2014

PROGRAMME STANDARDS: COMPUTING

Agensi Kelayakan Malaysia
Malaysian Qualifications Agency

Programme Standards: Computing
First Edition 2010
Second Edition 2014

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ISBN:
All the Agency's publications are available on our website: www.mqa.gov.my

Printed copies are available from:
The Standards Division
Malaysian Qualifications Agency

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FOREWORD

In its effort to ensure the quality of programmes in institutions of higher learning in Malaysia, Malaysian Qualifications Agency (MQA) has published various documents such as Malaysian Qualifications Framework (MQF), Code of Practice for Programme Accreditation (COPPA), Code of Practice for Institutional Audit (COPIA), Guidelines to Good Practices (GGP) and Programme Standards (PS). It is important that these quality assurance documents be read together with this document in developing and delivering higher education programmes in Malaysia.

The Programme Standards document outlines sets of characteristics that describe and represent guidelines on the minimum levels of acceptable practices that cover all the nine Malaysian quality assurance areas: programme aims and learning outcomes, curriculum design and delivery, assessment of student learning, student selection, academic staff, educational resources, programme monitoring and review, leadership, governance and administration, and continual quality improvement. The Programme Standards for Computing covers the education levels from certificate to doctoral.

This Programme Standards document has been developed by a panel of experts in consultation with various public and private Higher Education Providers (HEPs), relevant government and statutory agencies, professional bodies, related industries and students. My deepest gratitude goes to them and the MQA officers who put forth tremendous effort and generously gave their time in realizing the Programme Standards for Computing.

Thank you.

Dato' Prof. Dr. Rujhan Bin Mustafa
Chief Executive Officer
Malaysian Qualifications Agency (MQA)
2015

ABBREVIATIONS

ACM	Association for Computing Machinery
BOK	Body of Knowledge
CGPA	Cumulative Grade Point Average
COPIA	Code of Practice for Institutional Audit
COPPA	Code of Practice for Programme Accreditation
CPD	Continuous Professional Development
CS	Computer Science
GGP	Guidelines to Good Practices
HEP	Higher Education Providers
ICT	Information and Communication Technology
IEEE-CS	The Institute of Electrical and Electronics Engineers – Computer Society
IS	Information System
IT	Information Technology
MGC	Minimum Graduating Credits
MQA	Malaysian Qualifications Agency
MQF	Malaysian Qualifications Framework
SE	Software Engineering

1. INTRODUCTION

Computing, for the purposes of this Programme Standards involves the study of computers and their applications. Thus, Computing includes designing and building hardware and software systems for a wide range of purposes; processing, structuring, and managing various kinds of information; carrying out scientific studies using computers; making computer systems behave intelligently; creating and using communications and entertainment media; finding and gathering information relevant to any particular purpose.

In the Malaysian context, Information and Communication Technology (ICT) is widely used as a phrase to describe Computing. As a result, Computing degrees have always been referred to as ICT degrees.

For the purpose of Malaysian Higher Education sectors, the learning framework is based on the ACM Problem Space of Computing. Computing is broadly categorised into four (4) major disciplines namely Computer Science, Software Engineering, Information Technology and Information Systems:

i. Computer Science: Graduates of this discipline, called *Computer Scientists,* should be prepared to work in a broad range of positions involving tasks from theoretical work to software development and can adapt to innovations in ICT; essentially they are able to:
   a. Designing and implementing software.
   b. Devising new ways to use computers.
   c. Developing effective ways to solve computing problems.
   d. Planning and managing organizational technology infrastructure.

ii. Software Engineering: Graduates of this discipline, called *Software Engineers,* should be able to perform and manage activities at every stage of the life cycle of large-scale Software systems; they become specialist in designing and implementing software in the large.

iii. Information Technology: Graduates of this discipline, called *Information Technology Professionals,* should be able to work effectively at planning,

implementation, configuration and maintenance of an organisation's computing infrastructure; prepared to succeed in roles involving planning and managing technology infrastructure.

iv. Information Systems: Graduates of this discipline, call*ed Information Systems Specialists,* should be able to analyse information requirements and business processes and be able to specify and design systems that are aligned with organisational goals.

The four (4) disciplines provide the basic platform for placement of computing programmes. It is worth clarifying that Computer Science and Software Engineering programs prepare students for computing technology creation, while Information Technology and Information System are more designed for roles as experts in using technologies. The other disciplines such as computer engineering and creative multimedia programmes are not covered within this standard. Any programmes that do not comply with this standard should not use the naming conventions specified in this programme standard.

Further, potential employers of new computing bachelor degree graduates must be clear that each of the four disciplines are different. **For this reason, the nomenclature of diploma and bachelor degree awards in Computing must be prefixed by these four disciplines to avoid confusion**. Consistent nomenclature will reduce the gap between the fresh graduates' capabilities and expectation of employers. However for other than Diploma and Bachelor's Degree programmes, HEPs may determine the specific nomenclature for their awards based on existing national and international best practices.

To help employers select the right graduates for the ICT job role, Multimedia Development Corporation (MDeC) has developed Skills Competency Matrix (SCM). This enables the learning outcomes of the four disciplines to be mapped to the job functions in ICT as shown in the table in **Appendix 2**. Some examples are shown in the table below:

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
Programmer	• Programmer • Software Engineer • Software Developer	• Computer Science • Software Engineering
Network Engineer	• Systems Engineer • Systems Administrator • IT Administrator • Database administrator	• Computer Science • Information Technology
Database Administrator	• Database Analyst • Database Engineer • Database Specialist	• Computer Science • Information Systems

Table 1: Skills Competency Matrix (SCM)

Computer Science spans a wide range, from its theoretical and algorithmic foundations to cutting edge developments in Robotics, Computer Vision, Intelligent Systems, Bioinformatics, Forensic Computing and other exciting areas. It involves designing and implementing software, devising new ways to use computers and developing effective ways to solve computing problems.

Computer Science offers a comprehensive foundation that permits graduates to adapt to new technologies and ideas. Computer scientists extend theories and practice for implementation of computer systems which has grown to include aspects of web development, interface design, security issues, mobile computing, and involvement in devising new ways to use computers. Computer scientists are expected to be flexible in performing all types of computing task including software development, system administration, information analysis etc.

The general learning framework of the discipline is as mapped by the shaded portion of the diagram below:

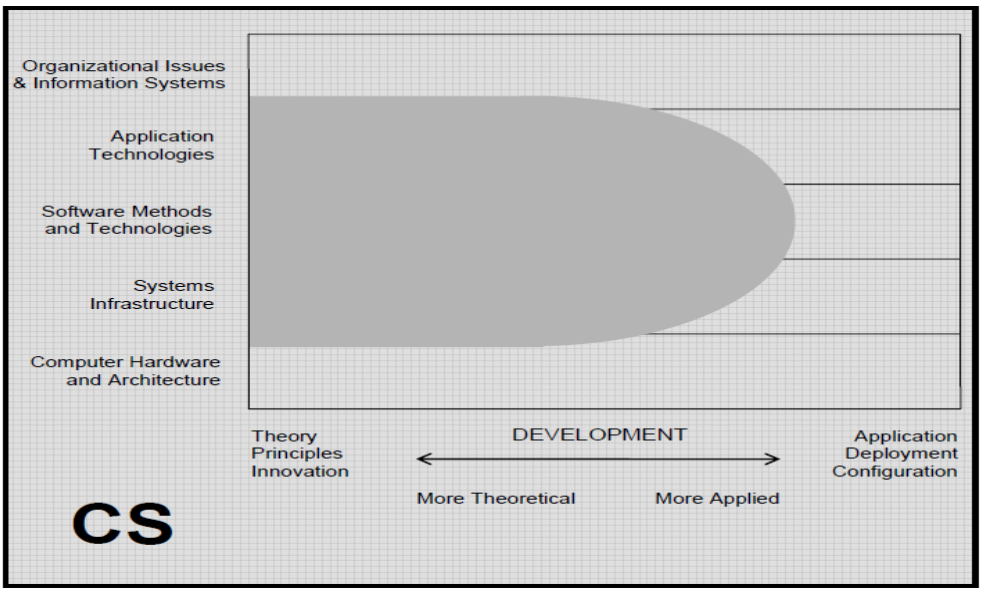

Diagram 1: Association for Computing Machinery (ACM) Problem Space Computing – Computer Science.

Software Engineering is the discipline of developing and maintaining software systems that behave reliably and efficiently, is affordable to develop and maintain and built to customers' specifications. It has evolved in response to factors such as the growing impact of large scale software systems in a wide range of situations and the increased importance of software in safety-critical applications.

Software Engineering programmes produce graduates, who can understand user requirements and develop software systems. Software Engineers are expected to develop systematic models and reliable techniques for producing high-quality software on time and within a budget.

The general learning framework of the discipline is as mapped by the shaded portion of the diagram below:

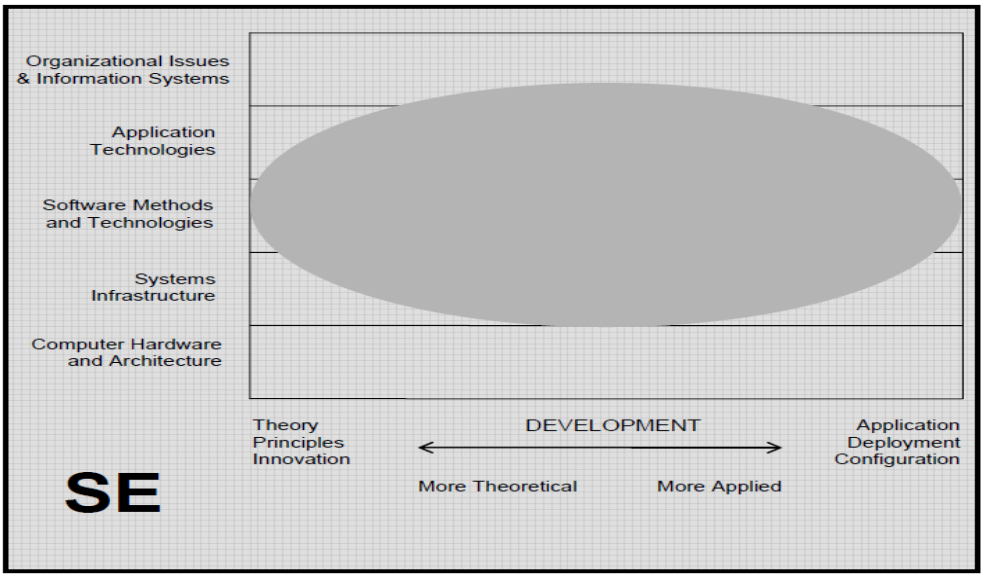

Diagram 2: Association for Computing Machinery (ACM) Problem Space Computing – Software Engineering.

Information Technology in the broadest sense refers to all aspects of computing. However, in academia, it often refers to meeting the technological needs of business, government, healthcare, schools, and other kinds of organisations through the selection, creation, application, integration and administration of computing technologies.

IT graduates are trained to focus on the application, deployment, and configuration needs of organisations and people over a wide spectrum. IT Professionals have a special focus on satisfying organisational needs that arise from Computing Technology. They assume responsibility for selecting hardware and software appropriate for an organisation, integrating these with organisational needs and its infrastructure, and installing, customising, and maintaining those applications for the computer users in the organisation.

The general learning framework of the discipline is as mapped by the shaded portion of the diagram below:

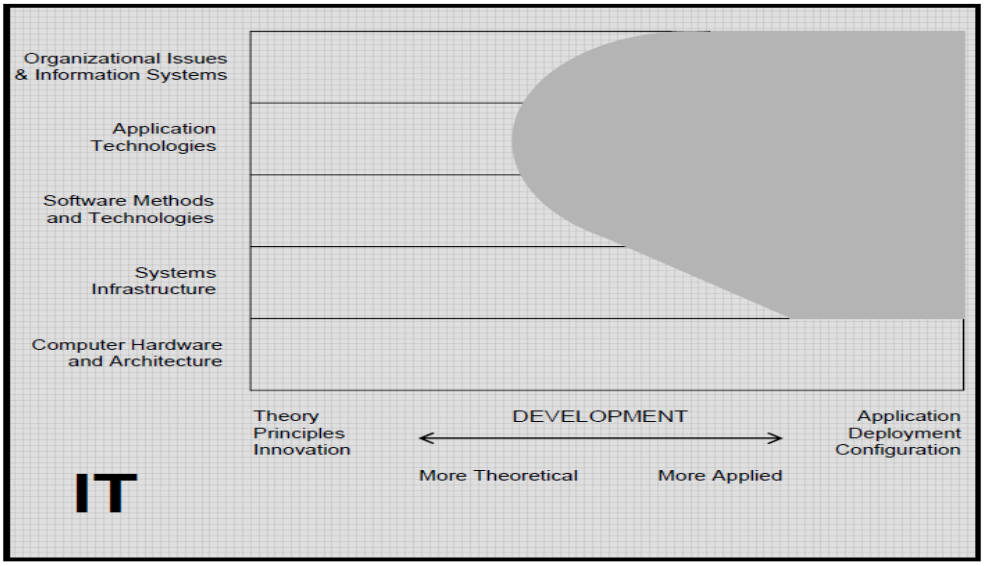

Diagram 3: Association for Computing Machinery (ACM) Problem Space Computing – Information Technology.

Information Systems integrate Information Technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in effective, efficient ways. This discipline's perspective on Information Technology emphasises Information, and views technology as an instrument for generating, processing and distributing information.

Information Systems programmes prepare graduates to work with business support applications such as payroll, accounts, receivables and inventory management. Information Systems Specialists are expected to become familiar with computer applications related to these traditional business areas, especially database-management systems and spreadsheets, and other off-the-shelf software products.

The general learning framework of the discipline is as mapped by the shaded portion of the diagram below:

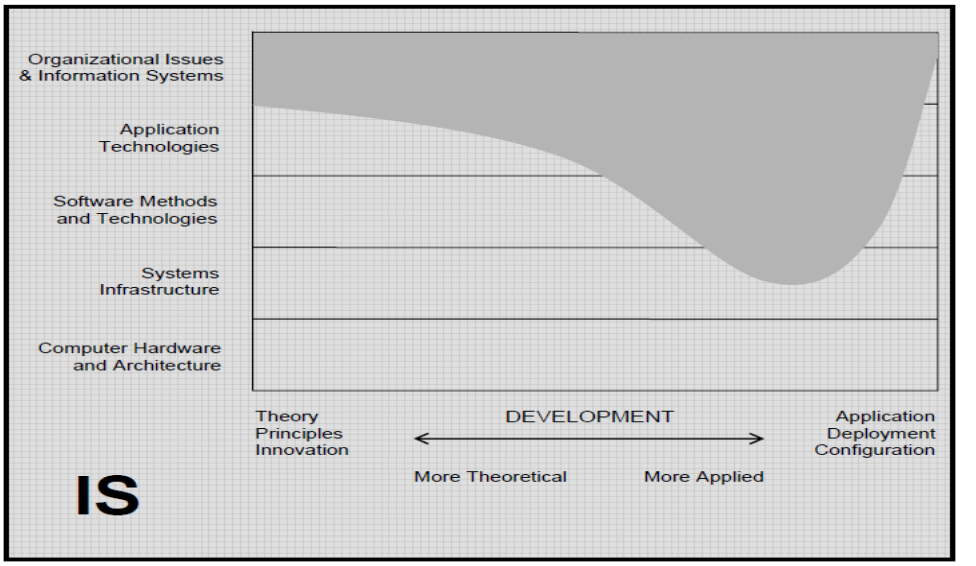

Diagram 4: Association for Computing Machinery (ACM) Problem Space Computing – Information System.

As a whole, the **Programme Standards for Computing** describes the different levels of standards leading to the award of individual qualifications, namely Certificate (Malaysian Qualifications Framework MQF Level 3), Diploma (MQF Level 4), Bachelor's Degree (MQF Level 6), Master's Degree (MQF Level 7) and Doctoral Degree (MQF Level 8). It has not incorporated Advanced Diploma (MQF Level 5) as the expert focus group for the Programme Standards felt that the qualification best fits the needs and demands of the non-conventional student entry mode and should be given opportunity to develop in accordance to the demand for such a qualification in the future.

These standards are designed to encourage diversity of approach within a framework that is compatible with the national and global human resource requirements and the socio-economic needs. HEPs are expected to combine, teach and assess the subject matter creatively. The Programme Standards provides an inventory of content; delivery and assessment of programmes, thus enabling identification of vital components of qualifications from Certificate to Doctoral awards.

As the statements within the Programme Standards should be viewed as benchmark statements, HEPs are encouraged to go beyond the basic minimum. This document is also intended to be valuable to potential students, their parents and guardians, employers, professional and regulatory bodies, universities, colleges and schools. Assessors and Auditors are guided by these standards in arriving at their recommendation and conclusions.

The development and implementation of this Programme Standards is to ensure that the graduates meet the professional requirements and expectations in their respective fields. HEPs must take into consideration the balance between the fundamental body of knowledge and the rapidly evolving subject matter and introduce effective and sustainable programme improvement. In doing so, the providers should also ensure that the graduates obtain the necessary skills to function effectively.

This is the second edition of the Programme Standards for Computing. A review has been done to the previous Programme Standards: Computing that has been adopted as a guide since 2010 by HEPs in Malaysia. This review process is to ensure that the document is updated with current policies and development of computing transformation.

It is important to note that all partnership or collaborative programmes should also comply with the requirement of this Programme Standards.

As the purpose of this Programme Standards is to provide guidelines in relation to the development and conduct of programmes in the identified fields, it is of paramount importance that this document be read with other quality assurance documents and policies by the Malaysian Qualifications Agency and related agencies. These include but are not limited to:

i. The Malaysian Qualifications Framework (MQF);
ii. The Code of Practice for Programme Accreditation (COPPA);
iii. The Code of Practice for Institutional Audit (COPIA); and
iv. Relevant Guidelines to Good Practices (GGP).

2. PROGRAMME AIMS

"A Programme's stated aims reflect what it wants the learner to achieve. It is crucial for these aims to be expressed explicitly and be made known to learners and other stakeholders alike" (COPPA, 2008, pp.10).

CERTIFICATE (Malaysian Qualifications Framework, MQF Level 3)

Computing programmes at Certificate level aim to provide computing graduates with a broad range of interpersonal skills and an in-depth understanding and knowledge within their field of study to responsibly take on appropriate jobs. The nomenclature for the Certificates, for example, Certificate in PC Maintenance and Certificate in Networking should reflect concentration areas of the Programme.

The programme aims for a Certificate are to train graduates who:

i. possess basic knowledge and skills in computing;
ii. can utilise computing tools and techniques by applying knowledge and interpreting information to solve problems;
iii. can execute routine tasks and are proficient in the use of relevant tools in their area of training;
iv. can perform IT support services;
v. have communication, team and interpersonal skills, and are aware of their social and ethical responsibilities; and
vi. possess skills for lifelong learning and career development.

DIPLOMA (MQF Level 4)

Computing programmes at Diploma level aim to provide graduates with the skills and a broad-based knowledge to responsibly take on appropriate jobs with moderate autonomy. The graduates should possess a combination of knowledge and skill to assist in an organisation's computing needs.

Generic Programme aims for a Diploma are to prepare graduates who:

i. possess relevant knowledge, skills and aptitude to meet job specifications;
ii. can utilise current computing tools and techniques by applying knowledge and interpreting information to solve problems;

iii. can execute and be responsible for routine tasks;
iv. have effective communication skills to convey information, problems and solutions;
v. have team and interpersonal skills, and are aware of their social and ethical responsibilities; and
vi. possess skills for lifelong learning and career development.

Subject to the concentration in a particular Diploma and its nomenclature, the **specific Programme aims for two categories consisting of four (4) Disciplines** identified in this Programme Standards are:

A. Computer Science or Software Engineering

The Programme should prepare graduates who:

i. have knowledge of algorithms, software methods and current programming languages;
ii. have the ability to analyse, design and develop computer applications;
iii. have the ability to assist in the development of systematic models; and
iv. have the skills to adhere to standard process-oriented methodologies and procedures for producing high-quality software on time and within a budget.

B. Information Technology or Information Systems

The Programme should prepare graduates who:

i. have knowledge of organisational and systems needs;
ii. have the ability to configure, integrate, deploy systems and utilise software according to the organisational needs as well as providing maintaining and technical support within the organisations; and
iii. have the ability to explain the concept importance of human-computer-interaction.

BACHELOR'S DEGREE (MQF Level 6)

Computing programmes at Degree level aim to provide graduates with sufficient knowledge and skills to take on appropriate responsibility with a higher degree of autonomy from the Diploma holders. The graduates should possess the ability to be responsible for an organisation's computing needs.

Generic programme aims for a Bachelor's Degree are to prepare graduates who:

i. possess skills for lifelong learning, research and career development;
ii. have communication, team, leadership and interpersonal skills, and aware of the social, ethical and legal responsibilities; and
iii. have entrepreneurial skill and a broad business and real world perspective.

Subject to the specialisation/major/minor in a particular Bachelor's Degree and its nomenclature, the specific **Programme aims for the four (4) Disciplines** identified in this Programme Standards are:

A. Computer Science

The Programme should prepare graduates who:

i. possess fundamental knowledge, principles and skills in Computer Science;
ii. have strong analytical and critical thinking skills to solve problems by applying knowledge, principles and skills in Computer Science;
iii. possess and able to apply fundamental mathematical, scientific and theoretical computing knowledge in analysing, modelling, designing, developing and evaluating computing solutions; and
iv. understand the interplay between theory and practice of computer science and the essential links between them;

B. Software Engineering

The Programme should prepare graduates who:

i. possess fundamental knowledge, principles and skills in Software Engineering;
ii. have strong analytical and critical thinking skills to solve problems by applying knowledge, principles and skills in Software Engineering; and
iii. are competent in applying appropriate methodologies, models and techniques that provide a basis for analysis, design, development, testing and implementation, evaluation, maintenance and documentation of a large scale software system.

C. Information Technology

The Programme should prepare graduates who:

i. possess fundamental knowledge, principles and skills in Information Technology;
ii. have strong analytical and critical thinking skills to solve problems by applying knowledge, principles and skills in Information Technology;
iii. possess the ability to design, implement and manage Information Technology solutions and resources, and recognise the impact of technology on individuals, organisations and society; and
iv. possess skills to integrate various technology solutions.

D. Information Systems

The Programme should prepare graduates who:

i. possess fundamental knowledge, principles and skills in Information Systems;
ii. have strong analytical and critical thinking skills to solve problems by applying knowledge, principles and skills in Information Systems;
iii. understand business requirements and have the ability to plan, design and manage business Information Systems, with the relevant technology and knowledge to enhance organisational performance; and
iv. Support the design and IT solutions.

MASTER'S DEGREE (MQF Level 7)

Computing programmes at Master's level aim to provide Master's Degree holders with advanced knowledge and skills to deal with an organisation's computing needs. The programmes are aimed to cater for both computing and non-computing graduates. In applying the aims below, HEPs are required to adapt in accordance to the needs of the candidates.

The programme aims for a Master's level are to:

i. provide graduates with advanced knowledge and skills in computing;
ii. equip graduates with advanced theoretical principles and scientific methods to create effective solutions to problems and to evaluate them;
iii. train graduates to work on a project in which they propose, design, build, test, analyse, and deliver a computing solution to meet appropriate computing standards and realistic constraints;
iv. instill graduates with skills to seek knowledge through lifelong learning;

v. equip graduates with the ability to supervise and carry out research under supervision;
vi. develop graduates' effective communication skills in both written and oral form; and
vii. inculcate graduates with professional and ethical responsibilities as well as understanding the possible social, economic, cultural, legal and environmental impact of their computing solutions in the global context.

DOCTORAL DEGREE (MQF Level 8)

Doctoral level qualification should provide graduates with the ability to develop and expand knowledge and application of computing, both in the organisation and society.

The programme aims for a Doctoral level are to:

i. prepare competent practitioners/researchers with a firm grounding in computing who can foster research and development of new knowledge in specific areas;
ii. equip practitioners/researchers with in depth knowledge of computing and a focused understanding in the area of expertise;
iii. prepare practitioners/researchers who can apply skills and principles of lifelong learning in academic and career development;
iv. develop practitioners'/researchers' effective communication skills in both written and oral form;
v. equip practitioners/researchers with the ability to supervise and carry out independent research; and
vi. inculcate practitioners/researchers with professional and ethical responsibilities as well as understanding the possible social, economic, cultural, legal and environmental impact of their computing solutions in the global context.

3. LEARNING OUTCOMES

Learning Outcomes are detailed statements described in explicit terms of learners' achievement and are achievable and assessable upon completion of a period of study.

"The quality of programme is ultimately assessed by the ability of the learner to carry out their expected roles and responsibilities in society. This requires the programme to have a clear statement of the learning outcomes to be achieved by the learner" (COPPA, 2008, pp.11).

These learning outcomes should **cumulatively reflect the eight domains of learning outcomes**, which are significant for Malaysia (MQF, 2007, Para 15, pp.4) and are related to the various levels of taxonomy accordingly, in line with national and global developments.

The eight domains of learning outcomes are:

i. knowledge;
ii. practical skills;
iii. social skills and responsibilities;
iv. values, attitudes and professionalism;
v. communication, leadership and team skills;
vi. problem solving and scientific skills;
vii. information management and lifelong learning skills; and
viii. managerial and entrepreneurial skills.

The knowledge and practical skills in computing encompass five areas in the Association for Computing Machinery (ACM) Problem Space Computing as follows:

i. Organisation issues and information system.
ii. Application technologies.
iii. Software methods and technologies.
iv. System infrastructure.
v. Computer hardware and architecture.

CERTIFICATE

Upon completion of the programme, graduates should be able to:

i. demonstrate an understanding of basic knowledge and skills in their area of concentration;
ii. utilise computing tools and techniques to solve problems related to the area of concentration;
iii. perform a range of support tasks such as installation, configuration, basic maintenance and data entry;
iv. execute instructions as described in user and technical manuals;
v. apply skills and principles of lifelong learning in academic and career development;
vi. communicate effectively with peers, clients, superiors and society at large;
vii. demonstrate teamwork, interpersonal, and social skills; and
viii. demonstrate professionalism, social and ethical considerations in accordance with ethical and legal principles.

DIPLOMA

Generic learning outcomes

Upon completion of the programme, graduates should be able to:

i. demonstrate the ability to articulate and document work-flow and processes during project development;
ii. apply skills and principles of lifelong learning in academic and career development;
iii. communicate effectively with peers, clients, superiors and society at large;
iv. demonstrate teamwork, interpersonal, entrepreneurial and social skills; and
v. demonstrate professionalism and social and ethical considerations in accordance with ethical and legal principles.

Subject to the concentration in a particular Diploma and its nomenclature, the **specific learning outcomes for the four (4) Disciplines** identified in this Programme Standards are:

A. Computer Science or Software Engineering

Upon completion of the programme, graduates should be able to:

i. develop and write computer programmes using at least one industry relevant general purpose programming language;
ii. analyse a problem, model and design a solution, implement and test projects to meet real world needs;
iii. select appropriate data structure and basic algorithms for software solutions;
iv. use industry relevant methods and tools to manage, configure and develop computer-based systems; and
v. apply industry standard practices in software development life cycle.

B. Information Technology or Information Systems

Upon completion of the programme, graduates should be able to:

i. obtain, analyse and document user requirements for real-world projects;
ii. develop appropiate IT solutions in relevant areas;
iii. design and manage computer networks or information system;
iv. provide technical support, configure, deploy and maintain computer solutions; and
v. interpret information and system models for an organisation's functional areas.

BACHELOR'S DEGREE

Generic learning outcomes

Upon completion of the programme, graduates should be able to:

i. apply skills and principles of lifelong learning in academic and career development;
ii. communicate effectively with peers, clients, superiors and society at large;
iii. demonstrate teamwork, leadership, interpersonal and social skills;
iv. utilise relevant techniques and demonstrate analytical and critical thinking skills in problem solving;
v. demonstrate professionalism and social and ethical consideration in accordance with ethical and legal principles; and
vi. apply broad business and real world perspectives daily and demonstrate entrepreneurial skills.

Subject to the specialisation/major/minor in a particular Bachelor's Degree and its nomenclature, the **specific learning outcomes for the four (4) disciplines** identified in this Programme Standards are:

A. Computer Science

Upon completion of the programme, graduates should be able to:

i. demonstrate knowledge of essential facts, concepts, principles, and theories relating to Computer Science;
ii. analyze algorithms as well as design and optimize computational solutions; and
iii. apply computing skills in analyzing, modelling, designing, developing, programming and evaluating efficient computing solutions.

B. Software Engineering

Upon completion of the programme, graduates should be able to:

i. demonstrate knowledge of essential facts, concepts, principles, and theories relating to Software Engineering;
ii. apply theoretical principles of Software Engineering in relevant areas; and
iii. apply appropriate methodologies, models and techniques that provide a basis for analysis, design, development, test and implementation, evaluation, maintenance and documentation of a large scale software.

C. Information Technology

Upon completion of the programme, graduates should be able to:

i. demonstrate knowledge of essential facts, concepts, principles, and theories relating to Information Technology;
ii. apply theoretical principles of Information Technology in relevant areas; and
iii. design, implement and manage Information Technology solutions and resources, and recognise the impact of technology on individuals, organisation and society.

D. Information Systems

Upon completion of the programme, graduates should be able to:

i. demonstrate knowledge of essential facts, concepts, principles, and theories relating to Information Systems;
ii. demonstrate understanding of business requirement;
iii. apply theoretical principles of Information Systems in relevant areas; and
iv. be able to plan, design and manage business Information Systems, with the relevant technology and knowledge to enhance organisational performance.

MASTER'S DEGREE

Upon completion of the programme, graduates should be able to:

i. apply and integrate knowledge concerning current research issues in computing
and produce work that is at the forefront of developments in the domain of the programme of study;
ii. evaluate and analyse computing solutions in terms of their usability, efficiency and effectiveness;
iii. develop computing solutions and use necessary tools to analyse their performance;
iv. apply existing techniques of research and enquiry to acquire, interpret and extend, knowledge in computing;
v. communicate and function effectively in a group;
vi. prepare, publish and present technical material to a diverse audience; and
vii. demonstrate behaviour that is consistent with codes of professional ethics and responsibility.

DOCTORAL DEGREE

Upon completion of the programme, graduates should be able to:

i. demonstrate a systematic comprehension and in-depth understanding of a discipline and mastery of skills and research methods related to the field of computing;
ii. critically analyse, evaluate and synthesise new and complex ideas;
iii. show scholarly capabilities to generate, design, implement and adopt the integral part of the research process based on the computing theoretical framework;
iv. contribute to original research that broadens the boundary of knowledge through an in-depth thesis, which has been presented and defended

according to International standards including writing in Internationally refereed publications;

v. communicate to peers, scholarly communities and society at large through the preparation, publication and presentation of technical material;

vi. promote the technological, social and cultural progress in a knowledge-based society in both academic and professional contexts;

vii. demonstrate behaviour that is consistent with codes of professional ethics, legal requirements and responsibility; and

viii. supervise research projects.

4. CURRICULUM DESIGN AND DELIVERY

For the purpose of this Programme Standards, reference is made to the Code of Practice for Accreditation of Programmes (COPPA) and in particular, the section on 'Curriculum Design and Delivery'. "The term 'curriculum design and delivery' is used interchangeably with the term 'programme design and delivery'. 'Programme' means an arrangement of courses that are structured for a specified duration and the learning volume to achieve the stated learning outcomes to lead to an award of a qualification" (COPPA, 2008, pp.12).

This section of the Programme Standards contains benchmarked statements pertaining to the structure and delivery of a programme within the field of Computing.

Tables below represent the benchmark requirements for all levels of qualifications and they include the requirements for the various classifications of modules (compulsory, core, concentration/specialization, field elective and free electives). Specific requirement as to the body of knowledge for the different levels (Certificate – Doctoral Degree) and disciplines are provided in **Appendix 3.** HEPs are given the flexibility to design their own programmes; however, they are expected to cover the body of knowledge indicated in this document. For academic collaboration programmes such as 3+0 in computing, the local HEPs shall deliver original curriculum offered by the foreign partner HEPs in its entirety.

Programming skills and the ability to learn new programming languages is very important in computing, especially in computer science and software engineering. For computer science programmes, students need to master a programming language that will enable them to appreciate the underlying computer architecture and prepare them for other critical programming tasks, such as C/C++. In addition they will need to master a second programming language that is relevant to the programme.

Industrial training is crucial in the development of students' maturity and experience. Hence, HEPs need to allocate a required number of units for this purpose. For the purpose of calculation of credits 1 credit is equal to a minimum of 2 weeks of training. For bachelor's degree programme it is highly recommended the duration for industrial

training should be around six consecutive months. While for diploma programme the recommended duration is three consecutive months**.**

CERTIFICATE **Minimum Graduating Credits – 60**		
Component	**Percentage (%)**	**Credits**
Mata Pelajaran Umum (MPU Modules	10 – 15	6 - 9
Core Modules	30 - 35	18 - 21
Concentration	43 – 77	26 - 46
Industrial Training	0 – 7	0 - 4

Recommended delivery methods:

i. Lectures
ii. Tutorials
iii. Practical Class
iv. Laboratory work

DIPLOMA **Minimum Graduating Credits – 90**		
Component	**Percentage (%)**	**Credits**
MPU Modules	9 – 12	8 - 11
Core Modules	24 – 39	21 - 35
Concentration	19 – 44	17 - 40
Elective Modules	9 – 22	8 - 20
Industrial Training	4 – 13	4 - 12

Recommended delivery methods:

i. Lectures
ii. Tutorials
iii. Practical Class
iv. Laboratory work
v. Blended Learning

BACHELOR'S DEGREE (COMPUTER SCIENCE) Minimum Graduating Credits – 120		
Component	**Percentage (%)**	**Credits**
MPU Modules	8 – 12	10 - 14
Core Modules	28 – 38	33 – 45
Specialisation / Field Electives	23 – 56	27- 67
Final Year Project	5 – 8	6 - 11
Industrial Training	5 – 10	6 - 12
Free modules (non computing preferred)	10 – 23	12 - 27

BACHELOR'S DEGREE (SOFTWARE ENGINEERING) Minimum Graduating Credits - 120		
Component	**Percentage (%)**	**Credits**
MPU Modules	8 – 12	10 - 14
Core Modules	45 – 55	54 - 66
Specialisation / Field Electives	10 – 33	12 – 40
Final Year Project	5 - 8	6 - 11
Industrial Training	5 – 10	6 - 12
Free modules (non computing preferred)	10 – 23	12 - 27

BACHELOR'S DEGREE (INFORMATION TECHNOLOGY / INFORMATION SYSTEM) Minimum Graduating Credits - 120		
Component	**Percentage (%)**	**Credits**
MPU Modules	8 – 12	10 - 14
Core Modules	28 - 38	33 - 45
Specialisation / Field Electives	23 - 56	27 – 67
Final Year Project	5 - 8	6 - 11
Industrial Training	5 - 10	6 - 12
Free modules (non computing preferred)	10 - 25	12- 30

Recommended delivery methods:

i. Lecture
ii. Tutorial
iii. Practical class
iv. Laboratory work
v. Field visit/Field work
vi. Role play/Simulation
vii. Case study
viii. Blended learning
ix. Open and Distance Learning (ODL)

MASTER'S DEGREE BY COURSEWORK **Minimum Graduating Credits - 40**		
Component	**Percentage (%)**	**Credits**
Core Modules including Research Methodology	50 - 63	20 - 25
Project Paper	23 - 30	9 - 12
Specialisation / Field Electives	15 - 20	6 - 12

Recommended delivery methods:

i. Lectures
ii. Industrial visits
iii. Case study
iv. Problem-based learning
v. Guest lecture series
vi. Interactive learning

MASTER'S DEGREE BY MIXED MODE **Minimum Graduating Credits – 40**		
Component	**Percentage (%)**	**Credits**
Core Modules including Research Methodology	30 - 50	12 - 20
Dissertation	50 - 70	20 - 28

Note:

i. Ratio of coursework to dissertation is within the range of 50:50 or 40:60 or 30:70.

Recommended delivery methods:

i. Lectures
ii. Industrial visits
iii. Case study
iv. Supervision of dissertation
v. Problem-based learning
vi. Guest lecture series
vii. Interactive learning
viii. Research seminars/workshop

MASTER'S DEGREE by RESEARCH **No given credit value**	
Component	**Remarks**
Dissertation	100%
Research Methodology	Compulsory
Relevant Pre-Requisites Modules	Optional

Note:

i. Students are required to undertake research in a related field of study and submit a dissertation.
ii. The HEP must have a set of procedures and guidelines pertaining to;
    a. Minimum and maximum periods of candidature.
    b. Format of the thesis.

Recommended delivery methods:

i. Field research
ii. Problem-based learning
iii. Supervision of dissertation
iv. Research seminars/workshop
v. Interactive learning

DOCTORAL DEGREE by RESEARCH No given credit value	
Component	**Remarks**
Thesis	100%
Research Methodology	Compulsory
Relevant Pre-Requisites Modules	Optional

Note:

i. Students are required to undertake research in a related field of study and submit a thesis.

ii. The HEP must have a set of procedures and guidelines pertaining to;
   a. Minimum and maximum periods of candidature.
   b. Format of the thesis.

Recommended delivery methods:

i. Lectures
ii. Field research
iii. Supervision of thesis
iv. Problem-based learning
v. Research seminars/workshop
vi. Colloquium
vii. Interactive learning

5. ASSESSMENT OF STUDENT LEARNING

"Student assessment is a crucial aspect of quality assurance because it drives student learning. It is one of the most important measures to show the achievement of learning outcomes. The result of assessment is also the basis in awarding qualifications. Hence, methods of student assessment have to be clear, consistent, effective, reliable and in line with current practices and must clearly support the achievement of learning outcomes" (COPPA, 2008, pp.15).

Specific methods of assessment will depend on the specific requirement of each module. However, as a general guide, the following must be considered:

i. The combination of the various assessment methods should show the achievement of the Learning Outcomes;
ii. Summative and formative assessments should be used;
iii. Knowledge and understanding (the cognitive domain) should be tested through written, oral or other suitable means but practical skills should be tested by practical evaluation such as Lab Tests;
iv. In modules requiring practical skills, pass in practical evaluation is compulsory. A pass here implies that the examiner is satisfied that the candidate has demonstrated the ability to perform required practical skills; and
v. The types of assessments indicated below are merely examples. Higher Education Providers (HEPs) are encouraged to use a variety of methods and tools appropriate for the learning outcomes and competencies.

Generally, students shall be evaluated either for continuous and final evaluation through:

i. Examination
   - Written examination such as quizzes, test and final examination.
   - Oral examination.
ii. Coursework
   - Assignments, Report.
iii. Project (Individual and/or Group)
   - Report, Group Activities, Presentation.

Other evaluation methods such as class participation and attendance may be used whenever appropriate.

Suggested breakdown for each level of award from Certificate to Master Degree are as given below. **Candidates should pass BOTH formative (continuous) and summative (final) assessment for every subject. HEPs can define the meaning of pass, however a pass should imply that the examiner must be satisfied that the candidate has met all the learning outcomes of the particular subject.**

The following tables provide a summary for the method of evaluation for the listed qualifications:

QUALIFICATIONS	MODULES		REQUIRED
	FORMATIVE ASSESSMENT (%)	SUMMATIVE ASSESSMENT (%)	
Certificate	50 - 70	30 - 50	• Written Assessment • Oral Assessment • Practical Assessment
Diploma	50 - 70	30 - 50	• Written Assessment • Oral Assessment • Practical Assessment • Industrial Attachment /Internship • Project
Bachelor's Degree	40 – 70	30 - 60	• Written Assessment • Oral Assessment • Practical Assessment • Industrial Attachment /Internship • Project
Master's Degree by Coursework	-	-	• Written Assessment • Presentation • Project Paper
Master's Degree by Mixed mode	-	-	• Written Assessment • Presentation

QUALIFICATIONS	MODULES		REQUIRED
	FORMATIVE ASSESSMENT (%)	SUMMATIVE ASSESSMENT (%)	
			• Dissertation • Viva Voce

For Masters and PhD by Research:

i. Formative assessment must include:
   a) Monitoring of research progress periodically (for example, through a progress report, or a proposal defense).
   b) Research presentation/colloquium/seminar/workshop.

ii. Summative assessment is used to assess all learning outcomes of a programme, and must include:
   a) completion of prescribed courses;
   b) thesis or dissertation; and
   c) viva voce.

The following table provides a summary for the method of evaluation for Masters and PhD by Research:

QUALIFICATIONS	MODULES		REQUIRED
	FORMATIVE ASSESSMENT (%)	SUMMATIVE ASSESSMENT (%)	
Master's Degree by Research	-	-	• Presentation • Thesis (two examiners) • Viva Voce • One (1) refereed publication
Doctoral Degree	-	-	• Thesis (internal and external examiners) • Viva Voce • One (1) internationally refereed publication

Compositions of dissertation/thesis examiners are prescribed in the Standards for Master's and Doctoral Degree. The name of all supervisors and examiners should be stated in the front pages of thesis and dissertation.

6. STUDENT SELECTION

This section of the Programme Standards concerns the recruitment of students into the individual programme of study. In general, admission policies of the Programme need to comply with the prevailing policies of the Malaysian government.

"There are varying views on the best method of student selection. Whatever the method used, the Higher Education Provider (HEP) must be able to defend its consistency. The number of students to be admitted to the Programme is determined by the capacity of the HEP and the number of qualified applicants. HEP admission and retention policies must not be compromised for the sole purpose of maintaining a desired enrolment. If an HEP operates geographically separated campuses or if the Programme is a collaborative one, the selection and assignment of all students must be consistent with national policies" (COPPA, 2008, pp.17).

The benchmarked standards for recruitment of students into computing programmes are provided below. The standards are created keeping in mind the generic national Higher Education policies pertaining to minimum student entry requirement. Higher Education Provider (HEP) must take cognisance of any specific policies that may apply to their individual Institution. All qualifications referred to below must be accredited by MQA or by an agency equivalent to MQA in the issuing country.

The minimum standards are as follows:

CERTIFICATE

i. A pass in Sijil Pelajaran Malaysia (SPM) or its equivalent with ONE (1) credit, and a Pass in Mathematics;
   OR
ii. A pass in Sijil Kemahiran Malaysia (SKM) Level 2 in a related field and a pass in Mathematics at SPM level or its equivalent.

DIPLOMA

i. A pass in SPM with at least Credit in any 3 subjects inclusive of Mathematics or any equivalent qualification;

OR

ii. A pass in Sijil Tinggi Persekolahan Malaysia (STPM), with a minimum of Grade C (GP 2.00) in any subject or any equivalent qualification and a credit in Mathematics at SPM level or its equivalent;

OR

iii. A pass in Sijil Tinggi Agama Malaysia (STAM) with a minimum grade of Maqbul (pass) and a credit in Mathematics at SPM level or its equivalent;

OR

iv. A pass in SKM Level 3, and a credit in Mathematics at SPM level or its equivalent;

OR

v. A pass in any qualifications equivalent to Certificate (MQF Level 3) and a credit in Mathematics at SPM level or its equivalent.

Candidates without a credit in mathematics at SPM level or its equivalent may be admitted if the Certificate programme contains subjects in mathematics that are equivalent to mathematics at SPM level.

Candidate with a credit in computing related subject at SPM level or its equivalent may be given preferential consideration.

BACHELOR'S DEGREE

Bachelor's Degree in Computer Science and Software Engineering

i. A pass in Matriculation or Foundation studies with minimum CGPA of 2.00 and a credit in Additional Mathematics at SPM Level or its equivalent;

OR

ii. A pass in Sijil Tinggi Persekolahan Malaysia (STPM) with a minimum Grade C (GP 2.00) in any 2 subjects and a credit in Additional Mathematics at SPM Level or its equivalent;

OR

i. A Diploma in Computer Science OR Software Engineering OR Information Technology OR Information Systems or equivalent with a minimum CGPA of 2.50 and a credit in Additional Mathematics at SPM Level or its equivalent. Candidates with CGPA below 2.50 but above 2.00 with a credit in additional mathematics at SPM level or its equivalent may be admitted subject to a rigorous internal assessment process;

OR

ii. Any other Diploma in science and technology with a minimum CGPA of 2.50 may be admitted subject to a rigorous internal assessment process and a credit in Additional Mathematics at SPM level or its equivalent.

Candidates without a credit in additional mathematics at SPM level or its equivalent may be admitted if the Diploma programme contains subjects in mathematics that are equivalent to additional mathematics at SPM level.

Candidate with a credit in computing related subject at SPM or STPM level or its equivalent may be given preferential consideration.

Bachelor's Degree in Information Technology and Information Systems

i. A pass in Matriculation or Foundation studies with minimum CGPA of 2.00 and a credit in Mathematics at SPM Level or its equivalent;

OR

ii. A pass in Sijil Tinggi Persekolahan Malaysia (STPM) with a minimum Grade C (GP 2.00) in any 2 subjects and a credit in Mathematics at SPM Level or its equivalent;

OR

iii. A Diploma in Computer Science OR Software Engineering OR Information Technology OR Information Systems or equivalent with a minimum CGPA of 2.50 and a credit in Mathematics at SPM Level or its equivalent;

OR

iv. Any other Diploma in Science and technology or business studies with a minimum CGPA of 2.50 may be admitted subject to a rigorous internal assessment process and a credit in Mathematics at SPM level or its equivalent.

Candidates with CGPA below 2.50 but above 2.00 with a credit in mathematics at SPM level or its equivalent may be admitted subject to a rigorous internal assessment process.

Candidate with a credit in computing related subject at SPM or STPM level or its equivalent may be given preferential consideration.

MASTER'S DEGREE

Master's Degree by Research

i. A Bachelor's Degree of Computing or in the area of science and technology or related to computing, with a minimum CGPA of 3.00;

OR

ii. A Bachelor's Degree of Computing or in the area of science and technology or related to computing, with CGPA below 3.00 but above 2.50, can be accepted subject to rigorous internal assessment process;

OR

iii. A Bachelor's Degree of Computing or in the area of science and technology or related to computing, with CGPA less than 2.50, with a minimum of 5 years working experience in a relevant field may be accepted.

Master's Degree by Coursework and Mixed Mode

i. A Bachelor's Degree or its equivalent, with a minimum CGPA of 2.75;

OR

ii. A Bachelor's Degree or its equivalent, with a minimum CGPA of 2.50 and not meeting CGPA of 2.75, can be accepted subject to rigorous internal assessment process;

OR

iii. A Bachelor's Degree or its equivalent, with CGPA less than 2.50, with a minimum of 5 years working experience in a relevant field may be accepted.

For candidates without Computing Degree, prerequisite modules in computing must be offered to adequately prepare them for their advanced study.

DOCTORAL DEGREE

A Master's Degree or equivalent **AND** candidates must have completed at least ONE (1) of their earlier Degrees (Master's or Bachelor's) in Computing or related to computing.

International students must have proof of good proficiency in verbal and written English. For example International English Language Testing System (IELTS) score of 6.0 or its equivalent. If a student does not meet this requirement, HEPs must offer English proficiency courses to ensure that the student's proficiency is sufficient to meet the needs of the programme.

Note for PhD by Research:

i. There shall be no direct entry from Bachelor's Degree level to PhD level.
ii. Candidates registered for Master's Degree by research programmes with a Bachelor's Degree level may apply to convert their candidacy to the PhD programmes subject to having shown competency and capability in conducting research at PhD level and approval by the HEP Senate.

7. ACADEMIC STAFF

"The quality of the academic staff is one of the most important components in assuring the quality of Higher Education and thus every effort must be made to establish proper and effective recruitment, service, development and appraisal policies that are conducive to staff productivity" (COPPA, 2008, pp.21).

Staff Development

Academic staffs are vital to deliver a quality programme and to perform teaching effectively, as well as to produce graduates that are employable and accepted by the industry. As the industry is dynamic and globally influenced, academic staff needs to continually update themselves with changes around the globe. Thus, HEPs must ensure that all academic staff is well-equipped with the latest knowledge and skills in their teaching and learning activities.

HEPs should facilitate academic staff to participate in relevant Continuous Professional Development (CPD) programmes of at least 40 hours per year, such as:

i. Professional development for full-time staff.
ii. Updated teaching and learning skills.
iii. Updated research and supervisory skills.
iv. Industry attachment (if required by HEPs).
v. Research, consultation and community services involvement.

The following sections provide benchmarked requirements for the various levels of the Computing qualifications.

CERTIFICATE

Academic staff qualification

i. Diploma with TWO (2) years relevant industrial experience or professionally certified in the relevant area **OR** Bachelor's Degree in related field.
   (30% of the staff with minimum TWO (2) years relevant industrial work experience or professionally certified in the relevant area).

Academic staff ratio

i. Full-time and Part-time teaching faculty – At least 50% full-time.
ii. Overall Staff-Student ratio – 1:20.

DIPLOMA

Academic staff qualification

i. Bachelor's Degree in related field.
ii. (30% of the staff with minimum TWO (2) years relevant industrial work experience or professionally certified in the relevant area).

Academic staff ratio

i. Full-time and Part-time teaching faculty – At least 60% full-time.
ii. Minimum number of academic staff – 6.
iii. Overall Staff-Student ratio – 1:20.

BACHELOR'S DEGREE

Minimum academic staff qualification

i. Master's Degree in the related field. For those without Bachelor's degree in computing or related field but teaching computing subject, this Master's Degree must be obtained through taught courses.
   (30% of the staff with minimum TWO (2) years relevant industrial work experience).
ii. Bachelor's Degree with FIVE (5) years related work experience in the subject taught.
   (The programme should not employ more than 20% of the staff of this category).

Academic staff ratio

i. Full-time and Part-time teaching faculty – At least 60% full-time.
ii. Minimum number of academic staff – 10.
iii. Overall Staff-Student ratio – 1:15.

MASTER'S DEGREE

Academic staff /supervisor qualification

i. Doctoral Degree in related field. For those without Bachelor's degree in computing or related field, the Master's Degree must be obtained through taught courses.
ii. Master's Degree in related field with FIVE (5) years relevant work experience. (The Programme should not employ more than 20% of the staff in this category).

Academic staff ratio

i. Full-time and Part-time teaching faculty – At least 60% full-time.

Supervisor-student ratio

i. Overall main supervisor-student ratio – 1:10 (by coursework and mixed mode).
ii. Overall main supervisor-student ratio – 1:7 (by research).
iii. Maximum number of postgraduate students per supervisor should not exceed 15.

DOCTORAL DEGREE

Academic staff / supervisor qualification

i. Doctoral Degree or equivalent in related field.
ii. For those Doctoral Degree holders with less than 2 years experience in teaching and research, a senior academic staff (with the experience of successfully graduating a postgraduate student) should co-supervise the student.

Academic staff ratio

i. Full-time and part-time teaching faculty – at least 60% of the staff are full-time.

Supervisor-student ratio

i. Overall main supervisor-student ratio – 1:7.
ii. The main supervisor must be a full-time staff of the conferring HEPs.
iii. Maximum number of postgraduate students per supervisor should not exceed 15.

8. EDUCATIONAL RESOURCES

"Adequate educational resources are necessary to support the teaching-learning activities of the Programme. These resources include finance, expertise, physical infrastructure, information and communication technology, and research facilities. The physical facilities of a programme are largely guided by the needs of the specific field of study" (COPPA, 2008, pp.23).

For Computing programmes, Higher Education Providers (HEPs) are required to provide sufficient resources conducive to support teaching and learning in the field. For lecture and tutorial rooms, and computer labs, sufficient space to accommodate student-centered learning must be provided. For research in Post-graduate programmes, candidates should be provided with a conducive work area.

CERTIFICATE and DIPLOMA

i. Computer Labs
ii. Tutorial Rooms
iii. Lecture Rooms (with sufficient Audio Visual facilities)
iv. Library (including on-line resources)
v. Internet Access
vi. Sufficient access to relevant software and hardware according to the needs of the programmes and students
vii. Computer Lab Demonstrator-Student ratio – 1:20

BACHELOR'S DEGREE

i. Computer Labs
ii. Research/Project Lab for final year students
iii. Specialised Lab according to programme needs
iv. Lecture Rooms (with sufficient Audio Visual facilities)
v. Tutorial Rooms
vi. Library (including on-line resources)
vii. Internet Access
viii. Sufficient access to relevant software and hardware according to the needs of the programmes and students
ix. Computer Lab Demonstrator-Student ratio – 1:20

MASTER'S and DOCTORAL DEGREES

i. Computer Labs
ii. Research/Project Lab
iii. Specialised Lab according to the Programme needs
iv. Lecture Rooms (with sufficient Audio Visual facilities)
v. Tutorial Rooms
vi. Working Space/Station
vii. Library (including on-line resources)
viii. Internet Access
ix. Relevant specialised software and hardware according to the needs of the programmes and students.

9. PROGRAMME MONITORING AND REVIEW

"Quality enhancement calls for programmes to be regularly monitored, reviewed and evaluated. This includes the monitoring, reviewing and evaluating of institutional structures and processes (administrative structure, leadership and governance, planning and review mechanisms), curriculum components (syllabi, teaching methodologies, learning outcomes) as well as student progress, employability and performance" (COPPA, 2008, pp.27).

Feedback from multiple sources such as students, alumni, academic staff, employers, professional bodies and parents must be obtained in order to assist in enhancing the quality of the programme. These feedback and the corresponding actions taken should be documented for auditing purposes.

In order to institutionalise the feedback mechanism, HEPs should establish at least the following committees;

i. Board of Studies
ii. Student representative committee
iii. Board of Examiners

Board of Studies

HEPs must provide a credible Board of Studies which meets at least once a year for the monitoring and reviewing of the Computing programmes. The Board of Studies should comprise computing professionals, industry representative, external academic evaluators, subject-matter experts, alumni and other relevant stakeholder.

One of the reports to be provided to Board of Studies concerns programme effectiveness that has been evaluated through various longitudinal studies of the graduates. The report should include perceptions of society and employers on the strengths and weaknesses of the graduates, graduate employability and benchmark against other HEPs.

Student Representative Committee

This committee comprises of students currently enrolled in the computing programmes. The committee members will meet with the HEPs administration at least once in a semester to provide feedback from the student perspective regarding the quality of the programmes and any other issues that impact their performance. Student feedback, for example, through questionnaires and representation in program committees, is keys for identifying specific problems and for continual improvement of the programme.

Board of Examiners

Board of examiners will meet at the end every semester to review student achievement and performance.

Feedback obtained from short term and long term analysis of student performance that is used to improve the quality of the programme. Measures of student performance would include the average study duration, assessment scores, passing rate at examinations, success and dropout rates, students' and alumni's report about their learning experience, as well as time spent by students in areas of special interest.

Evaluation of student performance in examinations can reveal very useful information. If student selection has been correctly done, a high failure rate in a programme indicates something amiss in the curriculum content, teaching-learning activities or assessment system. The programme committees need to monitor the performance rate in each programme and investigate if the rate is too high or too low.

HEPs are also advised to refer to Guidelines to Good Practices for Monitoring, Reviewing and Continually Improving Institutional Quality.

10. LEADERSHIP, GOVERNANCE AND ADMINISTRATION

"There are many ways of administering an Educational Institution and the methods of management differ between HEPs. Nevertheless, governance that reflects the leadership of an academic organisation must emphasise excellence and scholarship. At the departmental level, it is crucial that the leadership provides clear guidelines and direction, builds relationships amongst the different constituents based on collegiality and transparency, manages finances and other resources with accountability, forge partnership with significant stakeholders in educational delivery, research and consultancy and dedicates itself to academic and scholarly endeavours. Whilst formalised arrangements can protect these relationships, they are best developed by a culture of reciprocity, mutuality and open communication" (COPPA, 2008, pp.28).

Leadership

In this programme, academic leadership is largely focused on suitable qualified persons to carry out the necessary curriculum monitoring and review of computing programmes. The leaders of the programme should be a full time staff with relevant knowledge and reflects the attributes of good ethical values in work practices.

The leadership requirement of these programme standards is complementary to Area 8 in the COPPA document. Thus, the specific positions and the programme leadership positions (e.g., Coordinator, Head of Department, Head of Programme or Dean of faculty) offered at different levels in the institution must preferably fulfil the qualifications and experience as follows:

Diploma and Certificate

i. A Bachelor's Degree in Computing or related area with a minimum of FIVE (5) years relevant experience.

Bachelor's Degree and below

i. A Master's Degree with at least ONE (1) qualification in computing or related area.

Master's Degree and below

i. A Doctoral Degree, with at least ONE (1) qualification in computing or related area;

OR

ii. A Master's Degree with 10 years relevant experience, with at least ONE (1) qualification in computing or related area.

Doctoral Degree and below

i. A Doctoral Degree with THREE (3) years experience in related area, with at least ONE (1) qualification in computing or related area.

Governance

The HEPs must comply with the policies and practices of good governance according to applicable laws (e.g Private Higher Education Institutions Act 1996 (Act 555), circular). HEPs are encouraged to benchmark the programme in order to ensure comparability with computing programmes offered by international universities that have good standing.

For postgraduate programme in computing, the following items need special attention

- In order to ensure the quality of postgraduate programmes in computing, the HEPs should fulfil the Code of Practice for Institutional Audit (COPIA) requirements. The HEPs should also comply with MQA postgraduate standards. HEPs should implement monitoring and review policies to ensure postgraduate research students complete their studies within a reasonable time**.**
- Joint supervision should be encouraged with external supervisors locally and abroad.
- HEPs should establish mechanisms to ensure quality of research output, for example publication in books by reputable publishers, peer reviewed, international journals, policy recommendations, etc.

11. CONTINUAL QUALITY IMPROVEMENT

"Increasingly, society demands greater accountability from HEPs. Needs are constantly changing because of the advancements in science and technology, and the explosive growth in global knowledge, which are rapidly and widely disseminated. In facing these challenges, HEPs have little choice but to become dynamic learning organisations that need to continually and systematically review and monitor the various issues so as to meet the demands of the constantly changing environment" (COPPA, 2008, pp.30-31).

The Higher Education Providers (HEPs) are expected to provide evidence of ability to keep pace with changes in the field and requirements of stakeholders. These should be demonstrated by:

i. A comprehensive curriculum review should be conducted at least once every programme cycle. However, updating the curriculum to keep pace with the current developments should be conducted at a more regular interval.
ii. Continuous quality assessment processes by external reviewers who are qualified in the relevant fields.
iii. Continuous benchmarking against top universities at national and international level.

In addition HEPs are strongly encouraged to adopt the following practices, but not limited to;

i. linkages with industry;
ii. continuous review of industrial attachment practices and records;
iii. dialogue sessions with stakeholders;
iv. active participation of academic staff at relevant conferences, seminars, workshops and short courses;
v. presentations by invited speakers, local or international; and
vi. organisation of conferences, seminars and workshops.

HEPs are also advised to refer to Guidelines to Good Practices for Monitoring, Reviewing and Continually Improving Institutional Quality.

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Surat Makluman MQA Bil. 7/2014 – Garis Panduan Beban Staf Akademik, rujukan (MQA100-1/7/2(9)), dated 1st October 2014.

APPENDIX 1

LIST OF PANEL MEMBERS

NO.	NAME	ORGANISATION
1.	Prof. Datuk Dr. Shahrin bin Sahib@Sahibuddin -Chairperson- **Alternate Member:** Prof. Madya Dr. Mohd Khanapi bin Abd Ghani	Universiti Teknikal Malaysia Melaka (UTeM)
2.	Prof. Dr. Abdullah Mohd Zin -Co-Chairperson-	Universiti Kebangsaan Malaysia (UKM)
3.	Dr. Dzaharudin Mansor	Persatuan Industri Komputer dan Multimedia Malaysia (PIKOM)
4.	Dr. Simon Egerton	Monash University
5.	En. Tan Eng Hoo **Alternate Member:** En. Ang Kah Heng	Multimedia Development Corporation Sdn. Bhd. (MdeC)

APPENDIX 2

SKILLS COMPETENCY MATRIX (SCM)

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
.NET Programmer	• .Net Developer • Application Developer (.Net) • Application Engineer (.Net) • Software Engineer (.Net) • Software Programmer (.Net)	• Computer Science • Software Engineering
C/C++ Programmer	• C++ Developer • C++ Graphics Programmer • C++ Software Analyst • C/C++ Software Engineer	• Computer Science • Software Engineering
Cobol Programmer	• Cobol Developer • Microfocus COBOL Developer • PL/1 Developer (Cobol/DB2)	• Computer Science • Software Engineering
Computer Operator	• Computer Console Operator • Computer Technician • Systems Operator	• Computer Science • Software Engineering, • Information Technology • Information Systems
Contact Centre Agent (Inbound)	• Call Centre Agent (Customer Service) • Call Centre Officer • Call Centre Representative • Customer Care Coordinator • Customer Relationship Executive (Call Centre)	• Computer Science • Software Engineering • Information Technology • Information Systems

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
	• Customer Service Associate • Customer Service Executive (Contact Centre) • Customer Helpdesk Officer • Customer Service Officer • Customer Service Representative • International Customer Care Officer • Reservation Sales Executive • Customer Care Consultant	
Contact Centre Agent (Outbound)	• Contact Centre Personnel • Offshore Sales Executive • Outbound Contact Centre Consultant • Phone Consultant • Strategic Business Event Executive • Telesales Agent • Telesales Executive • Telesales Representative	• Computer Science • Software Engineering • Information Technology • Information Systems
Contact Centre Recovery Staff	N/A	• Computer Science • Software Engineering • Information Technology • Information Systems
Customer Support Engineer	• Customer Support Officer • Customer Support Representative • Product Engineer	• Computer Science • Software Engineering • Information Technology • Information Systems

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
	• Product Support Engineer • Product Support Officer • Customer Care Engineer	
Firmware Engineer	• Bios Engineer • Device Driver Engineer • Drivers Engineer • Embedded Software Engineer • Graphic Driver Engineer • Video Driver Engineer	• Computer Science • Software Engineering
Fraud Detector	• Transaction Monitoring Manager • Fraud Specialist	• Computer Science • Software Engineering • Information Technology • Information Systems
IT Marketing Executive	Marketing Manager	• Computer Science • Software Engineering • Information Technology • Information Systems
IT Project Coordinator	Project Administrator	• Computer Science • Software Engineering • Information Technology • Information Systems
IT Sales Engineer	• IT Sales Evangelist • Pre-sales engineer	• Computer Science • Software Engineering • Information Technology • Information Systems
Java Programmer	• J2EE Programmer • J2ME Programmer • Java Application Developer • Java Developer	• Computer Science • Software Engineering

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
	• Java EE Programmer	
JDE Consultant	• IT System Analyst (JDE) • JDE Application Specialist	• Computer Science • Software Engineering • Information Technology • Information Systems
Multimedia Programmer	• Multimedia Specialist • Media Producer • Multimedia Developer • Technical Artist	• Computer Science • Software Engineering • Information Technology • Information Systems
Network Engineer	• IT Network Systems Engineer • Network Analyst • Network Specialist • Systems Administrator	• Computer Science • Information Technology
Oracle Database Administrator	• Oracle Database Analyst • Oracle Database Engineer • Oracle Database Specialist	• Computer Science • Software Engineering • Information Systems
PHP Programmer	• PHP Developer • Web Programmer (PHP)	• Computer Science • Software Engineering
Product Characterization Engineer	N/A	Computer Science
RPG Programmer	• IT Executive (RPG) • RPG Business Analyst • RPG Software Developer • RPG Software Engineer • RPG System Analyst	• Computer Science • Software Engineering

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
Software Engineer	Software Development Engineer	• Computer Science • Software Engineering
Software QA Engineer	• QA Analyst • QA Executive • Quality Engineer • Product Assurance Engineer • Release Manager • Software Tester • Test Engineer	• Computer Science • Software Engineering
SQL Database Administrator	• SQL Database Analyst • SQL Database Engineer • SQL Database Specialist	• Computer Science • Software Engineering • Information Systems
Technical Helpdesk Analyst	• Access Administration Analyst • Contact Centre Executive • Contact Centre Service Desk Executive • Customer Care Consultant • Inbound Technical Support Representative • Technical Support (Contact Centre)	• Computer Science • Software Engineering • Information Technology • Information Systems
Technical Support Engineer	• Computer Support Engineer • IT Assistant • IT Support Executive • System Engineer • Technical Specialist	• Computer Science • Software Engineering • Information Technology • Information Systems
Test Development Engineer	N/A	• Computer Science • Software Engineering

Job Type	Alternative Job Titles	Discipline of Fresh Graduates
Web Designer	• Flash Animator • Flash Designer • Flash Developer • Interface Designer • Multimedia Designer • Multimedia Producer • Web Animator	• Computer Science • Software Engineering • Information Technology • Information Systems
Web Programmer	Web Developer	• Computer Science • Software Engineering • Information Technology • Information Systems
Webmaster	• Web Administrator • Web Content Manager	• Computer Science • Software Engineering • Information Technology • Information Systems

APPENDIX 3

BODY OF KNOWLEDGE

The breadth and depth of the required Computing (ICT) Body of Knowledge should reflect the different level of study from Certificate to Doctoral Degree level. Higher Education Providers (HEPs) are required to develop programmes to reflect current best practices. Institutions are advised to refer to the Association of Computing Machinery (ACM) website or other relevant Computing Curricula and Description.

CORES FOR COMPUTING

(A) CERTIFICATE

Body of Knowledge	Detail Topics
Computer Architecture	• Computer Systems • Data Representation and Manipulation • Registers • Memory Organization • Bus Configurations • Timing Issues and Pipelining • Assembly Language
Database	• Database Concepts • Normalization • Data Models • Database Management Systems • Introduction to SQL
Mathematics	• Number base systems • Control of accuracy • Formal Language • Set, Relation and Function • Counting Principle • Logic, truth tables • Boolean Algebra

Body of Knowledge	Detail Topics
	• Graphs and Trees
Network and Communication	• Data Communication and Transmission • Classifying Networks • LANs and WANs • Networking and Internetworking devices • Broadcasting Communications / Voice Over IP / Telecommunications • Network Protocols and Standards • Modulation and Multiplexing • Switching • Socket Programming
Operating Systems	• Hardware and Software • System Software and Architecture • Process Control Management • Deadlocks • Memory Management • I / O Management • File System Management • System Security • Network Operating System
Programming Fundamentals	• Problem Solving and Program Design • Programming Language concepts • Control Structures • Operators • Arrays • Functions/Methods • String Manipulation • Pointer expression/arithmetic • Development of Graphical User Interface

(B) DIPLOMA

Body of Knowledge	Detail Topics
Computer Architecture	• Computer Systems • Data Representation and Manipulation • Registers • Memory Organization • Bus Configurations • Timing Issues and Pipelining • Assembly Language
Database	• Database Concepts • Normalization • Data Models • Database Management Systems • Introduction to SQL • Database design
Discrete Mathematics	• Number base systems • Control of accuracy • Formal Language • Set, Relation and Function • Counting Principle • Logic, truth tables • Boolean Algebra • Graphs and Trees
Calculus and Algebra (Only for Computer Science and Software Engineering)	• Real number • Set, function and relation • Linear equation • Solving quadratic equation • Differentiation of simple functions • Integration of simple functions
Network and Communication	• Data Communication and Transmission • Classifying Networks • LANs and WANs

Body of Knowledge	Detail Topics
	• Networking and Internetworking devices • Broadcasting Communications/Voice Over IP/Telecommunications • Network Protocols and Standards • Modulation and Multiplexing • Switching • Socket Programming
Operating Systems	• Hardware and Software • System Software and Architecture • Process Control Management • Deadlocks • Memory Management • I/O Management • File System Management • System Security • Network Operating System
Programming Fundamentals	• Problem Solving and Program Design • Programming Language concepts • Control Structures • Operators • Arrays • Function /Methods • String Manipulation • Pointer expression/arithmetic • Development of Graphical User Interface
System Analysis and Design	• Fundamentals of SAD • Project Management • Overview of SDLC • Preliminary Investigation/Feasibility Study • Systems Analysis • Data Dictionary

Body of Knowledge	Detail Topics
	• Process Specification • Input / Output Design

(C) BACHELOR'S DEGREE

CORES FOR EACH OF THE FOUR (4) DISCIPLINES OF COMPUTING

a) Computer Science

The body of knowledge for the Computer Science discipline and corresponding detail topics are listed below. For more information, refer to "Computer Science 2013: Curriculum Guidelines for Undergraduate Programs in Computer Science".

Body of Knowledge	Detail Topics
Algorithms and Complexity	• Basic Analysis • Algorithmic Strategies • Fundamental Data Structures and Algorithms • Basic Automata, Computability and Complexity
Architecture and Organisation	• Digital Logic and Digital Systems • Machine Level Representation of Data • Assembly Level Machine Organization • Memory System Organization and Architecture • Interfacing and Communication
Computational Science	• Introduction to Modeling and Simulation
Discrete Structures	• Sets, Relations, and Functions • Basic Logic • Proof Techniques • Basics of Counting • Graphs and Trees • Discrete Probability
Graphics and Visualization	• Fundamental Concepts

Body of Knowledge	Detail Topics
Human-Computer Interaction	• Foundations • Designing Interaction
Information Assurance and Security	• Security Foundational Concepts in Security • Principles of Secure Design • Defensive Programming • Threats and Attacks • Network Security • Cryptography
Information Management	• Information Management Concepts • Database Systems • Data Modeling
Intelligent Systems	• Fundamental Issues • Basic Search Strategies • Basic Knowledge Representation and Reasoning • Basic Machine Learning
Networking and Communication	• Introduction • Networked Applications • Reliable Data Delivery • Routing And Forwarding • Local Area Networks • Resource Allocation • Mobility
Operating Systems	• Overview of Operating Systems • Operating System Principles • Concurrency • Scheduling and Dispatch • Memory Management • Security and Protection
Parallel and Distributed Computing	• Parallelism Fundamentals • Parallel Decomposition

Body of Knowledge	Detail Topics
	• Communication and Coordination • Parallel Algorithms, Analysis, and Programming • Parallel Architecture
Programming Languages	• Object-Oriented Programming • Functional Programming • Event-Driven and Reactive Programming • Basic Type Systems • Program Representation • Language Translation and Execution
Software Development Fundamentals	• Algorithms and Design • Fundamental Programming Concepts • Fundamental Data Structures • Development Methods
Software Engineering Methods	• Software Processes • Software Project Management • Tools and Environments • Requirements Engineering • Software Design • Software Construction • Software Verification and Validation • Software Evolution • Software Reliability
Systems Fundamentals	• Computational Paradigms • Cross-Layer Communications • State and State Machines • Parallelism • Evaluation • Resource Allocation and Scheduling • Proximity • Virtualization and Isolation • Reliability through Redundancy

Body of Knowledge	Detail Topics
Social Issues and Professional Practice	• Social Context • Analytical Tools • Professional Ethics • Intellectual Property • Privacy and Civil Liberties • Professional Communication • Sustainability

b) Software Engineering

The body of knowledge for the Software Engineering discipline and corresponding detail topics are listed below. For more information, refer to "SE 2004: Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering".

Body of Knowledge	Detail Topics
Algorithms and Complexity	• Basic Analysis • Algorithmic Strategies • Fundamental Data Structures and Algorithms • Basic Automata, Computability and Complexity
Architecture and Organisation	• Digital Logic and Digital Systems • Machine Level Representation of Data • Assembly Level Machine Organization • Memory System Organization and Architecture • Interfacing and Communication
Programming Languages	• Object-Oriented Programming • Functional Programming • Event-Driven and Reactive Programming • Basic Type Systems • Program Representation

Body of Knowledge	Detail Topics
	• Language Translation and Execution
Software Development Fundamentals	• Algorithms and Design • Fundamental Programming Concepts • Fundamental Data Structures • Development Methods
Information Assurance and Security	• Foundational Concepts in Security • Principles of Secure Design • Defensive Programming • Threats and Attacks • Network Security • Cryptography
Information Management	• Information Management Concepts • Database Systems • Data Modeling
Networking and Communication	• Introduction • Networked Applications • Reliable Data Delivery • Routing And Forwarding • Local Area Networks • Resource Allocation • Mobility
Operating Systems	• Overview of Operating Systems • Operating System Principles • Concurrency • Scheduling and Dispatch • Memory Management • Security and Protection
Construction Technologies and Methods	• API design and use • Code reuse and libraries • Object-oriented run-time issues • Parameterization and generics • Assertions, design by contract, defensive

Body of Knowledge	Detail Topics
	programming • Error handling, exception handling, and fault tolerance • State-based and table driven construction techniques • Run-time configuration and internationalization • Grammar-based input processing • Concurrency primitives • Middleware • Construction methods for distributed software • Constructing heterogeneous (hardware and software) systems • Performance analysis and tuning • Development environments • GUI builders • Unit testing tools • Application oriented languages • Application of abstract machines • Application of specification languages and methods • Automatic generation of code from a specification • Program derivation • Analysis of candidate implementations • Mapping of a specification to different implementations • Refinement
Mathematical Foundations	• Functions, Relations and Sets • Basic Logic • Proof Techniques

Body of Knowledge	Detail Topics
	• Basic Counting • Graphs and Trees • Discrete Probability • Finite State Machines, regular expressions • Grammars • Numerical precision, accuracy and errors
Engineering foundations and economics for software	• Empirical methods and experimental techniques • Statistical analysis • Measurement and metrics • Systems development • Engineering design • Theory of measurement • Value considerations throughout the software lifecycle • Generating system objectives • Evaluating cost-effective solutions • Realizing system value
Professional Practice	• Group dynamics / psychology • Communications skills (specific to SE) • Professionalism
Software Modelling and Analysis	• Modelling foundations • Types of models • Analysis fundamentals • Requirements fundamentals • Eliciting requirements • Requirements specification and documentation • Requirements validation
Software Design	• Design concepts • Design strategies • Architectural design

Body of Knowledge	Detail Topics
	• Human computer interface design • Detailed design • Design support tools and evaluation
Software Verification and Validation	• V&V terminology and foundations • Reviews • Testing • Human computer UI testing and evaluation • Problem analysis and reporting
Software Evolution	• Evolution processes • Evolution activities
Software Process	• Process concepts • Process implementation
Software Quality	• Software quality concepts and culture • Software quality standards • Software quality processes • Process assurance • Product assurance
Software Management	• Management concepts • Project planning • Project personnel and organization • Project control • Software configuration management

c) Information Technology

The body of knowledge for the Information Technology discipline and corresponding detail topics are listed below. For more information, refer to "IT 2008: The Computing Curricula Information Technology Volume".

Body of Knowledge	Detail Topics
Information Technology Fundamentals	• Pervasive Themes in IT • History of Information Technology

Body of Knowledge	Detail Topics
	• IT and Its Related and Informing Disciplines • Application Domains
Human Computer Interaction	• Human Factors • HCI Aspects of Application Domains • Human-Centred Evaluation • Developing Effective Interfaces • Accessibility • Emerging Technologies • Human-Centred Software Development
Information Assurance and Security	• Fundamental Aspects • Security Mechanisms (Countermeasures) • Operational Issues • Policy • Attacks • Security Domains • Forensics • Information States • Security Services • Threat Analysis Model • Vulnerabilities
Integrative Programming and Technologies	• Inter-systems Communications • Data Mapping and Exchange • Integrative Coding • Scripting Techniques • Software Security Practices • Miscellaneous Issues • Overview of Programming Languages
System Administration and Maintenance	• Operating Systems • Applications • Administrative Activities • Administrative Domains
System Integration and	• Requirements

Body of Knowledge	Detail Topics
Architecture	• Acquisition and Sourcing • Integration and Deployment • Project Management • Testing and Quality Assurance • Organizational Context • Architecture
Social and Professional Issues	• Professional Communications • Teamwork Concepts and Issues • Social Context of Computing • Intellectual Property • Legal Issues in Computing • Organizational Context • Professional and Ethical Issues and Responsibilities • History of Computing • Privacy and Civil Liberties
Web Systems and Technologies	• Web Technologies • Information Architecture • Digital Media • Web Development • Vulnerabilities
Information Management	• IM Concepts and Fundamentals • Database Query Languages • Data Organization Architecture • Data Modeling • Managing the Database Environment • Special-Purpose Databases
Math and Statistics for IT	• Basic Logic • Discrete Probability • Functions, Relations and Sets • Hypothesis Testing

Body of Knowledge	Detail Topics
	• Sampling and Descriptive Statistics • Graphs and Trees • Application of Math & Statistics to IT
Networking	• Foundations of Networking • Routing and Switching • Physical Layer • Security • Network Management • Application Areas
Programming Fundamentals	• Fundamental Data Structures • Fundamental Programming Constructs • Object-Oriented Programming • Algorithms and Problem-Solving • Event-Driven Programming
Platform Technologies	• Operating Systems • Architecture and Organization • Computing Infrastructures

d) Information Systems

The body of knowledge for the Information Technology discipline and corresponding detail topics are listed below. For more information, refer to "IS 2010: The Curriculum Guidelines for Undergraduate Degree Programs in Information Systems".

Body of Knowledge	Detail Topics
Foundations of Information Systems	• Characteristics of the Digital World • Information systems components • Information systems in organizations • Globalization • Valuing information systems • Information systems infrastructure • The Internet and WWW

Body of Knowledge	Detail Topics
	• Security of information systems • Business intelligence • Enterprise-wide information systems • Development and acquisition • Information systems ethics and crime
Data and Information Management	• Database approach • Types of database management systems • Basic file processing concepts • Physical data storage concepts • File organizations techniques • Conceptual data model • Logical data model • Physical data model • Database languages • Data and database administration • Transaction processing • Using a database management system from an application development environment • Use of database management systems in an enterprise system context • Data / information architecture • Data security management • Data quality management • Business intelligence
Enterprise Architecture	• Service oriented architecture • Enterprise architecture frameworks • Systems integration • Enterprise resource software • Monitoring and metrics for infrastructure and business processes • Green computing

Body of Knowledge	Detail Topics
	• Virtualization of storage and systems • The role of open source software • Risk management • Business continuity • Total cost of ownership and return on investment • Software as a service • Enterprise data models • Data / information architecture and data integration • Content management • Audit and compliance • System administration • IT control and management frameworks • Emerging technologies
IS Project Management	• Introduction to Project Management • The Project Management Lifecycle • Managing Project Teams • Managing Project Communication • Project Initiation and Planning • Managing Project Scope • Managing Project Scheduling • Managing Project Resources • Managing Project Quality • Managing Project Risk • Managing Project Procurement • Project Execution, Control & Closure • Managing Project Control & Closure
IT Infrastructure	• Core computing system architecture concepts • Core computing system organizing structures • Core technical components of computer-based systems

Body of Knowledge	Detail Topics
	• Role of IT infrastructure in a modern organization • Operating systems • Networking • Organizing storage on organizational networks • Data centers • Securing IT infrastructure • The role of IT control and service management frameworks (COBIT, ITIL, etc.) in managing the organizational IT infrastructure • Ensuring business continuity • Grid computing • Cloud computing, computing as a service • System performance analysis and management • Purchasing of IT infrastructure technologies and services
Systems Analysis and Design	• Identification of opportunities for IT-enabled organizational change • Business process management • Analysis of business requirements • Structuring of IT-based opportunities into projects • Project specification • Project prioritization • Analysis of project feasibility • Fundamentals of IS project management in the global context • Using globally distributed communication and collaboration platforms • Analysis and specification of system

Body of Knowledge	Detail Topics
	requirements • Different approaches to implementing information systems to support business requirements • Specifying implementation alternatives for a specific system • Impact of implementation alternatives on system requirements specification • Methods for comparing systems implementation approaches • Organizational implementation of a new information system • Different approaches to systems analysis & design: structured SDLC, unified process/UML, agile methods
IS Strategy, Management and Acquisition	• The IS function • IS strategic alignment • Strategic use of information • Impact of IS on organizational structure and processes • IS economics • IS planning • Role of IS in defining and shaping competition • Managing the information systems function • Financing and evaluating the performance of information technology investments and operations • Acquiring information technology resources and capabilities • Using IS/IT governance frameworks • IS risk management

APPENDIX 4

Glossary

1.	MPU Module	Module that is taken to fulfil national requirements as defined by the government.
2.	Computing	Computing is concerned with the understanding, design, implementation and exploitation of computation and computer, and communication technology.
3.	Core Modules	Modules that are deemed common to a specific discipline of Computing as defined by this Programme Standards.
4.	Concentration/Specialisation	Modules taken to fulfill the requirements within an identified specialisation within a specific discipline of Computing
5.	Formative Assessment	A process of monitoring the achievement of the learning outcomes of students at a periodic time. This is also referred to as continuous assessment.
6.	Summative Assessment	A process of evaluating and grading the learning of students at the end of a module. This is also referred to as final assessment. This assessment can be in the form of written examination, oral examination, skill assessment or presentation.
7.	Graduate	A student who has successfully completed any level of qualification within this Programme Standards.

8.	Fresh Graduate	Fresh Graduate is defined as a graduate that has less than one year working experience in the related fields.
9.	Industrial Attachment/ Industrial Training/Internship	A period of time within the programme where students are required to be placed in the industry to gain industrial experience and enhance soft skills.
10.	Internationally Refereed Publications	Peer reviewed publications of international standing either as conference proceedings or in journals.
11.	Module	A unit of learning and teaching also described, as subject or course or unit in a programme.
12.	Programme	A structured and sequenced set of modules leading to an academic award/qualification.
13.	Field Elective Module	A module which is selected by a student from a group of identified computing modules which form part of the Minimum Graduating Credits for the programme.
14.	Free Elective Module	A module which is selected by a student from inside or outside the computing field.
15.	Related field	A field of study in Science and Technology or related to computing.