2.3.1 The Compulsory Part

The Compulsory Part comprises five modules:

A. Information Processing

Introduction

This module provides students with a fundamental understanding of what information systems and information processing entail, and how data are represented inside a computer. Students will learn that different software is used to process different types of data. They will be given practical tasks to process and present information. Built on the basic knowledge, understanding and skills of word processing, spreadsheet, database and multimedia presentation acquired by students in junior secondary, this module will increase understanding of the terminology, advanced concepts and skills in using integrated software. This will enhance students' personal productivity in their work or study, and enable them to apply their learning effectively to problem-solving, data analysis and information presentation.

Learning Objectives

Students will learn about:

- information systems and processes in real-life contexts;
- the difference between information and data;
- how data are organised and represented inside a computer;
- the integrated use of office automation software, and the appropriate processing and presentation of different types of information; and
- how advances in ICT foster the development of the Information Age and its impact on society.

The time allocation for the module is about 54 52 hours.

Details

This module comprises five topics: "Introduction to Information Processing", "Organisation and Data Control", "Data Representation", "The Use of Office Automation Software" and "Presentation of Information". Details of the five topics are summarised below:

* Texts shaded are to replace texts with border in the HKDSE Examination starting in 2019 (i.e. S4 in 2016/17 school year leading to 2019 examination).

Topic	Learning Outcomes	Remarks
a. Introduction to Information Processing (5 hours)	• Describe the basic concepts of the Input-Process-Output cycle and the use of a stored program in a processing system.	
	• Identify and examine the components of an information system.	The components include the purposes, data, processes, technologies and personnel.
	• Distinguish between various information processes.	Information processes include data collection, organisation, analysis, storage, processing, transmission and presentation. Examples from daily life, both computer and non-computer-based processes, should be used to consolidate and enhance students' understanding of the activities involved.
	• Realise the difference between data and information, and identify different types of data as image, audio, video and text.	
	• Define Information Age and discuss the importance of information literacy in a knowledge-based society.	How the development of technologies leads to the emergence of the Information Age, and how information can be flexibly and analytically converted into knowledge in modern society should be discussed.

Topic	Learning Outcomes	Remarks
b. Data Organisation and Data Control (4 hours)	• Identify data, records, fields, files and databases in the hierarchical organisation of data. • Explain how records can be organised, stored and retrieved. State the advantages, disadvantages and applications of the two types of file access: direct access and sequential access. • Discuss the needs of data control. • Describe how errors can be detected by using validation and parity checking, and prevented by verification and validation.	
c. Data Representation (10 hours)	• Distinguish between analog and digital data. State applications or situations where conversion of analog to digital data is required, or vice versa. • Explain why IT uses digital data	The relationship between the number of bits and number of patterns/combinations available should be mentioned (e.g. three bits can be used to represent eight colours).

Topic	Learning Outcomes	Remarks
	• Convert integers from denary numbers to binary numbers or hexadecimal numbers, or vice versa.	Adopt two's complement for the representation of negative integers.
	• Perform simple calculations (addition and subtraction only) on binary numbers and analyse overflow errors.	In understanding errors, minimum and maximum numbers an n-bit can hold (maximum 2 bytes) should be considered.
	• Know how characters are represented by using common international standards such as American Standard Code for Information Interchange (ASCII), the Big-5 code, the Guobiao (GB) code and the Unicode.	The relationship between the size of the character set and the representation should be explained. Recall of specific codes is not required.
	• Know briefly how different multimedia elements are digitised. Convert them into different file formats and compare them for storing the same data.	Elementary file conversion is required but not the editing of a file. Students should be given the experience in creating various file formats such as wav vs. mp3, bmp vs. jpg, and avi vs. mpeg2.

Topic	Learning Outcomes	Remarks
d. The Use of Office Automation Software (30 28 hours)	• Design and create formatted documents or reports effectively and suitably using a word-processing tool.	Through meaningful tasks related to the real world, such as advertisements fliers, newsletters and reports, students are expected to apply formatting features such as tables, columns, text frames and graphics, with consideration of the use of colour, size and positioning in presenting their documents. Other features such as table of contents, indexes, footnotes, hyperlinks and checkers (e.g. Spelling checker) should be introduced to students to facilitate the writing of a report and to enhance the readability and accuracy of documents. Other features such as table of contents and hyperlinks should be introduced to students to facilitate the writing of a report and to enhance the readability of documents.
	• *Convert between various document / text formats and justify their usage.*	Examples of text formats are rich text format, hypertext document format, portable document format and word document format. Examples of text formats are rich text format, portable document format and word document format.

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Topic	Learning Outcomes	Remarks
	• Describe and use basic features of spreadsheets to solve problems.	The use of cell references in formulas, and functions, together with mathematical, logical and relational operators should form part of the content.
	• Demonstrate data manipulation techniques in spreadsheets.	This includes filtering, searching and sorting data using single or multiple criteria. The manipulation of data dynamically in multiple worksheets should also be introduced.
	• Apply spreadsheets as a data analysis tool by using a pivot table (and pivot chart), and "what-if" scenarios.	Through task-based activities, apart from the basic features and functions (sum, sub-total and average) of a pivot table, students should be led to observe and analyse the interdependency of data by varying the fields in a pivot table. Together with charting, simulating real-life situations and "what-if" scenarios, students should learn to identify trends, to make informed judgments, and to produce meaningful predictions which are required as critical thinkers throughout their careers.
	• Apply the concepts of data organisation to create and maintain a simple database using a Database Management Systems (DBMS) tool.	
	• Create and use a form for data entry.	

Topic	Learning Outcomes	Remarks
	• Practise data extraction and manipulation by querying a database and create reports.	This includes the selection, filtering and sorting of data using query in a single database table. Students should be able to trace and interpret simple Structured Query Language (SQL) statements. Though sophisticated reports are not required, they should create and format reports for intended users / audience.
	• Understand concepts of Object Linking and Embedding (OLE) and its applications.	
	• Use a software suite in an integrated and effective manner.	Students should be given experience of the integrated use of different programs in the software suite (e.g. spreadsheet / databases with word documents in mail merging).
e. Presentation of Information (5 hours)	• Construct and design a presentation incorporating multimedia elements.	The focus is on the planning of the storyboard and presentation, not the means of presentation. Students may choose a web-based presentation, a slide show, a multimedia document or other means of presentation. The presentation should be supplemented with verbal annotation, to develop students' communication skills and encourage them to articulate ideas / thoughts.

B. Computer System Fundamentals

Introduction

This module provides students with a basic understanding of how the different components of a computer system work together to perform computational tasks. This includes the learning of the functional units of a computer, the system software, and the different types of computer systems for different applications.

Learning Objectives

Students will learn about:

- the functions and properties of the major components of a computer system and how these components interact together to perform tasks;
- the functions and properties of major peripheral devices, and their uses in specific situations;
- the use of different utility programs in managing systems and files; and
- the capabilities of different operating systems, and the basic concepts of a computer network and its applications.

The time allocation for the module is about 25 hours.

Details

This module comprises three topics: “Basic Machine Organisation”, “System Software” and “Computer Systems”. Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Basic Machine Organisation (15 hours)	• Explain the functions of hardware within a computer system, namely input and output devices, the central processing unit, bus system and storage devices (both primary and secondary).	
	• Explain the structure and functions of a central processing unit (CPU) and its components.	Students should know how CPU is measured in terms of frequency. Units such as microsecond, nanosecond and picosecond should also be introduced.
	• Outline the steps in the fetch-decode-execute cycle and store using a single processor, and describe the roles of and the interdependence among components, registers and buses in the machine cycle.	The functions of the program counter, accumulator, instruction register, memory address register and memory data register should be briefly introduced to students. No assembly language is involved but instructions requiring LOAD, ADD, STORE and STOP may be used to illustrate how data and instructions are processed in the machine cycle.

Topic	Learning Outcomes	Remarks
	• Describe the functions and characteristics of Random Access Memory (RAM), Read Only Memory (ROM) and memory cache. Realise the relationship among the size of the memory, the memory address, word length and the performance of the computer.	Students' understanding of main memory should be extended to the current version / technologies in RAM and ROM in terms of capacity and data access rate. The meanings of units such as terabytes, gigabytes, megabytes and kilobytes should be introduced. Also, the distinction between prefixes used in computer and the Système International (SI) notation should also be made (e.g. 1KB = 1024 Bytes, not 1000 Bytes).
	• Describe the features, advantages, disadvantages and applications of the input and output devices. Select and justify the use of appropriate devices for collecting and displaying information in a given context.	Students should know the various hardware devices used for collecting and displaying different types of data such as image, audio, video and text. The technical details on how each device operates are not required.
	• Describe the functional characteristics of storage devices in terms of random or sequential access, volatile or non-volatile, data transfer rate and storage capacity.	Examples of storage devices are magnetic disk, optical disk, flash memory, magnetic tape and network storage. In understanding the characteristics of storage devices, students should be made aware of the trend to faster and greater storage capacity but smaller physical size over time.

Topic	Learning Outcomes	Remarks
	• Outline the latest developments in computer systems including processor capabilities, primary memory technologies, secondary storage devices and data communications.	Technical details are not required.
b. System Software (4 hours)	• Know the functions of system software and applications software, and the relationship between hardware, system software, applications software and users. • Outline the basic functions of an operating system and describe some common operating systems, and their differences and applications. • State the functions and needs of utility programs and driver programs.	Examples of the utilities are data compressors, virus checkers, file managers, defragmentation software and system monitoring software. Technical details of these programs are not required but demonstration or practice on their use should be given.

Topic	Learning Outcomes	Remarks
c. Computer Systems (6 hours)	• Compare the characteristics of different types of computers.	Types of computers include personal computers, mainframes, supercomputers, network computers, etc. Comparison should be made with respect to physical size, memory size, backing store capacity, input/output devices, processors, number of user supported, cost and applications.
	• Distinguish the characteristics and applications of various computer systems.	Computers systems to be considered are batch processing systems, on-line interactive systems and real-time systems, single-user systems and multi-user systems, parallel processing systems and distributed processing systems, and network systems.

C. Internet and its Applications

Introduction

This module is designed to acquaint students with Internet fundamentals. It encompasses the concepts of Internet access, services and applications of the Internet, and elementary web page design. Students will also be given the opportunity to critically analyse the reliability of the information retrieved from the Web and appreciate the impact of the Internet on various activities in society.

Learning Objectives

Students will learn about:

- how to connect to the Internet, and the hardware, software and Internet Service Provider (ISP) involved in accessing the Internet;
- the personal, social and commercial activities that are available on the Internet;
- how to participate in various Internet activities such as searching for information, sharing opinions, and exchanging messages and files;
- the technologies involved in transmitting and displaying multimedia elements on the Internet; and
- the design and construction of simple web pages for an intended audience.

The time allocation for the module is about 24 22 hours.

Details

This module comprises three topics: "The Networking and Internet Basics", "Internet Services and Applications" and "Elementary Web Authoring". Details of the three topics are summarised below:

* Texts shaded are to replace texts with border in the HKDSE Examination starting in 2019 (i.e. S4 in 2016/17 school year leading to 2019 examination).

Topic	Learning Outcomes	Remarks
a. The Networking and Internet Basics (9 hours)	• Define and compare Local Area Network (LAN) and Wide Area Network (WAN).	
	• Discuss the common services available in a networked environment.	Services include internal communications, conferencing and resources sharing.
	• Explain the functions of the hardware required for a network.	This includes communication links (phone line, coaxial cable, fibre optics, microwave, satellite, etc.), modem (including cable modem), network interface card, network connecting devices (hub, switch and router, etc.).
	• Compare common methods for Internet access in terms of speed, cost, security and availability.	This includes connections in wireless, leased line and broadband etc.
	• Understand the need for communications software and communication protocols.	

Topic	Learning Outcomes	Remarks
	• Describe how data is transmitted over the Internet and understand concepts of Internet Protocol (IP), Uniform Resource Locator (URL), Domain Name System (DNS) and Hypertext Transfer Protocol (HTTP). • Describe how data is transmitted over the Internet and understand concepts of Internet Protocol (IP), Uniform Resource Locator (URL), Domain Name System (DNS), Hypertext Transfer Protocol (HTTP) and File Transfer Protocol (FTP).	
b. Internet Services and Applications (7 5 hours)	• Formulate an effective strategy for searching for specific information on the Web by using search-engines, and critically analyse the sources of information. • Identify various graphics, audio, video file formats suitable for web pages. Use plug-ins and players for the multimedia elements found on the Internet.	

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Topic	Learning Outcomes	Remarks
	• Apply various services such as File Transfer Protocol (FTP), remote logon, online chat, newsgroup, discussion forum and email on the Internet. • Apply various services such as file transfer, remote logon, online chat, discussion forum and email on the Internet. • Describe the concepts of streaming technology and its applications in voice mail, videoconferencing, and webcasting etc. on the Internet.	*Email protocols such as Post Office Protocol (POP), Internet Message Access Protocol (IMAP), Simple Mail Transfer Protocol (SMTP) and their functions should be included.* Technical details of streaming technology are not required.
	• Value and appraise the significance of the development of the Internet for various activities in society.	The benefits and limitations of various activities, such as e-commerce, e-government, e-learning and e-entertainment, as compared to the traditional methods, should be discussed. In e-commerce, for instance, this may range from activities such as Electronic Fund Transfer (EFT) to current practices in corporate / organisation web portals in the digital economy. Appreciation of technology advancement as a change agent for the betterment of humanity should be fostered among students.

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Topic	Learning Outcomes	Remarks
c. Elementary Web Authoring (8 hours)	• Recognise the basic constructs of Hypertext Markup Language (HTML) which is a means to address cross-platform issues.	
	• Design and construct web pages for an intended audience and upload them onto the World Wide Web.	The organisation of information includes ease of navigation, appropriate placement of links, tables, frames and multimedia elements, colour combinations, background design, font size and style, for an intended audience. Students are not required to memorise HTML codes.

D. Basic Programming Concepts

Introduction

This module is designed to provide students with a basic understanding of the steps and strategies involved in solving a problem systematically. It emphasises the design of a solution, the algorithm, which is essential in computer programming, and with which students need to be equipped to manage complex problems they may encounter in their lives. The realisation of the algorithm in a syntactic language is introduced in *Software Development*. Students should learn to solve problems analytically and logically, not just to write computer programs.

Learning Objectives

Students will learn about:

- the systematic approach to problem-solving;
- the application of concepts of systematic problem-solving to real-life problems;
- the use of pseudocode and/or a program flowchart to represent the algorithm;
- how to identify the objectives of an algorithm, trace the logical flow and examine values of variables during execution; and
- various ways of solving the same problem, and the differences between them.

The time allocation for the module is about 20 24 hours.

Details

This module comprises three topics: “Problem-Solving Procedures”, “Algorithm Design” and “Algorithm Testing”. Details of the three topics are summarised below:

* Texts shaded are to replace texts with border in the HKDSE Examination starting in 2019 (i.e. S4 in 2016/17 school year leading to 2019 examination).

Topic	Learning Outcomes	Remarks
a. Problem-Solving Procedures (4 hours)	• Outline the major stages in problem-solving and explain the needs of each stage. • Use real-life examples to illustrate the various stages in problem-solving procedures. • Explain the importance of formulating and defining the scope of a problem precisely. • Solve a problem by breaking it down into sub-problems or modules.	The sub-problems, for instance, may represent the input, process and output of the solution to the problem.
b. Algorithm Design (13 hours)	• Define algorithm. Use pseudocode and program flowchart as methods for representing algorithms. • Outline and discuss the input and output requirements of a problem, and design an appropriate user interface.	

Topic	Learning Outcomes	Remarks
	• Recognise the uses and nature of simple data types and data structures in solving a problem.	Simple data types are restricted to integer, real, character and Boolean while simple data structures are limited to string and one-dimensional array. Boolean logic (AND, OR, NOT) and truth tables should be introduced.
	• Select appropriate data types for the solution to a particular problem and discuss the merit of the chosen types.	
	• Design and construct standard algorithms involving basic control structures.	The control structures are sequence, selection (binary and multi-way) and iteration (pre-test, post-test and for loops).
	• Create and examine algorithms such as to load and print an array, and to add or delete an item from an array.	
	• Describe the advantages of modularity in designing computer solutions.	When designing a solution to a complex problem, students should be encouraged habitually to use the modular approach to structure the algorithm.

Topic	Learning Outcomes	Remarks
c. Algorithm Testing (3 7 hours)	• Trace and test algorithms.	Students need to identify boundary cases and generate appropriate test data. Students should be able to trace and test an algorithm with manual methods or using some tools, such as Scratch, Microsoft Small Basic, or Raptor. The idea of debugging should also be introduced. Students need to identify boundary cases and generate appropriate test data. Recall of specific operation/command of the tools is not required.
	• Compare different solutions to the same problem.	Comparison of the steps of operation and resource usage of different algorithms to solve the same problem should be encouraged.

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E. Social Implications

Introduction

This module provides students with an understanding, and ethical analysis, of various issues arising from the use of ICT. These issues have economic, legal, social, ethical and security consequences. Students should be given experience in discussing and debating these issues to develop the analytical and interpretive skills required to construct their own normative practices in the use of ICT. With the pervasiveness of the Internet, students should be made fully aware of the potential threats associated with its use, and the possible measures to safeguard their data and information. This module encourages students to act in a socially responsible, ethical and legal way in using the technologies throughout their studies, careers and other areas of their lives.

Although these issues are introduced specifically in this module, they should also be re-considered and re-addressed in various other parts of the course as a means to strengthen students' awareness of them. For instance, security measures on networks will be considered again in more detail in *Data Communications and Networking*.

Learning Objectives

Students will learn about:

- equity issues relating to access to ICT;
- health hazards and preventive measures in using ICT;
- major issues regarding intellectual property and privacy;
- the potential threats on the Internet and measures to reduce them; and
- the need to use ICT safely, sensibly, legally and ethically.

The time allocation for the module is about 22 hours.

Details

This module comprises four topics: "Equity of Access", "Work and Health Issues", "Intellectual Property" and "Threats and Security on the Internet". Details of the four topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Equity of Access (2 hours)	• Discuss the pros and cons of freedom of information on the Internet. • Discuss equity issues in terms of the digital divide, gender equity and access for the disabled from local and global perspectives.	In explaining the digital divide, the rise of a knowledge-based society as a result of the development of ICT should also be discussed.
b. Work and Health Issues (2 hours)	• Realise that technological innovations can bring major benefits to society if they are used properly, but damage society when they are misused. • Discuss change in the nature of work in areas such as work monitoring, telecommuting, working hours, virtual organisations and the removal of national and international barriers to business. • Identify health hazards associated with the use of ICT, and propose good ergonomic practices when using them.	In ergonomics, consideration includes the reduction of injuries which arise from RSI and electromagnetic radiation, the suitable design and placement of the furniture, the design of the software (with user-friendliness features such as ease of use and a consistent user interface) and work environment.

Topic	Learning Outcomes	Remarks
	• Be aware of the consequences of indulgence in Internet activities for individuals.	Examples of Internet activities are online games, Internet chat and web surfing.
c. Intellectual Property (6 hours)	• Understand the basic ideas of intellectual property and copyright. • Know the difference between open source and non-open source software. • Debate the benefits and risks of different licensing schemes such as freeware, shareware, open source software and copyrighted software from the perspectives of users and software developers. • Relate acts of possible infringement of copyright in software and Internet piracy.	Students should discuss the social, legal and economic implications of acts of infringement of copyright. They should also develop the habit of acknowledging the source of information and be aware of the appropriate use of multimedia materials, and the possible crimes and consequences of illegal uses and broadcasting of these materials (e.g. Bit Torrent -- BT)

Topic	Learning Outcomes	Remarks
	• Be aware of ways to reduce intellectual property theft on digital property. • Know some of the legal consequences, especially in education, related to the infringement of copyright in Hong Kong.	Examples of measures are the use of a digital watermark and digital signature. Teachers can quote some of the legal consequences related to infringement of copyright.
d. Threats and Security on the Internet (12 hours)	• Know, from the users' perspective, possible security threats on the Internet. • Demonstrate the control of intrusion using security applications on a computer.	Supported by crimes reported in the news, students should know about the security threats such as malware, spyware and adware from the automatic intrusion via dynamic web pages, peer-to-peer (p2p) and files download. Examples of security applications are browsers, firewalls and anti-virus software.

Topic	Learning Outcomes	Remarks
	• Discuss the possible privacy threats on the Internet, and suggest ways to maintain privacy.	Supported by crimes reported in the news, violation of the secrecy of data as a result of eavesdropping, hacking, phishing, spamming and junk mails etc. should all be considered and discussed with students. The ways to maintain privacy, such as anonymity and passwords, should be stressed. Teachers can quote some of the legal consequences related to unauthorised access to computers.
	• Be aware of information encryption technologies so as to prevent eavesdropping and interception.	This includes the basic concepts of data encryption, public and private key encryption systems, and the relationship between the size of the key used and the degree of security, e.g. Hong Kong Public Key Infrastructure (PKI).
	• Explain authentication and authorisation as a means to control access of information on the Internet.	Basic concepts include the authentication methods for individuals, types of tokens used in authentication processes, and digital certificates and the procedures involved in obtaining a certificate.

Topic	Learning Outcomes	Remarks
	• Know about security used in electronic transactions. • Be aware of the latest developments in security measures.	The concepts of Secure Sockets Layer (SSL) in secured transmission in e-commerce should be introduced. Other security measures in online transaction such as smart cards, security tokens, digital certificates and mobile Short Message Service (SMS) should also be introduced.

2.3.2 The Elective Part

The Elective Part comprises four options.

A. Databases

Introduction

This option is designed to provide students with the fundamental concepts of databases and relational database design. It covers the application, management and design aspects of databases. Students will learn how to construct simple data models using Entity Relationship (ER) diagrams and to appreciate the importance of good database design. They will also learn to use SQL to construct, manipulate and retrieve information from a relational database. In addition, students will be exposed to database security, integrity, and data privacy issues, and be aware of the impact of database development on society. Through studying this option, students will acquire a basic understanding of the concepts, skills and applications of databases, and elementary data modelling concepts.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module A *Information Processing* before progressing to this option.

The sub-topics under topic (b) "Relational Databases" in the present option are designed as extensions of topic (b) "Data Organisation and Data Control" in the Compulsory Part – module A *Information Processing*.

Learning Objectives

Students will learn about:

- concepts and applications related to databases and the DBMS;
- the basic concepts of a relational database, and the construction, manipulation and extraction of information from a relational database using SQL;
- how to identify and perform an analysis of the data requirements of simple scenarios in different applications;
- the construction of simple data models using the ER diagrams methodology;
- the importance of good database design as a blueprint for the development of a database management system;
- the importance of data privacy and measures for its improvement;
- the database application development lifecycle and the main activities associated with the development stages; and
- database development and its impact on society.

The time allocation for the option is about 75 hours.

Details

The option *Databases* comprises four topics: “Introduction to Databases”, “Relational Databases”, “Introduction to Database Design Methodology” and “Database Applications, Development and Society”. Details of the four topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Introduction to Databases (8 hours)	• Be aware of the uses and applications of databases in our everyday life, such as database usage in education, public services, and business and commerce. • Discuss the importance of databases in an organisation and how it improves the operations of an organisation. • Know database models, such as relational model and hierarchical model, and list examples of their usage. • Explain the use of database instance and schema in database modelling. • Describe the purposes and functions of DBMS. • Explain the concepts of data definition language, data manipulation language, and data dictionary, and construct a simple data dictionary. • Describe and explain the relationship of fields, records, tables, files and databases.	

Topic	Learning Outcomes	Remarks
	• Describe common data types such as integer, real, character, string, Boolean, and date.	
b. Relational Databases (28 hours)	• Explain the concept of program-data independence.	
	• Describe the basic concepts of relational databases.	It includes entity, relationship, attribute, domain, index, key (such as primary key, foreign key and candidate key), and integrity (such as entity integrity, referential integrity and domain integrity). Students should be able to identify these basic elements in examples taken from everyday applications.
	• Create a simple relational database.	Students should know how to organise data differently but sensibly in a relational database and be able to establish the required relationships among the tables.

Topic	Learning Outcomes	Remarks
	• Use SQL to maintain a simple relational database, and manipulate its data or retrieve the required information in at most three tables.	Skills involved include: • modify the structure of the tables • add, delete and modify the data in the tables • view, sort, and select contents by filtering, and create different views • use appropriate operators and expressions such as arithmetic operators and expressions, comparison operators, logical operators and the in, between and like operators. to perform specific operations • use simple built-in functions such as aggregate and string functions • perform queries on multiple tables, including the use of equi-join, natural join and outer join • perform sub-queries (for one sub-level only) • export query results to, for example, text, HTML or spreadsheet format
c. Introduction to Database Design Methodology (22 hours)	• Be aware of and appreciate the importance of a good database design in effective database management.	

Topic	Learning Outcomes	Remarks
	• Describe the needs of the three levels of data abstraction, namely conceptual level, physical level and view level. • Be aware of the different types of relationships among entities in a relational database. • Analyse simple scenarios in business, education or other fields and create simple ER diagrams involving binary relationship only in designing databases. • Explain the concepts of data redundancy and discuss the methods or measures used to reduce data redundancy. • Transform the ER diagrams to tables in relational databases.	The resolution of many-to-many relationship into multiple one-to-many relationships should also be introduced. Students should be able to reduce data redundancy through normalisation up to Third Normal Form (3NF).

Topic	Learning Outcomes	Remarks
d. Database Applications, Development and Society (17 hours)	• Understand the stages involved in the database application development lifecycle and the links between them.	The main stages involved in the database application development lifecycle include requirements collection and analysis, system definition, application and database design, DBMS selection, form and report design, prototyping, implementation, data migration, conversion and loading, testing, and operational maintenance. Students should recognise that the stages of the database application development lifecycle often involve review and repetition of previous stages through feedback loops.
	• Practise the main activities associated with the stages of the database application development lifecycle in an educational or commercial scenario.	Students should be able to apply simple Computer Aided Software Engineering (CASE) tools to automate, manage and simplify the database design process. CASE supports may include tools for data dictionary construction, and those for facilitating data models development, etc.
	• Be aware of the uses and applications of data mining in daily life and explain how data mining can improve the quality of living.	

Topic	Learning Outcomes	Remarks
	• Discuss the needs and trends of future database development and the corresponding applications.	Students should be able to discuss the impact of technologies such as mobile and wireless technologies, and dynamic web pages on database development. In considering the need for different database applications, factors such as volume of data, variety of data and variety of users should be discussed. Trends in database models, including distributed, parallel, and multimedia, etc. and their impact, should be introduced.
	• Identify different database personnel such as database administrators, designers, developers and data entry operators, and describe their roles and responsibilities in database development and maintenance.	The responsibilities and ethics of different database personnel should be stressed.
	• Discuss the importance of data privacy and develop proper attitudes to be an ethical user of database to respect data privacy.	Ways to achieve data privacy in database applications using access rights should be discussed.
	• Appreciate how effective use of database applications changes people's lives.	

Symbols used in ER diagrams

Meaning	Symbol
Entity	
Attribute	
Key Attribute	
Relationship	
One-to-One Relationship	
One-to-Many Relationship	
Many-to-Many Relationship	
Participation constraints: - Use | on Mandatory side - Use ○ on Optional side	

B. Data Communications and Networking

Introduction

This option is designed to give students an understanding of the basic principles of data communications and networking, and the knowledge and skills associated with the design, implementation and maintenance of a simple network. Students will also be made aware of the common security threats to networks and of measures to improve network security. This option gives students a solid foundation on data communications and networking. Students will find it valuable and practical, whether they continue to study in this area in tertiary education or join the workforce.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module C *Internet and its Applications* and module E *Social Implications* before progressing to this option.

The sub-topics "Network components", "Protocols", "Types of network", and "Network applications" under topic (a) "Data Communications and Networking Basics", and the sub-topic "Network security" under topic (c) "Network Management and Security" in the present option are designed as extensions of topic (a) "The Networking and Internet Basics" in the Compulsory Part – module C *Internet and its Applications*, and topic (d) "Threats and Security on the Internet" in the Compulsory Part – module E *Social Implications.*

Learning Objectives

Students will learn about:

- the basic concepts and technologies behind data communications and networking;
- the components involved in computer networks and their functions;
- the uses and applications of a computer network;
- the design and implementation of a simple computer network;
- the performance monitoring of a computer network and measures to improve it;
- the importance of computer network security and measures to improve it; and
- the latest developments and future trends in networking technology.

The time allocation for the option is about 75 hours.

Details

The option *Data Communications and Networking* comprises three topics: "Data Communications and Networking Basics", "Network Design and Implementation" and "Network Management and Security". Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Data Communications and Networking Basics (38 hours)		
i. Communications model and data encoding	• Understand the simple model of communications.	Components of the model include agent, input device, transmitter, transmission medium, receiver, and output device.
	• Know the basic concepts of data encoding.	Distinction between data and signals should be known. Students should know that either form of digital and analog data can be encoded into either form of digital and analog signal.
	• Understand some error detection methods.	The error detection methods include parity check, checksum and cyclic redundancy check (CRC). Implementation arithmetic for parity check and checksum should be known.
ii. Network components	• Know the roles of client and server as two basic network devices in a network.	
	• Describe the functions of network adapters.	

Topic	Learning Outcomes	Remarks
iii. TCP/IP protocol suites	• Compare different data transmission media.	The transmission media include copper wires, glass fibers, radio, microwave, and infrared, etc. They are compared in terms of types of signal transmitted, levels of resistance to transmission impairments caused by attenuation and noise, capacity, transfer distance, cost, and security considerations.
	• Compare the functions of the various network connecting devices.	The network connecting devices include hub, switch, router, and access point, etc.
	• Know the simple concept of layering in a Transmission Control Protocol/Internet Protocol (TCP/IP) reference model.	The basic concept of data encapsulation across layers should be introduced.
	• Know the basic concepts of IP addressing including the scheme and classes of IP addresses.	
	• Explain the functions of TCP/IP.	
	• Compare TCP/IP protocol suites such as Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6) from an evolutionary perspective.	Different versions of TCP/IP protocol suites are compared in terms of address size and their support for audio and video.

Topic	Learning Outcomes	Remarks
iv. Basic concepts of data transmission	• Identify and describe the three communication modes: simplex, half-duplex and duplex. • Compare asynchronous and synchronous transmission in terms of timing and overhead. • Know the simple concept of multiplexing and its function in sharing the capacity of data transmission media. • Explain briefly the mechanism used to co-ordinate data transmission in Ethernet and wireless networks. • Understand the simple concepts of circuit switching and packet switching.	Knowledge of both Carrier Sense Multiple Access with Collision Detection (CSMA/CD) and Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) is required. The basic function of each component of a packet including header, data and trailer should be known.
v. Types of network	• Describe the characteristics of the different types of network, including the LAN, WAN and Personal Area Network (PAN).	

Topic	Learning Outcomes	Remarks
	• Describe the characteristics of basic network topology such as bus, ring and star.	
	• Describe the characteristics of a client-server network and a peer-to-peer network, and explain the factors that need to be considered in choosing between them as a network solution.	The factors include the network services required, set-up and maintenance costs, and the workload of the network administrators, etc.
	• Understand the basic features of a wireless computer network in terms of its underlying technologies and the hardware used.	The common industry standards for wireless computer networks should be introduced to students. Relevant concepts including frequency, bandwidth, interference and roaming, etc. are required.
	• Explain the factors that need to be considered in choosing between wired and wireless computer networks.	The strengths and weaknesses of both network solutions should be considered. The possibility of a hybrid solution should also be introduced to students.
vi. Network applications	• Describe the services provided by common network servers.	The common network servers include the Dynamic Host Configuration Protocol (DHCP) server, domain controller, file server, proxy server, and gateway, etc.

Topic	Learning Outcomes	Remarks
	• Describe and appreciate the applications of various networks.	The applications include resources sharing, web serving, and telecommuting, etc. Simple knowledge of the latest mobile computing applications and their role in supporting the mobile business, mobile government services and mobile life initiatives should be discussed.
	• Describe the different personnel involved in a networking environment.	The types of personnel should include network engineers and network administrators.
b. Network Design and Implementation (26 hours)		
	• Conduct a simple needs analysis on a proposed network and translate the needs identified into requirements and specifications. • Design a network to meet the requirements generated in the needs analysis and represent it in a diagram. • Justify their designs based on technical, cost-effectiveness and other considerations.	

Topic	Learning Outcomes	Remarks
	• Set up simple Ethernet and wireless networks.	Students should know the use of a subnet and know which subnet an IP address belongs to from a simple subnet mask.
	• Share various resources among the networked computers/stations.	The resources include files, printers and Internet connection, etc.
	• Set folder/ file-sharing permissions, including read, write and execute rights, etc.	
	• Design a simple test plan based on the requirements and specifications to validate a network system.	
	• Document the user requirements, a schematic diagram for the network and specifications of the network.	Documentation of industry standards is not required.
	• Be aware of the importance of adequate end-user support and training for the attainment of the benefits sought.	
	• Appreciate and value the use of various networking technologies in meeting different user requirements.	

Topic	Learning Outcomes	Remarks
c. Network Management and Security (11 hours)		
i. Network management	• Develop the basic skills of monitoring and fine-tuning the performance of a simple network.	Students should be able to use some simple network monitoring software to interrogate devices to determine their status and to obtain statistics about the networks for monitoring and fine-tuning purposes.
	• Develop the basic skills of analysing problems of a networked environment and performing troubleshooting for it.	The problems may involve cabling, Network Interface Card (NIC), driver, Network Operating System (NOS), and configuration of a network, etc.
	• Be aware of the importance of backup in disaster planning and recovery measures.	
	• Know the common hardware and software components of a network backup solution.	Students should be introduced to the different components/technologies of a network backup solution including network backup servers, network backup and recovery software, Uninterruptible Power Supply (UPS), and Redundant Array of Independent Disks (RAID), etc.

Topic	Learning Outcomes	Remarks
ii. Network security	• Describe the potential risks caused by the common network security threats.	The threats include virus, worm and Trojan programs, spyware, unauthorised access, interception, and Denial of Service (DoS) attack, etc.
	• Propose effective measures to improve network security for both wired and wireless networks.	The measures include anti-virus software, authentication, access and user right control, packet filtering, firewall, public and private key encryption, Wired Equivalent Privacy (WEP), and IPsec used in Virtual Private Network (VPN), etc. Encryption mechanisms to guarantee a message is both authentic and private should be known. Detailed implementation algorithms of public and private key encryption are not required. Technical details on how a VPN is constructed are not required.

C. Multimedia Production and Web Site Development

Introduction

This option is designed to equip students with the basic concepts, technologies and tools in developing multimedia products. It provides them with useful and practical knowledge related to web page design and web site development. This includes the learning of the incorporation of multimedia elements in web pages, and the fundamentals of designing, developing and publishing dynamic web pages on the Internet.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module A *Information Processing* and module C *Internet and its Applications* before progressing to this option.

All the sub-topics under topics (a) "Multimedia production" and (b) "Web site development" in the present option are designed as extensions of topic (e) "Presentation of information" in the Compulsory Part – module A *Information Processing*, and topics (b) "Internet Services and Applications" and (c) Elementary Web Authoring" in the Compulsory Part – module C *Internet and its Applications*.

Learning Objectives

Students will learn about:
- the benefits of multimedia applications;
- the different kinds of multimedia elements;
- the integrated use of multimedia elements in a simple multimedia application;
- design factors for presenting information effectively on the Internet;
- web authoring and web site publishing; and
- dynamic and interactive web pages.

The time allocation for the option is about 75 hours.

Details

The option *Multimedia Production and Web Site Development* comprises two topics: "Multimedia Production" and "Web Site Development". Details of the two topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Multimedia Production (25 hours)		
i. Multimedia applications	• Describe and appreciate the applications of multimedia.	The applications include advertisements, entertainment, public information, and training and education, etc.
	• Identify the benefits of multimedia applications.	
ii. Multimedia basics	• Describe and identify different types of multimedia elements.	
	• Describe the attributes of different multimedia elements.	For example, font size and typeface of text, colour depth and resolution of graphics, bit rate and frequency of audio signal, frame size and frame rate of video.
	• Know the different multimedia file types.	For example, the difference between bitmaps and vector graphics, and the difference between wave files and midi files.
	• Understand the meaning of digitisation, coding-decoding and compression.	

Topic	Learning Outcomes	Remarks
iii. Multimedia products	**(1) Preparing multimedia elements**	
	• Prepare multimedia elements.	Students should be able to prepare multimedia elements by capturing audio information, digital images and video with various devices, importing and converting from ready-made files, constructing from scratch and by using various media authoring tools.
	(2) Multimedia editing and processing	
	• Perform simple editing and processing on multimedia elements.	For example, changing the sharpness and brightness of graphical images, applying filters to give special effects, mixing of wave files, and adding a simple transition effect / text / image on video clips.
	• Convert multimedia elements from one file format to another and know the potential information loss.	
	(3) Finalising multimedia products	
	• Examine how multimedia elements of a multimedia product function together to produce meaning for an audience.	

Topic	Learning Outcomes	Remarks
	• Export a multimedia product to different file formats. • Compress a multimedia product. **(4) Multimedia design factors** • Recognise the essential design factors. • Integrate multimedia elements into a cohesive multimedia product in a given context. • Understand the need to strike a balance between qualities and constraints in processing multimedia elements.	By demonstrating some multimedia applications, students should understand that the essential design factors are audience awareness and content purpose. The required multimedia elements are texts, digital images/photos, sound clips, video clips, and frame-by-frame animations with shape/motion tweening and morphing.

Topic	Learning Outcomes	Remarks
b. Web Site Development (50 hours)		
i. Presenting information on the Internet	• Outline and discuss the various factors to be considered in the construction of web pages.	By demonstrating some web sites, students should discuss successful design factors such as the web site structure, audience awareness, content purpose, site map, use of the workspace available on each page, arrangement of elements on screen, appropriateness of embedded graphics/sound/animations, use of frames and meaningful contextual links, grouping related information into tables/lists, providing channels for feedback, providing details in downloadable files, and structuring contents for easy printing. Students should also discuss the hardware constraint and platform compatibility factors such as computer processing power, bandwidth limitation, browser and plug-in compatibility, viewing environment, and language and colour compatibility. They should analyse and judge the use of the right resolution and file format for images and photos in order to keep download time low.

Topic	Learning Outcomes	Remarks
	• Know that there are guidelines to cater for web accessibility by people with special needs.	For example, providing an additional text-only version, and including brief descriptions and text links in existing websites to make the web pages more accessible to the visually-impaired.
ii. Web authoring tools	• Construct simple web pages.	Students should be able to use different features (e.g. links, anchors, lists, tables, frames, Mailto and Fill-out Forms) in constructing the web page. They should also be able to embed multimedia elements in the web page and apply a consistent look and style across a set of web pages.
	• Create and manipulate browser windows.	Students should be able to create pop-up windows, manipulate window location, and window size, and allow scrollbars to appear when necessary. They should also be able to embed messages in browser window's status bar such as displaying the current date, time, URL and its description.
	• Perform special effects.	Students should be able to create special effects such as scrolling messages, rotating image banners, mouse over effect, blinking text and changing colours.

Topic	Learning Outcomes	Remarks
	• Publish web site.	Students should know the basics of getting a domain name and web hosting. They should also be able to transfer web pages onto web sites on the Internet.
iii. Dynamic and interactive web pages	• Understand the difference between server-side and client-side technologies.	
	• Describe the characteristics of client-side scripting.	
	• Create interactive menus upon user selection.	Students should be able to create interactive user selection, such as the 2-level interdependent select list, pull down menu and click-to-expand menu.
	• Validate and manipulate input data.	Students should be able to check text data, numeric data, required input, length of input, manipulate radio buttons and check boxes and valid values for all input data. They should also be able to perform simple computations to create quizzes and simple mathematics games.
	• Retrieve and save client information.	For example, the use of Cookies for collection of user information.

D. Software Development

Introduction

This option is designed to provide students with the basic concepts of systems development, and further programming concepts and programming languages, to develop their problem-solving skills through a systematic approach to algorithm design and programming, as well as to improve their logical thinking and critical thinking skills. By studying this option, students will understand the whole process of software development. They will be able to design and develop computer programs independently for solving problems. Students will also be exposed to various principles and techniques of algorithm design, and different programming paradigms and phases of systems development. This will develop students' creativity and broaden their views on software development. This understanding will offer students a wider choice from which to think and select an appropriate approach to solve a specific problem in future.

Students should have acquired the necessary knowledge and skills in the Compulsory Part – module D *Basic Programming Concepts* before progressing to this option.

The sub-topics "Problem definition and analysis", "Design of solutions", "Implementation" and "Testing and evaluation" under topic (a) "Programming" in the present option are designed as extensions of sub-topics "Problem-solving Procedures", "Algorithm design" and "Algorithm testing" in module D *Basic Programming Concepts*.

Learning Objectives

Students will learn about:

- how to define and analyse problems;
- the importance of good programming skills and good programming styles;
- the importance of formulating appropriate algorithms in solving problems;
- creative design and development of computer programs;
- how to illustrate different programming paradigms with appropriate programming languages;
- how to choose different languages to meet different needs;
- the importance of a systematic approach to software development; and
- how to apply concepts underlying software development in a systematic way.

The time allocation for the option is about 75 hours.

Details

The option *Software Development* comprises three topics: "Programming", "Programming Languages" and "Systems Development". Details of the three topics are summarised below:

Topic	Learning Outcomes	Remarks
a. Programming (47 hours)		
i. Problem definition and analysis	• Define problems. • Identify the inputs and outputs involved in solving a problem. • Plan solutions by choosing an appropriate problem-solving approach. • Describe the concept of stepwise refinement. • Apply structured programming to program writing.	The problem-solving approaches included are the top-down approach and the bottom-up approach. Modularity has been discussed in the Compulsory Part.
ii. Design of solution	• Select appropriate data types for a solution. • Represent algorithms with flowcharts or block diagrams.	The data types included are simple data types, structured data types and user-defined data types. Simple data types have been discussed in the Compulsory Part.

Topic	Learning Outcomes	Remarks
	• Apply algorithms of counting, accumulating, swapping, searching, sorting and merging in writing programs.	The search algorithms included are linear search and binary search. The sorting algorithms included are bubble sort, insertion sort and merge sort. Merging involves only two arrays of data at one time. Students should realise that there are some other sorting algorithms, say quick sort, other than the three stated above.
	• Choose an appropriate algorithm for a task.	Students should be aware that a problem may be solved by several different algorithms. The selection of algorithms sometimes depends on their complexities and data structures as well as their trade-off. Students should evaluate the algorithm with respect to efficiency, correctness and appropriateness for a task.
iii. Implementation	• Apply various basic constructs in a solution.	Students should be able to use global variables, local variables, constants, assignment statements, input statements, output statements, arithmetic operators, string operators, Boolean operators and Boolean logic, and operations of the operators including precedence and association.
	• Apply control structures in a solution.	Sequence, selection and iteration have been introduced in the Compulsory Part.

Topic	Learning Outcomes	Remarks
	• Construct lists, stacks and queues in terms of arrays.	Students should be able to create and manipulate linear linked lists, stacks and queues in terms of arrays.
	• Manipulate text files through file-handling statements.	The manipulation involves file updating statements to delete, insert, append and amend records.
	• Implement parameters passing in manipulating sub-programs.	The sub-programs are called by two parameters passing methods: call by value and call by reference.
	• Realise the importance of good programming styles.	Students should develop the habit of using meaningful variable names, comments, annotations, space and indentation.
	• Appraise the use of structured programming to design, implement, and debug errors.	
iv. Testing and evaluation	• Interpret errors.	The numerical errors included are rounding errors, truncation errors, overflow errors and underflow errors. Other errors are syntax errors, logical errors and run-time errors.
	• Apply both manual methods and software debugging tools to program debugging.	Use stubs, flags, break points and program traces for debugging.

Topic	Learning Outcomes	Remarks
v. Documentation	• Design sets of test data for program testing. • Develop the habit of documenting the processes of program development. • Recognise various documents for documenting a program.	Test data for boundary cases has been discussed in the Compulsory Part. The documents included are algorithm representation, program listings, the sets of test data and user manuals.
b. Programming Languages (12 hours)		
i. Programming paradigms **ii. Language translators and compilers**	• Be aware of the evolution of programming languages. • Recognise the programming paradigms involved in procedural, logic, object-oriented and query languages. • Describe the criteria for selecting a programming language for a specific problem. • Define code generation, linkers and loaders.	One programming language for each paradigm is selected for illustration.

Topic	Learning Outcomes	Remarks
	• Compare compilers and interpreters.	
c. Systems Development (16 hours)		
i. Basic concepts	• Define a system and recognise the basic elements of a system.	The basic elements of a system are environment, inputs, outputs, processes, interfaces and storage.
	• Know the development of a simple computer-based system.	
	• Describe the phases involved in systems development using the Waterfall Model.	By using suitable case studies, students should experience the processes and activities involved in various phases of systems development.
ii. Systems analysis	• Identify the major task involved in solving a problem.	
	• List some common methods and activities to gather information for analysing problems and documenting users' requirements.	The common methods and activities are interviews, surveys, questionnaires, observations and document review.
	• Know the need for a feasibility study for a proposed solution.	

Topic	Learning Outcomes	Remarks
	• Examine the pros and cons of alternative proposals.	
	• Write requirement specifications.	
iii. Systems design	• Describe the functions of each part of a computer-based system and the related issues.	This covers the hardware platform, software, inputs, outputs, user interfaces, database structures, data processing, data control, data security and system security.
	• Design and appraise an effective interface between the user and the system.	Different types of human-machine interfaces are compared.
	• Know system flowcharts, structure charts, data flow diagrams and data dictionaries to design and document a proposed system.	
	• Use Gantt Charts for project management.	
iv. Systems implementation	• Design and prepare computer-based solutions.	
	• Explain different types of testing and their uses.	The types included are unit testing, system testing and acceptance testing.

Topic	Learning Outcomes	Remarks
	• Design a simple test plan for functionality of parts of a system.	
v. Systems conversion and maintenance	• Compare different strategies of systems conversion.	The strategies included are pilot conversion, phased conversion, parallel conversion and direct cutover conversion.
	• Explain the need for ongoing maintenance, upgrading and training.	
vi. Systems documentation	• Differentiate different types of documentation and their purposes.	The types included are system documentation, technical documentation and user manuals.
	• Document the processes and specifications.	The examples of documentation are requirement statements, project plans and design plans.
vii. Alternative approaches	• Explore the limitations and shortcomings of the Waterfall Model.	
	• Recognise the benefits and limitations of other approaches.	Other approaches include Prototyping and Rapid Application Development (RAD).
viii. The personnel	• Identify various job titles for different stages of systems development.	