UNIVERSITY *of* CAMBRIDGE
International Examinations

SYLLABUS

Cambridge IGCSE®
Computer Studies (US)

0441

For examination in June and November 2014

**This syllabus is available only to Centers taking part in the
Board Examination Systems (BES) Pilot.**

**If you have any questions about this syllabus, please contact Cambridge at
international@cie.org.uk quoting syllabus code 0441.**

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1. Introduction

1.1 Why Choose Cambridge?

University of Cambridge International Examinations is the world's largest provider of international education programs and qualifications for 5 to 19 year olds. We are part of the University of Cambridge, trusted for excellence in education. Our qualifications are recognized by the world's universities and employers.

Recognition

Every year, hundreds of thousands of learners gain the Cambridge qualifications they need to enter the world's universities.

Cambridge IGCSE® (International General Certificate of Secondary Education) is internationally recognized by schools, universities, and employers as equivalent to UK GCSE. Learn more at **www.cie.org.uk/recognition**

Excellence in Education

We understand education. We work with over 9,000 schools in over 160 countries that offer our programs and qualifications. Understanding learners' needs around the world means listening carefully to our community of schools, and we are pleased that 98% of Cambridge schools say they would recommend us to other schools.

Our mission is to provide excellence in education, and our vision is that Cambridge learners become confident, responsible, innovative, and engaged.

Cambridge programs and qualifications help Cambridge learners to become:

- **confident** in working with information and ideas—their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference.

Support in the Classroom

We provide a world-class support service for Cambridge teachers and exams officers. We offer a wide range of teacher materials to Cambridge schools, plus teacher training (online and face-to-face), expert advice, and learner support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from our customer services. Learn more at **www.cie.org.uk/teachers**

Nonprofit, Part of the University of Cambridge

We are a part of Cambridge Assessment, a department of the University of Cambridge and a nonprofit organization.

We invest constantly in research and development to improve our programs and qualifications.

1.2 Why Choose Cambridge IGCSE?

Cambridge IGCSE helps your school improve learners' performance. Learners develop not only knowledge and understanding, but also skills in creative thinking, inquiry, and problem solving, helping them perform well and prepare for the next stage of their education.

Cambridge IGCSE is the world's most popular international curriculum for 14 to 16 year olds, leading to globally recognized and valued Cambridge IGCSE qualifications. It is part of the Cambridge Secondary 2 stage.

Schools worldwide have helped develop Cambridge IGCSE, which provides an excellent preparation for Cambridge International AS and A Levels, Cambridge Pre-U, Cambridge AICE (Advanced International Certificate of Education), and other education programs, such as the US Advanced Placement Program and the International Baccalaureate Diploma. Cambridge IGCSE incorporates the best in international education for learners at this level. It develops in line with changing needs, and we update and extend it regularly.

1.3 Why Choose Cambridge IGCSE Computer Studies?

The Cambridge IGCSE Computer Studies syllabus enables candidates to develop an interest in computing and gain confidence in the use of computers. Candidates develop an appreciation of the broad range of computer applications in order to improve their understanding of the power and versatility of the computer and the benefits of its use, but also its limitations and potential disadvantages. Cambridge IGCSE Computer Studies is an ideal foundation for further study at Cambridge International A Level, and the skills learned can also be used in other areas of study and in everyday life.

1.4 Cambridge International Certificate of Education (ICE)

Cambridge ICE is the group award of Cambridge IGCSE. It gives schools the opportunity to benefit from offering a broad and balanced curriculum by recognizing the achievements of learners who pass examinations in at least seven subjects. Learners take subjects from five subject groups, including two languages, and one subject from each of the other subject groups. The seventh subject can be taken from any of the five subject groups.

Computer Studies (0441) falls into Group V, Creative, Technical, and Vocational Subjects.

Learn more about Cambridge IGCSE and Cambridge ICE at **www.cie.org.uk/cambridgesecondary2**

1.5 How Can I Find Out More?

If You Are Already a Cambridge School

You can make entries for this qualification through your usual channels. If you have any questions, please contact us at **international@cie.org.uk**

If You Are Not Yet a Cambridge School

Learn about the benefits of becoming a Cambridge school at **www.cie.org.uk/startcambridge**.
Email us at **international@cie.org.uk** to find out how your organization can become a Cambridge school.

2. Assessment at a Glance

Candidates take Paper 1 and Paper 2.

Candidates take:
Paper 1: Theoretical paper   2 hours, 30 minutes This written paper contains short-answer and structured questions. There is no choice of questions. 75% of total marks
Paper 2: Coursework (internal assessment) This is a single piece of coursework of a complex nature, which involves the use of a computer to solve a specific problem. Candidates do the coursework over an extended period. The coursework enables candidates to use their skills and experience gained during the course to analyze, design, implement, test, and evaluate the solution to a problem. 25% of total marks

Availability

This syllabus is examined in the May/June examination series and the October/November examination series.

Combining This with Other Syllabi

Candidates can combine this syllabus in an examination series with any other Cambridge syllabus, except:

• syllabi with the same title at the same level

3. Syllabus Goals and Objectives

3.1 Goals

The goals of the Cambridge IGCSE Computer Studies syllabus are to enable candidates to:

* develop an appreciation of the range and power of computer applications
* foster an interest in, enjoyment of, and confidence in the use of computing
* develop the ability to solve problems using computing techniques
* develop an awareness of the place of computing in society and issues computing raises in society
* gain a firm understanding of the basic techniques and knowledge required for computing applications
* develop a desire to use computers within other interests

3.2 Scheme of Assessment

All candidates need to demonstrate basic levels of knowledge and understanding. To do this, they need to recall information and either apply that information or explain it. All candidates also need to demonstrate some level of practical skill through the project. This will require them to show their ability to comprehend, analyze, explain, synthesize, and justify, to varying degrees, information and situations which should be broadly familiar to candidates.

Paper 1

This is a mandatory question paper, consisting of short-answer and structured questions. Candidates must answer all the questions.

Paper 2: Coursework (Internal Assessment)

The purpose of this project is to allow candidates to demonstrate their ability to undertake a complex piece of work, which is a computer-based solution to a significant problem, and to complete the solution and present their results. A complex piece of work is one that involves one of the following:

* integrating components of two generic application packages to form a single solution
* using some of the more advanced functionalities of a single application package
* using modules and file handling in a coded solution.

In all cases, candidates must fully document the solution.

Teachers assess the coursework, and Cambridge moderates a proportion of the work. At least one teacher in each Center offering a subject including coursework must be accredited by Cambridge. To get approval, teachers have to satisfy Cambridge requirements concerning marking and internal moderation of coursework. Cambridge offers Centers Coursework Training Handbooks for teachers who do not meet these requirements.

Teachers award marks for the following skills:

- Analysis   11 marks
- Design   14 marks
- Implementation   8 marks
- Testing   7 marks
- Documentation   5 marks
- Evaluation   5 marks

  TOTAL   50 marks

Further information on Coursework projects and guidance for their assessment appears in "Notes for the Guidance of Teachers" section in the Appendix.

3.3 Assessment Objectives and Their Weighting in the Exam Papers

There are three assessment objectives in Cambridge IGCSE Computer Studies:

A.   Knowledge and Understanding

Candidates should be able to demonstrate knowledge and understanding of computing, in relation to:

- the range and scope of information processing applications
- the effects of the use of computers, both practical and social
- the range of equipment, tools, and techniques used to solve problems
- the functions of the main hardware and software components of information-processing systems
- appropriate terminology

B.   Problem-Solving and Realization

Candidates should be able to:

- identify problems within the field of information processing
- analyze problems by considering relevant functional, practical, human, and economic factors
- draw up specifications for the computer-based solutions of problems
- select from a range of resources those that are most suitable for solving problems
- develop solutions using appropriate methods
- implement solutions using equipment, tools, and techniques sensibly
- test, evaluate, and refine solutions systematically
- document solutions to problems

C.   Communication

Candidates should be able to:

- interpret and organize information
- recognize and present information in a variety of forms
- communicate in appropriate ways information about applications of computers, problems, and their solutions

Assessment objective	Paper 1	Paper 2	Overall
Knowledge and understanding	30%	5%	35%
Problem-solving and realization	20%	15%	35%
Communication	25%	5%	30%
Total	75%	25%	100%

4.   Curriculum Content

Centers should read this syllabus as an integrated whole and not as a progression. The sections of the syllabus overlap and interrelate and the order of the sections reflects a top-down view of the subject: a study of the applications of computers and the effects of their use is supported by a study of the design processes, methods, and mechanisms that underlie such applications.

The sections of the syllabus are:

1. Applications of computers and their social and economic implications
2. System life cycle
3. Problem solution, including algorithm design, programming concepts, and logic gates
4. Generic software and the organization of data
5. Hardware, systems, and communications

Each syllabus section contains a number of subsections, and there are descriptions of goals for each section and objectives for each subsection. The content of the syllabus is in two columns, with a list of topics on the left and notes on the topics on the right. Some topics have no notes while some others have extended notes. **The absence, brevity, or length of the notes does not indicate the weighting of the topic**. Instead, this relates to whether or not there are suitable, widely available sources of clear and unambiguous information on the topic elsewhere. Where the notes contain definitions of terms, the definitions are for the purposes of the syllabus; they are not necessarily universal definitions.

The purpose of this syllabus is not to show how to organize a course. However, here is a suggestion of a possible course structure, which may be helpful to some Centers, although it is not meant to be prescriptive.

A successful course based on this syllabus could start with a study of a simple application, including topics from throughout the syllabus that relate to that application. This could be repeated with other increasingly complex applications from a variety of areas. Within this overall structure, candidates would need to study particular topics in the syllabus in more detail, but, as far as possible, topics could be studied in the context of their application. In parallel with these studies, there would be practical work designed to build upon and illustrate the applications and topics that candidates are studying.

When considering a problem that may be solved using computers, candidates must learn to analyze the problem first to establish the desired outcome and the information requirements. This is followed by the design of a suitable overall system. Then candidates need to be able to specify parts of the system and the interactions between the parts, in detail, and to select an appropriate form of solution for each of these parts. In order to implement the solutions effectively, they need to choose suitable data organizations, algorithms, software and hardware components, and use appropriate tools and techniques. Some understanding of the underlying system software and architecture assists in the sensible and efficient uses of resources in the implementation of solutions.

Section 1: Applications of Computers and Their Social and Econo[mic] Implications

The goal of this section of the syllabus is to cover as broad a range of computer applications as possible, so as to provide an understanding of the power and versatility of the computer and the benefits of its use, and also its limitations and the problems and potential disadvantages of its use.

1.1 The Range and Scope of Computer Applications

Candidates should be able to demonstrate a knowledge and understanding of a wide variety of computer applications. They do not need to have specific knowledge of every kind of application, but they should be able to comment sensibly on any suggested application and make use of specific relevant examples for illustration.

1.1.1 General application areas

The range of computer applications is vast. Candidates can achieve an awareness of this range and of the nature of a variety of application areas through a general study of a number of applications of different kinds. The relevant aspects of any application include the following:

1. The purpose of the application
2. The required outcome
3. The overall system design, including both the computerized and the noncomputerized parts of the application
4. The necessary inputs to the system and the means by which any data is captured
5. The overall organization and processing of the data within the system
6. The use and organization of the major software and hardware components of the system
7. The need for recovery in the event of a system failure
8. The interface between the system and its users
9. The effectiveness of the system in practice
10. The effects of the application on individuals and organizations.

There are many examples in each application area and some are listed below. Candidates should study a varied sample of these.

1.1.2 Communication and information systems, online services, remote databases	Examples studied should include:

- electronic mail (email)
- video-conferencing (e.g., the reasons for increased use in recent years, hardware and software requirements, positive environmental aspects of such systems)
- digital telephone facilities (e.g., VoIP)
- information retrieval and database systems
- office automation (e.g., use of word processors, electronic filing, databases, the need to learn new skills)
- library systems (e.g., files containing book details and borrower's details, automatic reminders, use of barcodes to track books and identify customers)
- multimedia (e.g., use of sound, animation, and video to help in education/training, producing presentations)
- e-commerce (e.g., online banking, credit card purchases)
- wireless technology (e.g., security aspects, allows no trailing wires)
- broadband versus dial-up modems
- virtual reality applications (e.g., views inside a house, kitchen design)

1.1.3 Commercial and general data processing	Examples studied should include:

- banking systems (e.g., check processing, updating of accounts, stages that occur when purchases are made using a bank account)
- hospitals (e.g., patient records, need to update records regularly, hospital administration)
- personnel records (e.g., what would be stored, use of databases, need to keep up-to-date, how these link into other areas such as payroll)
- automatic stock control and order processing (e.g., use of barcodes in supermarket stock control)

1.1.4 Industrial, technical, and scientific uses	Examples studied should include:

- weather forecasting (e.g., how data is gathered and processed, how information is conveyed, predictions based on new data and existing data)
- computer aided design (e.g., features of CAD, banks of "parts," ability to do costings, applications such as electronic circuit design)
- simulation and modeling (e.g., how data is gathered for a model, how predictions are made, why modeling is done, use of the model in applying to real applications)
- use of virtual reality (e.g., designing new chemical/nuclear plants, ability to "see inside" plants using special devices, safety applications)
- training (e.g., airline pilots—advantages of doing this, what hardware is used, why training simulators are used)

1.1.5 Monitoring and control systems	Examples studied should include:

- monitoring hospital patients (how equipment monitors vital signs, how the system knows when to notify doctors)
- chemical/nuclear plants (using sensors to monitor and control the plants, what is monitored, how plant status is relayed to operators, why plants are controlled by computers)
- traffic control (how models/simulators are used to set traffic light timings, types of sensors used to gather data, how system "decides" timing of lights)

1.1.6 Automation and robotics	Examples studied should include:

- domestic equipment (e.g., use of microprocessors to control microwave ovens, etc., intelligent cookers that use barcodes to automatically set cooking times/temperatures)
- navigation systems (e.g., satellite navigation used in ships, airplanes, and cars (global positioning), directions given by voice synthesis, benefits and drawbacks of these systems)
- industrial robots (e.g., in car manufacturing and other automated processes, advantages in terms of quality control and the environment, effects on work force)
- use of CCTV (e.g., cameras used in surveillance, automatic warning of intruders, use of sensors to control camera)

1.1.7 Expert systems	Examples studied should include:

- mineral prospecting
- medical diagnosis
- diagnostics (e.g., car engines, electronic devices)

Candidates should be aware of the following aspects of expert systems:

- how they are created
- how they function (role of inference engine, rule base, knowledge base, and human-machine interface)
- why and where they are used to great effect

1.1.8 Education and training, entertainment	Examples studied should include:

- computer-based learning (e.g., interactive learning and assessment)
- applications in music (e.g., how music is produced and generated using computers, teaching how to play musical instruments through computer systems/electronic interfaces)
- computer graphics in animation for TV and movies (e.g., how cartoons/animation is produced, special effects, synchronizing speech with animation, superimposing humans into cartoons)
- virtual reality in training (e.g., use in dentistry, learning to operate chemical/nuclear plants)

1.1.9 Use of the Internet

Examples studied should include:

– designing Internet sites (e.g., web page features customers expect to see when ordering online, obtaining information, etc., online banking and e-commerce)

– use of search engines (e.g., how to refine your searches, features of search engines)

– security (e.g., how credit card protection features are built in (e.g., encryption, use of smart card slots in keyboards), people's fear of the Internet)

– society (e.g., effects on society of using Internet-based shopping, information retrieval and education systems)

– other applications (e.g., ability to use live satellite maps, interactive maps that combine traditional maps with satellite images, other modern applications)

– use of intranets (e.g., many large companies adopt intranets as well as Internet access, the differences between intranets and the Internet)

1.2 The Social and Economic Implications of the Use of Computers

In addition to knowledge about applications, candidates should be able to demonstrate a broad knowledge of the economic reasons for using computers and the effects of their use across a range of application areas. They should be able to formulate a reasoned view of the potential effects of any suggested application or development and to show their critical abilities in balancing the advantages and disadvantages of a computerized system.

1.2.1 Social and economic effects on people and organizations associated directly with the application, on other individuals and organizations, and on society in general

The social and economic effects of the use of computers should be discussed in the context of particular computer applications, with any general principles being based upon real examples. For example, the de-skilling brought about through the replacement of skilled and semi-skilled labor by microprocessor-controlled systems in manufacturing; the ability to site operations anywhere in the world, e.g., call centers, online retailing; the benefits to unions and to management of "new technology" agreements leading to greater productivity and better working conditions.

Candidates should consider the economic reasons for using computerized systems, the changes to existing methods and services, and the changes to the working environment because computerized systems are used. The applications discussed in Section 1.1 should be used as a basis for this study.

Candidates should consider the health and safety aspects of using computers in the workplace.

1.2.2 Changes in employment, retraining

Candidates should identify the need for retraining of staff as existing packages are upgraded and new ones are published. This includes the use of multimedia training packages for individual use on CD-ROM or DVD.

1.2.3 Privacy and integrity of data	To ensure data is kept safe from hackers (e.g., by passwords, firew... and data is protected from corruption, etc.
1.2.4 Data protection legislation	For example the features expected in a data protection act, such as data must be up-to-date, data must be accurate, data must be obtained lawfully
1.2.5 Security and reliability; the consequences of system failure	The requirements for security and reliability vary considerably depending on the nature of the application. For example, a failure during a batch update of a sequential master file is irritating and will cause delay, whereas a failure in an air traffic control system could well have catastrophic results.
1.2.6 Hacking and other computer crime	Computer crime includes activities such as the cracking of ineffective security systems in order to gain unauthorized access to commercially sensitive or confidential personal files, and fraud through the improper transfer of funds from one account to another. Computer criminals may work within the organization or may be outsiders. Measures taken to combat computer crime include physical security, development of complex security codes and systems, encryption of sensitive data, and monitoring of all attempts to access the system, whether successful or not. Modern security systems include the use of smart cards (which are slotted into the side of a keyboard and prevent access unless the PIN typed in matches the one stored on the chip) and other electronic devices (e.g., modern passports and security passes contain a chip and/or loop circuit recognized by an electronic reading device).
1.2.7 Computer viruses	What a virus is, the effect of a virus on a computer system, how to guard against viruses (e.g., use of appropriate software, firewalls).
1.2.8 Internet security and usage	Potential problems with Internet use in the form of, for example:

– viruses
– hacking
– spam
– spyware
– cookies
– phishing
– pharming

Modern developments in the use of the Internet, for example:

– wikis
– social networking
– blogs
– digital media sharing websites
– web browsers
– ISPs
– tagging
– podcasts
– bit streaming

Section 2: System Life Cycle

The goal of this section of the syllabus is to cover the main principles of the system life cycle, which include aspects of fact finding, feasibility study, analysis, design, implementation, testing, documentation, methods of changeover, evaluation, and maintenance. This is achieved partly through the study of computer applications, in particular the methods by which a problem has been analyzed to lead to a successful solution for the user, and partly through practical work.

2.1 Systems Analysis and Design

Candidates should be able to describe the main steps involved in systems analysis and they should be able to use charts and diagrams. They should be able to apply the principles of systems analysis in their coursework projects.

A variety of problems/solutions should be examined beginning with the relatively simple (e.g., keeping a record of pocket money—how to go from a paper-based record to using a spreadsheet) to the more complex (e.g., an automatic stock control system replacing a paper-based system in a supermarket).

	Candidates should be aware of what is required at each stage of the system life cycle. The use of various diagrams (e.g., top-down design, systems flowcharts, dataflow diagrams) is essential when studying actual examples.
2.1.1 Fact finding	Candidates should know the methods used in fact finding (and which method is appropriate for an application).
2.1.2 Feasibility study	Candidates should understand what forms a feasibility study.
2.1.3 Analysis	Candidates should be aware of what forms the analysis stage.
2.1.4 Design	Candidates should be aware of what forms the design stage.

2.2 Implementation, Evaluation, and Maintenance

2.2.1 Implementation	Cambridge should be able to develop solutions using appropriate methods.
2.2.2 Testing	Candidates need to be aware of testing strategies and should be capable of choosing appropriate test data.
2.2.3 Documentation	Candidates should know what items are included in a user guide and in technical documentation.
2.2.4 Changeover	Candidates should understand appropriate methods for changeover (including the advantages and disadvantages of the common methods).
2.2.5 Evaluation	Candidates need to be aware of how a system is evaluated.
2.2.6 Maintenance	Candidates need to be aware of how a system is maintained.

Section 3: Problem Solution Including Algorithm Design, Programming Techniques, and Logic Gates

The goal of this section of the syllabus is to cover the design, development, implementation, maintenance, and review principles, which include techniques and tools relating to the solution to a problem. A study of these topics is reinforced through practical work and illustrated by a consideration of existing problem solutions in computer applications.

3.1 Algorithm Design and Testing

3.1.1 Make an overall plan	Most of this work should be conducted through the use of practical exercises.
	Define the scope of separate modules
	Design algorithms that relate clearly to the requirements of the system
	Explain algorithms and how they relate to the system
	Explain how hardware needs arise from the output required from the system
3.1.2 Algorithm tools	Top-down design, structure diagrams, flowcharts, libraries of procedures, and subroutines.
3.1.3 Interpret and test algorithms	Candidates should be able to work out the purpose of an algorithm using dry runs, and to suggest and apply suitable test data. Candidates should use trace tables to find the value of variables at each stage in an algorithm. Candidates should be able to identify errors in given algorithms and suggest ways of removing these errors.

3.2 Programs, Representation of Algorithms, and Documentation

Candidates should have experience in representing algorithms as structure diagrams, flowcharts, step sequences, and description, and more formally in pseudocode. Candidates should appreciate the main requirements of a programming language, to allow manipulation of data of various types and structures, including control of input and output, and to provide for selection, repetition, and subprogram intercommunication. Candidates should have a basic understanding of the functions of interpreters, compilers, and assemblers, and an appreciation of the benefits offered by the existence of a range of languages, both high- and low-level.

3.2.1 The concept of a program	Candidates do not need to code in any particular language but they should be familiar with the concepts of sequence, selection, and repetition. They should understand the concepts of totals and counting. Candidates should be able to produce an algorithm for a given written problem (either written in pseudocode or in the form of a flowchart). They should have the ability to identify errors and suggest corrections in a given piece of pseudocode.
3.2.2 High-level languages	For example: these are portable, need to be compiled or interpreted, easier to write and debug.
3.2.3 Low-level languages	For example: machine-specific types of language (machine code or assembly code), why these languages are used.

3.2.4 Pseudocode structures	repeat … until
	if … then … else … endif
	case of … … … otherwise … endcase
	while … do … endwhile
	for … to … next
	input and output (e.g., read, print)
	totals (e.g., sum = sum + number)
	counting (e.g., count = count + 1)

| 3.2.5 User guide, technical documentation | Candidates should be able to distinguish between the documentation that users require and the documentation required by those responsible for improving and maintaining a solution in working order or for developing the solution to meet new needs. |

3.3 Logic Gates and Circuits

Candidates should be aware of the use of logic gates in creating electronic circuits and components. It is useful to use kits available on the market to understand how logic gates work and to build some simple circuits. There are numerous websites, such as **www.kpsec.freeuk.com** (choose the STUDY section and then the LOGIC GATES option) that help in supplying worked examples.

| 3.3.1 Basic logic gates | Candidates should be able to understand and define the function of NOT, AND, OR, NAND, and NOR logic gates including the binary output produced from all possible binary inputs. They need to be able to draw truth tables and recognize a logic gate from its truth table. |

| 3.3.2 Logic gate symbols | Candidates need to recognize two ways of representing the logic gates: |

3.3.3 Interpreting simple logic circuits

Candidates should be able to produce truth tables for given logic circuits (maximum of 3 inputs and 6 gates).

a	b	c	output
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

3.3.4 Designing simple logic circuits

Candidates should be able to produce a simple logic circuit from a given written statement (e.g., *if A AND B are on AND if C is on then the lights will be on*).

Section 4: Generic Software and the Organization of Data

4.1 Generic Software Packages

The aim of this section is to give candidates a broad overview of generic software packages. These should be experienced through practical work. Although candidates may choose to become expert in the use of a particular package, they only need a general knowledge of the kinds of features typical of generic packages.

Software for word processing, database management, spreadsheets, graphics, communications, multimedia, data-logging, CAD, programming, desktop publishing, and web design

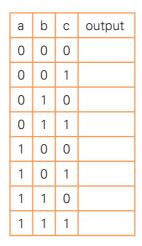Candidates should appreciate ways, including import and export, of using programming, desktop publishing, word processing packages, spreadsheets, databases, graphics packages, and information retrieval packages, and show an understanding of the use of graphical user interfaces, communications software (including email), web browsers, search engines, and authoring packages (also refer to section 1.2). They should appreciate the advantages and disadvantages of generic packages compared with specially written custom-made software and how packages may be customized by the use of macros. They should be able to explain the use of the tools associated with data-logging.

4.2 Data

Candidates should be aware of the standard methods of data collection, verification, and validation, and where it is appropriate to use particular methods.

Candidates should understand that data, particularly data held in files, requires access in different ways depending on the particular application. The medium on which the data is stored, and particularly the way in which it is organized, depend on the requirements for access. Candidates should be familiar with the idea of file ordering and the principles of sorting and merging. They should have experience of sequential file processing and of processing individual records by means of record keys.

4.2.1 The relationship between information and data; the collection of data; methods of ensuring its correctness (including validation and verification and the distinction between these); the coding of data for input; the presentation of useful information from processed data; analog-to-digital and digital-to-analog conversions

Candidates should be able to describe and select:

– automatic data capture techniques in a number of applications (e.g., barcodes in automatic stock control systems, OCR/OMR techniques (e.g., use in reading questionnaires), sensors in data logging (also refer to section 5.1))

– data collection methods (e.g., automatic methods as described above, manual inputting via keyboards and touch screens)

– validation techniques (e.g., range checks, type conversion checks). The use of check digits (candidates should be able to understand how check digits are generated and why they are used).

– verification techniques (i.e., methods that can be used such as double entry and visual checks); the uses for verification (e.g., checking password entries)

– ADC and DAC (e.g., how these are used in control and monitoring of processes; refer to section 5.1)

4.2.2 File organization: different forms of organization, depending on the data stored and the requirements for processing; processing methods

Candidates should be able to describe:

– the need to process files

– how files are processed

– file maintenance (updating, inserting, and deleting data from files as appropriate)

Candidates should be able to select with reasons:

– the appropriate file organization and processing methods for a particular application.

4.2.3 Data types for numbers, characters, strings, arrays; the need for different data types and structures to represent the data of problems which are being solved using a computer

Candidates should be able to:

– identify the different forms of data and explain how the data is represented for processing with reference to a given problem

– explain the need for different data types and structures and how these relate to the data of the given problem.

Section 5: Hardware, Systems, and Communications

The goal of this section is to draw together the experience of various kinds of hardware and types of processing, and to examine the concepts of operating systems and communications.

5.1 Hardware

5.1.1 Computer, microcomputer, microprocessor, standard input and output devices, broad classes of processor power

Candidates should be able to identify:

– the use of laptop computers (including their differences from desktop PCs)
– the required specification for a laptop (i.e., it should consume little power, run cool, etc.)
– the use of microprocessors in everyday-life objects (e.g., cameras (including CCTV), digital watches, televisions)

Candidates should be able to describe/select:

– suitable input and output devices in relation to the requirements of the application
– the use of specialist input and output devices (e.g., to help disabled people communicate with a computer system, devices to communicate with virtual reality systems)

5.1.2 The functions and characteristics of storage media

Candidates should have a good understanding of the operation of internal memory devices such as RAM, ROM, hard disk.
Candidates should understand the operation and areas of application for traditional external storage media such as CD-ROM, CD-RW, and DVD.
Candidates should understand the operation of other memory devices such as:

– USB flash memories
– memory systems used in MP3/4 players
– HD cards in digital cameras
– use of modern devices in storing music and movies (e.g., use of hard drive which allows recordings to take place at the same time as playing back files)

5.1.3 The characteristics and performance of a range of peripherals (including control and communication devices)

Candidates should be able to discuss the suitability of different peripherals for various applications.
Candidates should be aware of the role of the cell telephone in communications systems (this can cover a wide range of topic areas such as Internet access, use as cameras, use as MP3 players, etc.).

Candidates should be aware of the different types of sensor used in a wide variety of control and monitoring applications, such as:

– temperature (e.g., heating systems)
– moisture (e.g., greenhouse applications)
– gas (e.g., environmental monitoring)
– light (e.g., operating automatic doors)
– infrared (e.g., detecting intruders)

5.2 Systems and Communications

5.2.1 The nature of batch, online, multi-access, real-time transaction processing, multitasking, network, and process-control operating systems

A real-time transaction processing system is an online system that processes individual, discrete transactions as they occur, e.g., an airline booking system and an online stock control system. This use of the term real-time differs from its use in a real-time process-control system, which continuously monitors and processes physical quantities sufficiently rapidly to be capable of influencing the sources of data.

5.2.2 The form of interface between the operating system and the user; use of command line and use of graphical user interfaces

5.2.3 Management of files; file directories; folders

The need for and use of facilities to copy, move, list, print files. The use of sub-directories.

5.2.4 Peripheral device control; use of buffers; interrupts and interrupt priorities; polling; handshaking; checksums

For an interrupt system the external device or event interrupts the processor, whereas in a polling system the processor interrogates the device or status register. These two alternative methods have very different processing requirements.

Adding together all of the elements (for example, bytes) of a block produces a single element known as the checksum. This can then be stored with the block and provides a check when the block is transferred.

5.3 Types of Systems

Candidates should be able to distinguish between the different types of systems, to describe what is needed to support them, to explain which is the most suitable for any given application, and to discuss the consequent implications for the user. Candidates should be able to describe particular problems in the management of the various types of systems, such as conflicting access to common data or critical timing considerations.

5.3.1 Batch processing systems	In broad terms, a batch processing system processes a job without any direct interaction between the job and the user. Typical applications are payroll and billing systems.
5.3.2 Interactive systems	In contrast to the above, an interactive system provides for interaction between the job and the user, which may influence the future course of processing. Such systems may be single-user (for example, a personal computer) or multi-user. Typical applications are word processing and online information retrieval.
5.3.3 Network systems	A network system is one in which processing occurs independently in more than one location, but with shared and controlled access to some common facilities, which normally include file storage and information resources. Candidates should be able to describe and compare the topology principles of ring, bus, and star networks and also understand the need for local (e.g., intranet) and shared resources and gateways for accessing wide area networks (WANs).
5.3.4 Control systems	In a control system, one or more computers control the operation of some non-computer equipment, usually involving some monitoring and logging of physical quantities, providing some analysis of performance, and allowing some user interaction. Feedback is an essential element in most control systems. Timing considerations are often critical and the term "real-time control system" is sometimes used to indicate this. Control systems are used in applications such as oil-refining, chemical processing, and integrated traffic-control systems.
5.3.5 Automated systems	Automated systems are broadly similar to control systems but are dedicated to a particular task, and lack the ability to collect and analyze data and the flexibility to allow for and act on user interaction beyond a very simple level. Examples are the systems found in equipment such as washing machines and cameras.
5.3.6 Multimedia	Candidates should be able to specify minimum hardware and software requirements for multimedia applications and describe typical features and uses of multimedia systems.

5. Appendix

5.1 Notes for the Guidance of Teachers

Introduction

The purpose of these notes is to provide assistance for teachers preparing candidates for the Cambridge IGCSE Computer Studies examination. They contain notes on equipment, facilities, and resources, and sources of further information. The sections on approaches to practical work and to the project (Paper 2) are particularly detailed.

Equipment and Facilities

Computer Studies is a practical subject and the Cambridge IGCSE syllabus places emphasis on the use of commercial and other major packages and on the applications of computers. Centers must ensure that their equipment and facilities are adequate for candidates to be able to satisfy the requirements of the syllabus. The hardware facilities needed will depend on the number of candidates, but should be sufficient for all candidates to have enough time to become familiar with both systems software and applications packages, and possibly to develop their own software. The software available needs to be sufficient in quality and range to enable candidates to experience a variety of applications of computers in a practical way, as required in the syllabus.

Hardware

Candidates need to have access to a system with direct-access file capability on backing store and hardcopy facilities for both text and graphics.

The principal danger of using microcomputers exclusively is that many candidates gain the impression that all computing is exemplified by the facilities of the microcomputer. Candidates will find it useful to visit such places as retail outlets, libraries, factories, banks, and so on, in order to see the need for large computer systems.

Software

Access to a wide variety of software packages is very important. Such software packages should include word processing, spreadsheets, information retrieval/file management systems, desktop publishing, and graphics as well as facilities for data-logging.

Candidates should have experience in using systems software and in using utility programs, such as routines for data transfer, sorting, searching, and merging.

Books

Provision of textbooks is difficult as new titles are available all the time. Teachers will need to consult several books to cover the whole syllabus adequately. There is a suggested book list on our website. Many Centers prefer to have a wide range of reference books rather than a class textbook.

Practical Work

Computer Studies is a practical subject and a range of practical exercises should supplement the study of most parts of the syllabus.

It is important that Centers encourage candidates, as early as possible in the course, to develop a systematic approach to practical problem-solving using appropriate resources.

In addition to the practical work that candidates do throughout the course, there is the requirement to present one significant piece of practical work for assessment.

General Practical Work

Candidates need to learn the techniques of problem-solving. This involves:

- the definition of the problem
- the choice of a method of solution
- the selection of the appropriate hardware and software
- the documentation of the solution.

The definition of the problem should include a description of the organization for which a problem has been jointly identified together with a description of that problem.

The method of solution includes:

- the breakdown of the problem into sub-problems
- a description of the processes to be carried out
- the design of the presentation of the results.

It should also take into account:

- the implications for human resources
- the resources required which may be standard or purpose-designed hardware
- general or special-purpose application packages or the use of a programming language.

The documentation of the solution is in two parts.

- The first provides technical information about the solution, which explains and justifies its design and is sufficient to allow maintenance and development (technical documentation).
- The second contains general information about this problem and its solution, which enables a user to make effective use of the solution (user guide).

Candidates will find it easiest to use a top-down approach. After carefully defining the problem, they can break down the algorithm for its solution into component parts at successively lower levels in small sections known as modules.

Assessed Practical Work (Paper 2)

Candidates need to present one complex piece of practical work for the purpose of the examination. The weighting given to this work is 25%; therefore, this is a very important part of the course. The teacher acts as supervisor of the candidates and must carry out the assessment in accordance with the instructions on the Individual Candidate Record Card. **The submitted project must be the unaided work of each and every candidate.**

In the role of supervisor, the teacher should do the following.

(a) Help each candidate choose practical work that is within the candidate's capability and range of interests.

Good project topics are open-ended in the sense that if the work proves to be easier or the candidate more able (and enthusiastic) than the teacher first thought, it can be developed further.

Similarly, if the work proves more difficult or the candidate less able than was first thought, it should be possible to simplify it.

(b) Ensure that candidates start their documentation as soon as they start the work. The early documentation may need revision as the project proceeds.

(c) Insist on seeing a written description of the goals of the practical work before it is started.

The teacher should discuss the length of time that candidates should spend on each stage, and should tell the candidates (and periodically remind them) of the final date for submission to the teacher.

Teachers should set this date at least one month before the final date when they have to submit assessed practical work to Cambridge for moderation.

(d) Closely supervise the work throughout.

Candidates should provide documentation and teachers should regularly inspect it. The teacher may give detailed assistance if necessary, but he/she must take into consideration the amount of help of this kind when assessing the work. The teacher must include a note about the assistance given in the appropriate place on the Individual Candidate Record Card.

(e) Encourage candidates to implement a back-up policy.

(f) Candidates should use a word processor to produce their documentation and include an overall report contents page; failure to do so will result in a loss of marks.

The mark a candidate can achieve is often linked to the problem definition and therefore teachers should guide candidates in their choice of problem. Teachers must provide on-going support, guidance, and supervision during the project. However, if a teacher has to provide excessive help or guidance, the candidate will lose marks: the teacher will decide the level of deduction by taking into account the amount of help given. Excessive help or guidance is when the teacher tells the candidate exactly what to do and the candidate makes no further progress in that particular area. If such help forms part of the normal teaching process, then the teacher should not deduct marks. Also if the help enables the candidate to achieve a higher standard without further assistance, then the teacher should not deduct marks. However, if a Center makes a deduction, then the teacher must clearly annotate the reason for the deduction **on the individual assessment form** for that particular candidate, and the candidate's project must be included as part of the sample for moderation.

Teachers should make candidates aware that hardcopy output of results is essential except where this is inappropriate (for example in a control application or some graphical solutions). For projects involving control or graphics, Centers usually find no difficulty in obtaining photographs of the screen or screen dumps; the teacher must authenticate any such photos. If a candidate undertakes hardware control or animated projects, they can submit visual evidence in DVD format.

If candidates use material from magazines, books, the Internet, or other sources in their projects, they must acknowledge this material. Teachers should ensure that they do this.

Suggestions for Practical Work

The exact method of solution will be the choice of each candidate, but the teacher will need to ensure that they have covered all options during the course. Cambridge will not recommend the use of any specific programming language; the Center should choose the language according to the resources available. However, if candidates choose to write their own program, then the choice of language must allow them to construct their program using a structured modular approach. Previous experience with candidates' work indicates that the choice of certain projects involving games, quizzes, and word processing are unsuitable projects and do not provide the opportunity to achieve high marks. Teachers may find it useful to use the discussion forum to share topics and ideas for project work.

Moderation

(a) Internal Moderation
Teachers assess the completed projects. If more than one teacher in each Center is involved in assessment then the Center must make arrangements for internal moderation to ensure that all teachers are marking to the same standard. The Center must also moderate the marks for each skill assigned within different teaching groups (e.g., different classes).

(b) External Moderation
Cambridge carries out external moderation of internal assessment.

Centers complete the Individual Candidate Record Cards and Coursework Assessment Summary Forms and send them to Cambridge.

If there are 10 or fewer candidates entered for a Coursework component, Centers must submit all the Center-based assessment that contributed to the final mark for that component. If there are more than 10 candidates, then Cambridge will select a sample of candidates for external moderation. Centers must submit all the Center-based assessment that contributed to the final mark for that component for these candidates.

The *Cambridge Handbook* and the *Cambridge Administrative Guide* both contain further information about external moderation.

Centers should keep all records and supporting written work until after publication of results.

5.2   Forms

See the following pages for samples of the forms required.

COMPUTER STUDIES

INDIVIDUAL CANDIDATE RECORD CARD

CAMBRIDGE IGCSE 2014

Centre Number					Centre Name		
Candidate Number					**Candidate Name**		**Teaching Group/Set**

Please use the space on the reverse for any comments about the project(s), marking, and help given to the candidate beyond normal supervision. Comments are especially important where the marks awarded differ from what might have been expected on the sole evidence of the submitted material.

Title(s) of Project(s)

	Analysis					Design					Implementation			Testing		Documentation		Evaluation				
	Description of the Problem	Objectives	Description of existing solution	Evaluation of existing solution	Description of other possible solutions	Action plan	Systems Flowchart	Description of method of solution	Hardware	Software	Method of solution related to problem	Accurate method of solution	Programming code	Test strategy	Test results	Technical documentation	User guide	Evaluation	System development	TOTAL	Deduction for teacher assistance	FINAL TOTAL
Section	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		20	
Max	2	3	2	2	2	3	2	3	3	3	2	3	3	3	4	2	3	3	2	50	10	50
Mark																						
Page(s)																						

Name of teacher completing this form		Signature		Date					
Name of internal moderator		Signature		Date					

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COMPUTER STUDIES
COURSEWORK ASSESSMENT SUMMARY FORM
CAMBRIDGE IGCSE 2014

Please read the Assessment Criteria and the General Coursework Regulations in the Handbook for Centres before completing this form

Centre Number						Centre Name		June/November	2	0	1	4

Candidate Number	Candidate Name	Teaching Group/Set	Title of Project	Assessment Under Headings																					Total Mark (max 50)	Internally Moderated Mark (max 50)	Moderated Mark (max 50)
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			

Name of teacher completing this form		Signature		Date						
Name of internal moderator		Signature		Date						

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5.3 Assessment Criteria for Coursework (Internal Assessment)

ANALYSIS	1 mark	2 marks	3 marks
1. Description of the problem	Brief description of the background to the business or organization	Description of the background to the business or organization, together with the nature of the problem to be solved	
2. Objectives **(must be stated in relation to the proposed solution)**	Objectives listed in general business terms, e.g., to make a process faster, to save time, or resources	Objectives listed in computer-related terms, e.g., create a database, sort, search a database, edit a record	Objectives listed in both general business terms and computer-related terms
3. Description of existing solution	Incomplete description of the current solution	A full description of the current solution, including data input requirements (data capture methods and data dictionary, if applicable) and specifications, the data processing and output requirements and specifications	
4. Evaluation of existing solution	Incomplete evaluation of the current solution	Complete evaluation of the current solution highlighting advantages, disadvantages, **and** any suggested improvement(s)	
5. Description of other possible solutions, (including the proposed solution)	Description of the proposed solution	Description of the proposed new solution **and** at least one other solution	

DESIGN	1 mark	2 marks	3 marks
6. Action plan, in terms of system life cycle	Incomplete or unclear action plan	Detailed action plan, including time schedule	Detailed formal plan, including a Gantt or PERT chart
7. Systems flowchart	Correct symbols used for systems flowchart	Complete solution represented in systems flowchart with correct use of symbols	
8. Description of the method of solution	Unclear or confused description of method of solution	Clear description of method of solution but some aspects of the method of solution are missing	Clear and detailed description of the method of solution, including database tables, any relationships, formulas, etc. (Must include annotation or explanation of at least one module of any software generated coding/queries)
9. Hardware	A list of hardware	A detailed hardware specification for the proposed solution	A complete list of hardware together with at least two reasons why such hardware is needed in the context of the proposed solution
10. Software	List of software used	Description of the software used	Justification as to why this software is being used or written, e.g., why two facilities are needed from the software

IMPLEMENTATION	1 mark	2 marks	3 marks
11. Method of solution related to the problem by suitable means, including annotated coding, spreadsheet formulas, database tables, site plans of website	Description of the method of solution described in generic terms	Description of the method of solution described in specific details relevant to the problem	
12. Accurate method of solution	Partly successful, at least one computer-related objective achieved	Partly successful, some of the computer-related objectives achieved as listed previously	Completely successful, all of the previously listed computer-related objectives achieved.
13. Programming code	Use macros or pre-written code	Code and annotate own macro(s)	Code and annotate complete solution in any programming language

TESTING	1 mark	2 marks	3 marks	4 marks
14. Test plan **(Must include the expected results)**	Incomplete test strategy, which must include the data to be tested together with the expected results	Complete test strategy, which must include the data to be tested together with the expected results	Complete test strategy, which must include the data to be tested together with the expected results and **linked to the computer objectives in section 2**	
15. Test results (acceptable (normal), unacceptable (abnormal), and boundary (extreme) data)	One type of data tested	Two types of data tested	Three types of data tested	Three types of data tested covering all aspects of functionality (data input, processes, and output)

DOCUMENTATION	1 mark	2 marks	3 marks
16. Technical documentation	Contents page for technical documentation but unclear or inadequate documentation	Contents page for technical documentation and clear and complete documentation, which would enable maintenance or modification of the system	
17. User guide	Inadequate or unclear details	Clear details but incomplete	Clear and complete user guide

SYSTEM EVALUATION AND DEVELOPMENT	1 mark	2 marks	3 marks
18. Evaluation	Inaccurate or trivial evaluation	Reasonable evaluation	Reasonable evaluation **linked to the computer objectives in section 2 and the testing**
19. Developments (the candidate does not necessarily have to be capable of carrying out these suggestions)	Some minor improvements suggested	Realistic and meaningful suggestions for development with explanations	

The relevant page number(s) should be written underneath the marks awarded for each section on the Individual Candidate Record Card. See section 5.2 of the Appendix for details.

6. Additional Information

6.1 Guided Learning Hours

Cambridge IGCSE syllabi are designed with the assumption that candidates have about 130 guided learning hours per subject over the duration of the course. ("Guided learning hours" include direct teaching and any other supervised or directed study time. They do not include private study by the candidate.)

However, this figure is for guidance only, and the number of hours required may vary according to local curricular practice and the candidates' prior experience with the subject.

6.2 Recommended Prerequisites

Candidates beginning this course are not expected to have studied Computer Studies or ICT previously.

6.3 Progression

Cambridge IGCSE Certificates are general qualifications that enable candidates to progress either directly to employment or to proceed to further qualifications.

Candidates who are awarded grades C to A* in Cambridge IGCSE Computer Studies are well prepared to follow courses leading to Cambridge International AS and A Level Computing, or the equivalent.

6.4 Component Codes

Because of local variations, in some cases component codes will be different in instructions about making entries for examinations and timetables from those printed in this syllabus, but the component names will be unchanged to make identification straightforward.

6.5 Grading and Reporting

Cambridge IGCSE results are shown by one of the grades A*, A, B, C, D, E, F, or G, indicating the standard achieved, Grade A* being the highest and Grade G the lowest. "Ungraded" indicates that the candidate's performance fell short of the standard required for Grade G. "Ungraded" will be reported on the statement of results but not on the certificate.

6.6 Access

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments and to demonstrate what they know and what they can do. For this reason, very few candidates will have a complete barrier to the assessment. Information on reasonable adjustments is found in the *Cambridge Handbook*, which can be downloaded from the website **www.cie.org.uk**

Candidates who are unable to access part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award based on the parts of the assessment they have taken.

6.7 Support and Resources

Copies of syllabi, the most recent question papers, and Principal Examiners' reports for teachers are on the Syllabus and Support Materials CD-ROM, which we send to all Cambridge International Schools. They are also on our public website—go to **www.cie.org.uk/igcse**. Click the **Subjects** tab and choose your subject. For resources, click "Resource List."

You can use the "Filter by" list to show all resources or only resources categorized as "Endorsed by Cambridge." Endorsed resources are written to align closely with the syllabus they support. They have been through a detailed quality-assurance process. As new resources are published, we review them against the syllabus and publish their details on the relevant resource list section of the website.

Additional syllabus-specific support is available from our secure Teacher Support website **http://teachers.cie.org.uk**, which is available to teachers at registered Cambridge schools. It provides past question papers and examiner reports on previous examinations, as well as any extra resources such as schemes of work (unit lesson plans) or examples of candidate responses. You can also find a range of subject communities on the Teacher Support website, where Cambridge teachers can share their own materials and join discussion groups.