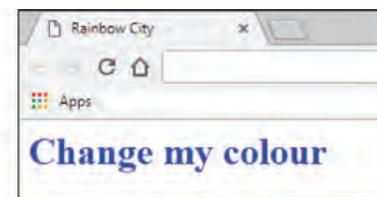
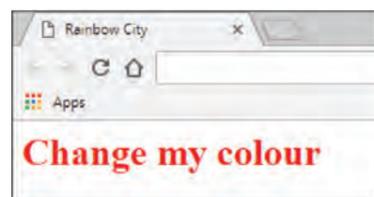
JavaScript uses the `onmouseover`, `onmouseout` and `onclick` events to make web content interactive. These events are implemented by placing the mouse event inside the HTML element according to the syntax shown below:

```
<img onmouseover=" ">
```

The action to be executed when the event occurs is placed inside the inverted commas.

## Example 1

The following example uses the `onmouseover` and `onmouseout` mouse events to change the colour of an `h1` heading. The colour of the `h1` heading changes to red when the mouse pointer moves over it and changes to blue when the mouse moves away.



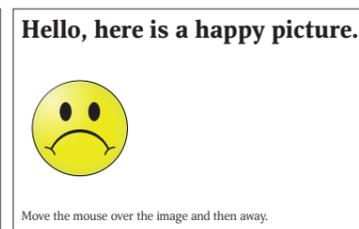
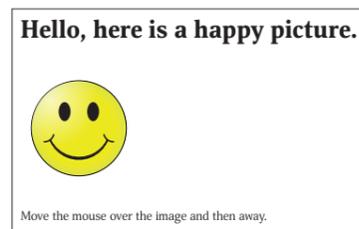
```
<html>
<head>
  <title>Rainbow City</title>
</head>
<body>
  <h1 onmouseover="style.color='red'" onmouseout="style.color='blue'">Change my
  colour</h1>
</body>
</html>
```

## Example 2

The following example uses the `onmouseover` and `onmouseout` mouse events to change the image that is displayed when the mouse pointer moves over or away from an image element.

Each function is passed the `img` element as a parameter using "this".

The first function changes the `src` for the image to a sad image, and the second function changes the `src` for the image to a happy image.



contd

```
<html>
<head>
  <title>Mood Swings</title>
</head>
<body>
  <h1>Hello, here is a happy picture.</h1>
  
  <p>Move the mouse over the image and then away.</p>

  <script>
    function sad(x) {
      x.src = "SadPic.bmp";
    }
    function happy(x) {
      x.src = "HappyPic.bmp";
    }
  </script>
</body>
</html>
```



## Example 3

The following example uses the `onclick` mouse event to make the text in a `p` element visible when an image is clicked.

When the web page is initially loaded, a paragraph element is hidden by applying a CSS class that uses the rule `display: none;` which makes the `p` element invisible.

The image element uses an `onclick` event that uses the ID of a paragraph element to execute the action `display='block'`. This action makes the `p` element visible on the page.

```
<html>
<head>
  <title>Jokes World</title>
  <style>
    .hidden{display: none;}
  </style>
</head>
<body style="background-color:lightblue; font-size:24px;">
  <p>Why did a night club on Mars close down?</p>
  
  <p id="show" class="hidden">Nobody came because there was no atmosphere!</p>
</body>
</html>
```

The web page when it loads is shown to the right.

After "Punchline" has been clicked, the text in the second paragraph is made visible.


 THINGS TO DO AND THINK ABOUT

Try out the three examples of JavaScript used in this spread by entering the code into a text editor such as Notepad or WordPad.

 ONLINE TEST

Take the test on Implementation (JavaScript) at [www.brightredbooks.net](http://www.brightredbooks.net)

DON'T FORGET 

There are many JavaScript mouse events, but for this course you only need to know about the `mouseover`, `mouseout` and `onclick` events. You may be asked written questions on these events in the exam, and also you may be required to write code to implement these actions in your practical assignment task.

DON'T FORGET 

YouTube is a good place to look for further examples of JavaScript tutorials on `mouseover`, `mouseout` and `onclick` events – but remember that JavaScript is a very large and complex language, so restrict yourself to the events required for this course.



# COMPUTING SCIENCE

Alan Williams

This BrightRED Study Guide is the ultimate companion to your CfE Higher Computing Science studies! Written by our trusted author and experienced Computing teacher, Alan Williams, this book is full-colour and packed with clear and accessible information, excellent examples, activities and advice. Inside, you will find:

- ▶ **Completely updated content with the latest course and exam developments**, brand new questions and answers included.
- ▶ **All the essential course information** arranged in easily digestible double-page topic spreads.
- ▶ **Detailed full-colour** diagrams, illustrations and data boxes to make sure all that study sticks!
- ▶ **Don't forget** pointers offering advice on the key facts to remember, and on how to avoid common mistakes.
- ▶ **Things to do and think about** sections encouraging the regular review of key points covered.
- ▶ **Digital Zone activities and tests** to supercharge your learning efforts online!
- ▶ **An index** of key terms to help when revising.

Your future's bright with BrightRED Study Guides!

Twice winner of the IPG Education Publisher of the Year award.



BE BRIGHT BE READY

Bright Red Publishing's easy to use, high-quality educational resources are trusted by teachers and custom designed to improve students' study experience to help them to achieve their potential.

To see more of what we do and stay up to date with all things Bright Red:

- ▶ follow us on Twitter @\_BrightRed
- ▶ like us on Facebook at [www.facebook.com/brightredbooks](http://www.facebook.com/brightredbooks)
- ▶ follow us on Instagram @bright\_red\_publishing
- ▶ visit us at [www.brightredpublishing.co.uk](http://www.brightredpublishing.co.uk)
- ▶ or call us on 0131 220 5804 – we'd be delighted to hear from you!

[www.brightredpublishing.co.uk](http://www.brightredpublishing.co.uk)



Check out the **BrightRED Digital Zone** – for a world of tests, activities, links and more at [www.brightredbooks.net!](http://www.brightredbooks.net!)



BrightRED

ISBN 978-1-84948-325-4



9 781849 483254