SUBJECT BENCHMARK STATEMENT

IN

INFORMATION TECHNOLOGY

Quality Assurance and Accreditation Council
University Grants Commission
Sri Lanka

December 2010

CONTENT

		Page No
Foreword		III
1	Introduction	1
	1.1 Subject Benchmark Statement – Scope and Purposes	1
	1.2 Level of Teaching	2
	1.3 Importance of the Field	2
	1.4 Scope of Employment of Graduates	3
2	Subject Aims	3
3	Subject Knowledge and Understanding	4
4	Skills and Attitudes	6
	4.1 Skills	6
	4.2 Attitudes	6
5	Teaching and Learning Strategies	6
6	Assessment Strategies	7
7	Maintaining Standards	7
8	Level of Achievements	8
9	References	14
10	Annexes	15

FOREWORD

The work in connection with the development of Subject Benchmark Statements was begun in August 2003 as a part of the overall quality assurance framework that supports academic standards and the furtherance and dissemination of good practice in Universities in Sri Lanka.

Subject Benchmark Statements will support and promote quality and standards by:

- Providing universities with a common and explicit reference point for internal and external programme approval and review;

- Guiding and promoting curriculum development, especially in new departments and new universities, and in other institutions of higher education;

- Evolving over time to take account of changes and innovations that reflect subject development and new expectations;

- Providing an authoritative and widely recognized statement of expectations of what is expected of a graduate in a specific (or designated) subject area in a form readily accessible to students, employers and others with a stake in higher education;

- Providing a clear and transparent reference point for External Examiners;

- Assisting international comparison and competitiveness of higher education awards and student achievement.

SUBJECT BENCHMARK STATEMENT
INFORMATION TECHNOLOGY

1. INTRODUCTION

1.1. Subject Benchmark Statement – Scope and Purpose

Subject Benchmarking (SB) is an essential component of quality assurance in the university system. This Subject Benchmark Statement in Information Technology (SBS-IT) provides general guidelines and an academic reference point for the three-year and four-year Bachelor's degree programmes in Information Technology (B.Sc. in Information Technology) offered by universities in Sri Lanka.
It stipulates the,

a) nature and characteristics of Bachelor's degree programmes in Information Technology (IT),
b) desired attributes and capabilities the graduates in Information Technology are expected to possess and be able to demonstrate, and
c) expected specific standards for the award of a three-year and four-year Bachelor's degrees in Information Technology at threshold level, typical level and excellent level.

It is expected that this SBS-IT would be used as an external point of reference and a broad framework for the B.Sc. Information Technology degree to enable:

a) national universities to design new Bachelor's degree programmes in IT by introducing innovative approaches for the delivery of the curriculum;
b) internal academic reviewers to evaluate and validate Bachelor's degree programmes in IT offered by their respective universities, and to ensure maintenance of their high academic standards and quality;
c) external academic reviewers to compare and verify standards of the different Bachelor's degree programmes in IT offered by universities;
d) professional bodies to review the processes and content of the Bachelor's degree programmes in IT offered by universities for the purpose of accreditation;
e) interested stakeholders, especially prospective students and employers to obtain information on the nature and content of Bachelor's degree programmes in IT.

The SBS-IT is not intended to be used as a prescription on the time allocated for teaching different subtopics or the order in which the sub topics should be taught. It is neither a syllabus nor a crude checklist of regulatory criteria for individual Bachelors degree programmes in IT, but intended to be used as a valid framework of reference in conjunction with the relevant programme specifications and internal evaluation documentation to arrive at a reasonable judgment as to its suitability based on a broad range of evidence.

The document is the first attempt to provide general academic standards for three-year or four-year Bachelor's degree programmes in IT, which are credit based and modular in structure comprising a minimum of 90 or 120 Carnegie credits, and conducted over six or eight semesters in the Sri Lankan universities, respectively. It has been prepared on the authority of the University Grants Commission (UGC) as an activity of the Quality Assurance and Accreditation Council (QAAC) by a team

of nominated senior academics representing all faculties of IT in the country, and acting on behalf of the subject community.

The educational institutions may reproduce the Benchmark Statement in IT for academic purposes. Extracts from this could be used or quoted in studies and research, but with due acknowledgment.

1.2 Level of Teaching

In Sri Lanka there are two main categories of IT degrees. They are, four-year special degree programs and three-year general degree programs. In addition to these main categories, there are three year external IT degree programs. In some of these degree programs, in addition to IT related subjects, certain subjects related to other computing disciplines are offered.

In addition to IT degree programs mentioned above, in some other Sri Lankan degree programs such as physical science programs, IT related subjects are offered.

1.3 Nature and Extent

The term Information Technology (IT) has two meanings. In the broadest sense, it is used to refer to all of computing. In academia, it refers to degree programs that prepare students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations [1].

IT is one of the disciplines that come under the broader discipline called Computing [1]. We can define computing to mean any goal-oriented activity requiring, benefiting from, or creating computers. It is a very broad discipline including areas like building hardware and software systems; information management and processing; doing scientific studies using computers; communication and multimedia, etc. Due to this wide scope of the discipline, today, computing is not considered as a single discipline, but a family of disciplines. Within this family, five major computing disciplines can be identified. They are, *Computer Engineering*, *Computer Science*, *Information Systems*, *Information Technology*, and *Software Engineering*. This subject benchmark document focuses on the Information Technology discipline.

Computer Engineering is concerned with the design and construction of computers and computer-based systems. It involves the study of hardware, software, communications, and the interaction among them. *Computer Science* spans a wide range. The main areas of computer science are, designing and implement software, devising new ways to use computers, and devising effective ways to solve computing problems. *Information Systems* specialists focus on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective and efficient way. *Software Engineering* is the discipline of developing and maintaining software systems that behave reliably and efficiently, are affordable to develop and maintain, and satisfy all the requirements that customers have defined for them.

Information Technology addresses the practical, everyday technical needs of business and other organizations, which use computers and information systems. Main emphasis of IT is on technology rather than information. For smooth and uninterrupted operations, modern organizations need to have appropriate systems in place. These systems must work properly, be secure, and upgraded, maintained, and replaced as appropriate. Employees throughout an organization require support from IT staff that understand computer systems and their software and are committed to solving computer-related problems they might have. Graduates of information technology programs address these needs.

Education systems in the disciplines such as engineering, medicine, law, and accountancy have more than 200 years of history. Therefore, primary and secondary education systems contain all the required elements which inculcate attributes so required to follow tertiary education programmes conducted by TEIs in those areas. IT as a discipline emerged in the last three decades after the invention of personal computers and the Internet. Elements that should be in the primary and secondary education system are still emerging. Therefore, required attributes in the intake have to be correctly identified before enrolling students to the IT professional programmes such as diploma, advanced diploma, and degree programmes since the current primary and secondary education system does not inculcate attributes so required to follow the IT degree programmes.

1.4 Scope of Employment of Graduates

IT graduates join industry as entry level professionals in the fields of software engineering and programming, technical support, testing and quality assurance, systems and network administration, database administration and development, business analysis and systems integration, and technology marketing [2].

Graduates who study at either General or Special degree level, can enter the employment market in various sectors. Main employment sectors include:

- State and private, secondary and tertiary level institutes of education;
- State and private, organizations which use computers and information systems;
- State and private, organizations which provide ICT solutions to public and private sector;
- Self-employment (Entrepreneurs/IT service providers).

2. SUBJECT AIMS

The main aims of a degree programme in Information Technology are:

- to develop confidence to use latest concepts to design and develop IT solutions for a organization/individual;
- to develop lone learning aptitude to acquire new knowledge required for an assignment which associated with novel concepts;
- to admire intellectual works of others and to abide by industry norms and ethics stipulated by professional bodies;
- to communicate effectively and efficiently with clients and with peers both verbally and in writing;
- to collaborate in groups to achieve common goals;

- to satisfy the academic criteria required for the membership of professional institutions.

3. SUBJECT KNOWLEDGE AND UNDERSTANDING

Information Technology is an integrative discipline. It combines together the IT knowledge areas of databases, human-computer interaction, networking, programming, and web systems. Solid backgrounds in each of these areas enable graduates to solve all types of computing and informational problems, regardless of their origin.

The computing discipline has expanded to such an extent that it is impossible for undergraduates to learn every topic that has at one time been considered fundamental to any particular computing discipline. However, a core consists of all essential areas that must be included in any IT undergraduate degree program can be identified. Core areas in a degree programme can be given as:

- IT fundamentals: This introduces academic discipline of IT. Pervasive IT themes; IT history; Organizational issues; Relationship of IT to other computing disciplines;
- Programming fundamentals: Introduction to the basics of programming, including data structures, programming constructs, object oriented programming, algorithms and problem solving, event driven programming, and recursion;
- Computer fundamentals: Principles of computer hardware and low-level software, including logic circuits (combinatorial and sequential), assembly language, I/O, storage, & program execution;
- Operating systems: Basics of computer operating systems including configuration, file systems, security, administration, interfacing, multitasking, performance analysis;
- IT systems: Introduction to the basic components of IT systems including networking, web systems, databases, scripting, system administration and maintenance, and system integration;
- Web systems: Introduction to web technologies and systems; including hypertext, self-descriptive text, web page design, web navigational systems and digital media;
- Networking: Builds a deeper understanding of how networks work; including the topics of LANs, WANs, service providers, packets, hubs, routers, switches, Internet protocols;
- Databases: Builds a deeper understanding of how databases work; including the topics of database theory and architecture, data modeling, normalization, query languages, security, and web applications;
- Human-computer interaction: Introduction to the basic concepts of human-computer interaction, including human factors, performance analysis, cognitive processing, usability studies, environment, and training;
- Professional communication: Introduction to written and oral technical and professional communication, including proposals, reports, presentations, formal papers;
- Information assurance and security: Introduction to the concepts of data security, including policies, attacks, vulnerabilities, encryption, information states, and forensics;
- Professional ethics: Covers all the areas of ethics in the computing profession.

In addition to above key areas, a successful IT graduate needs many skills in the following areas. Therefore, it is recommended to have modules covering these areas as well.

Mathematics
Scientific method
Familiarity with application domains
Communication skills

In the case of a 4 year special degree in IT, in addition to above mentioned areas, advanced modules from following areas (not limited to) may be included.

Human-computer interaction: Human-centered design and evaluation, graphical user interfaces, multimedia systems development, interactive systems development, computer-supported cooperative work, human cognitive skills;

Information assurance and security: Cryptography, forensics and incident response, biometrics, security policies and procedures;

Information management: Advanced databases, database design, transaction processing, distributed and object-oriented databases, data mining, data warehousing, multimedia information systems, digital libraries;

Integrative programming and technologies (IPG): Fundamentals of n-Tier architectures, implementing n-Tier architectures;

Networking: Advanced computer networks, distributed systems, wireless and mobile computing, cluster computing, data compression, network security, enterprise networking, digital communications;

Programming: Object-oriented programming, event-driven programming, functional programming, logic programming;

Platform technologies: Advanced computer architecture; parallel architectures, VLSI development and technologies, advanced computing techniques;

System administration and maintenance: Network management, technical support, database administration;

System integration and architecture: Software acquisition and implementation, system needs assessment, software economics, enterprise systems, knowledge management, computing economics;

Social and professional issues: Professional practice, social context of computing, computers and ethics, IT and economic development, computer law, intellectual property, privacy and civil liberties;

Web systems and technologies: Programming for the WWW, e-commerce, data-driven websites, web software tools;

In addition to above knowledge areas, both 3-year and 4-year degrees must include project work.

In the case of a 3-year degree, there must be a third year project including teamwork, professional communications (reports and presentations), design, implementation, and testing.

In the case of a 4-year special degree, there must be a fourth year project including project proposal, feasibility studies, teamwork, budgets, project management, professional communication (reports and presentations), design, implementation, and testing.

4. SKILLS AND ATTITUDES

4.1. Skills

The degree programme in Information Technology should attempt to develop generic skills as well as subject specific skills in a graduate.

4.1.1. Generic Skills

The generic skills should include the following:

- Ability to extract information from appropriate sources such as Internet, digital libraries, forums, wikis;
- Ability to critically evaluate the information gathered and relate them to appropriate situations;
- Creative thinking skills;
- Critical thinking and problem solving skills;
- Interpersonal and teamwork skills;
- Communication skills and proficiency in English language;
- Lone learning aptitude.

4.1.2. Subject Specific Skills

The subject specific skills should include the following:

- Business analysis and process engineering skills
- Systems analysis and design skills
- Programming skills
- Hardware/software acquisition, implementation and maintenance/troubleshooting skills
- Network design and implementation skills
- Database design and administration skills
- Internet and systems security skills
- Project, people, and change management skills

4.2. Attitudes

Curricular activities can be complemented with required content to inculcate following attitudinal aspects in graduates such as:

- Ethical use of software and work done by third parties
- Honesty and integrity
- Teamwork and cooperativeness
- Punctuality and commitment to work
- Adaptability to diverse social, cultural and work situations
- Social responsiveness

5. TEACHING AND LEARNING STRATEGIES

IT professionals are primarily entrusted with the integration of different technologies, and the integration of the technology into organizations. This requires a familiarity with the technology that goes beyond the purely theoretical. IT undergraduate programs must therefore be designed in a way that allows graduates to develop a practical understanding of the technology. At the same time, they must have a thorough understanding of the underline theoretical concepts.

Students are unlikely to acquire the practical knowledge expected from an IT undergraduate degree without a significant *experiential learning* component in their program of study. Experiential learning should therefore permeate the IT curriculum. There are, of course, different ways of providing experiential learning, including but not limited to:

- Instructor demonstrations,
- Structured and unstructured labs,
- Relevant field trips,
- Multi-stage individual and group projects,
- Interviews with IT professionals and/or job shadowing,
- Design, implementation, and documentation projects,
- Preparation and presentation of a technical report,
- Group work to develop team-working.

IT is a knowledge domain which evolves in an exponential rate. This pose a huge pedagogical challenge to cope up with the rapid evolution of the subject domain. Group and individual assignments can be included in all levels to develop lone learning aptitude.

6. ASSESSMENT STRATEGIES

Knowledge, understanding and skills are assessed according to the expected learning outcome of a module. There are various assessment methods available and instructors should choose assessment methods appropriate for their course. It may consist of a combination of written examinations, assignments, presentations, quizzes, etc. Instructors are free to use different methods taking into account student's educational background and experience.

7. MAINTAINING STANDARDS

Quality assurance of curricula, teaching and learning methodology and relevant procedures should be ensured through mechanisms such as:

- Departmental reviews
- Peer evaluations
- Student evaluations
- Tracer studies

Quality assurance of assessments must be ensured trough mechanisms such as:

- Moderation of question papers

- Second marking of answer scripts
- Assessment by external examiners

8. LEVEL OF ACHIEVEMENTS

The objective of any assessment should be to evaluate students against expected skill sets listed below:

Three-year Degree Programme

Threshold Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT and application of them in the context of well-defined scenarios
- Knowledge of computing and mathematics appropriate to the discipline
- Ability to recognize the problem, and identify the computing requirements needed to its solution
- Understand concepts related to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs
- Identify the user needs and take them into consideration in the selection, creation, evaluation of computer based systems
- Knows current techniques, skills and tools necessary for IT practice
- Communicates meaningfully with peers and clients
- Understand different roles played by team members to accomplish a common goal
- Recognize the importance of ethical, legal, security and social issues and responsibilities
- Understand the need of continuing professional development

Typical Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT in an appropriate manner in the context of loosely defined scenarios
- Apply knowledge of computing and mathematics appropriate to the discipline
- Ability to analyze the problem, and identify and define the computing requirements appropriate to its solution
- Ability to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs
- Identify and analyze the user needs and taken them into consideration in the selection, creation, evaluation of computer based systems
- Able to use current techniques, skills and tools necessary for IT practice
- Communicates effectively with peers and clients
- Ability to function in teams to accomplish a common goal
- Understand professional, ethical, legal, security and social issue and responsibilities
- Recognize the need for continuing professional development

Excellent Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT in an innovative and creative manner in the context of loosely defined scenarios
- Apply knowledge of computing and mathematics appropriate to the discipline

- Critically analyze a problem, and identify and define the computing requirements best suits to its solution
- Ability to design, implement, critically evaluate and review a computer based system, process, component, or program to meet desired needs
- Identify and analyze the user needs and taken them into consideration in the selection, creation, evaluation of computer based systems
- Able to use current techniques, skills and tools necessary for IT practice
- Communicates effectively with a range of audiences
- Ability to function effectively in teams to accomplish a common goal and work with minimum guidance
- Know professional, ethical, legal, security and social issue and responsibilities
- Able to engage in continuing professional development
- Use and apply current technical concepts and practices in the core information technologies;
- Analyze, identify and define the requirements that must be satisfied to address problems or opportunities faced by organizations or individuals;
- Design effective and usable IT-based solutions and integrate them into the user environment;
- Assist in the creation of an effective project plan;
- Identify and evaluate current and emerging technologies and assess their applicability to address the users' needs;
- Analyze the impact of technology on individuals, organizations and society, including ethical, legal and policy issues;
- Demonstrate an understanding of best practices and standards and their application;
- Demonstrate independent critical thinking and problem solving skills;
- Collaborate in teams to accomplish a common goal by integrating personal initiative and group cooperation;
- Communicate effectively and efficiently with clients, users and peers both verbally and in writing, using appropriate terminology;
- Recognize the need for continued learning throughout their career.

Four-year Degree Programme

Threshold Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT and application of them in the context of loosely-defined scenarios
- Knowledge of computing and mathematics appropriate to the discipline
- Ability to recognize the problem, and identify the computing requirements needed to its solution
- Understand concepts related to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs
- Identify the user needs and take them into consideration in the selection, creation, evaluation of computer based systems
- Knows current techniques, skills and tools necessary for IT practice
- Communicates meaningfully with peers and clients
- Recognize the importance of ethical, legal, security and social issues and responsibilities
- Knows to integrate IT-based solutions into the user environment

- Understand best practices and standards and their applications
- Understand different phases of an IT project and know the documentation required
- Contribute to teamwork and reflect on team performance
- Demonstrate reasonable time management, lifelong learning and independent study skills

Typical Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT in an appropriate manner in the context of loosely defined scenarios
- Apply knowledge of computing and mathematics appropriate to the discipline
- Ability to analyze the problem, and identify and define the computing requirements appropriate to its solution
- Ability to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs
- Identify and analyze the user needs and taken them into consideration in the selection, creation, evaluation of computer based systems
- Able to use current techniques, skills and tools necessary for IT practice
- Communicates effectively with peers and clients
- Understand professional, ethical, legal, security and social issue and responsibilities
- Able to effectively integrate IT-based solutions into the user environment
- Know to effectively apply best practices and standards
- Know to engage in different phases of an IT project and able to produce documentation required
- Identify realistic goals, organize and contribute to teamwork and reflect on team performance
- Demonstrate satisfactory time management, lifelong learning and independent study skills

Excellent Level

- Ability to apply essential concepts, principles of key areas of the discipline of IT in an innovative and creative manner in the context of loosely defined scenarios
- Apply knowledge of computing and mathematics appropriate to the discipline
- Critically analyze a problem, and identify and define the computing requirements best suits to its solution
- Ability to design, implement, critically evaluate and review a computer based system, process, component, or program to meet desired needs
- Identify and analyze the user needs and taken them into consideration in the selection, creation, evaluation of computer based systems
- Able to use current techniques, skills and tools necessary for IT practice
- Communicates effectively with a range of audiences using appropriate technology
- Know professional, ethical, legal, security and social issue and responsibilities
- Able to effectively integrate and evaluate IT-based solutions into the user environment
- Know to effectively apply best practices and standards
- Know to effectively engage in different phases of an IT project and able to produce documentation required
- identify realistic goals, convince and motivate others, organize, lead and contribute to teamwork and reflect on team performance

- Demonstrate efficient time management, lifelong learning and independent study skills

9. REFERNCES

[1] Computing Curricula 2005: The Overview Report, compiled by the joint task force for computing curricula 2005, a cooperative project of the Association of Computing Machinery, the Association for Information Systems, and the Computer Society (IEEE-CS)

[2] “Rising Demand”, Sri Lanka Information and Communication Technology Association, April 2007

[3] Subject Benchmark Statement in Agriculture, Quality Assurance and Accreditation Council, University Grants Commission, Sri Lanka, January 2010

10. ANNEX1. MEMBERS OF THE BENCHMARK GROUP

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