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Ministry of Higher Education & Scientific Research

Council for Accreditation & Quality Assurance

National Academic Reference Standards (NARS)

Undergraduate Computing Programs

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Contents

PREFACE

The Council for Accreditation and Quality Assurance in Higher Education (CAQAY) is pleased to introduce this document that contains the National Academic Reference Standards for Computing. In the light of its mission and general policy for developing National Academic Reference Standards (NARS) for higher education, the Council intends to present this document with a view to provide higher education institutions with reference points in the design, delivery and review of their academic programs. It also aims at providing these institutions with a general guidance for articulating the graduate attributes and intended learning outcomes associated with the programs. By these National Academic Reference Standards stated in this document, the Council hopes to solve the problems that higher education institutions face during the process of programs' review or development by bridging the gap that usually arises as a result of the general absence of national academic reference standards. Hence, there is a genuine need for National Academic Reference Standards for computing programs.

The graduate attributes presented in this document and the learning outcomes derived from them as well as teaching and assessment methods provide faculties of computing deans, department chairs and faculty members with a frame of reference for reviewing their curriculum. The Council is confident that if the design, content, and implementation of faculties of computing curricula are guided by the set of graduate attributes and learning outcomes presented in this document, the computing education students will be well prepared to assume their expected professional duties as high-quality specialized graduates.

The Council recognizes that faculties of computing have to respond to unprecedented changes in the methods of computing education. We hope that faculties of computing will respond to the intent of this document with some sense of urgency. Faculties of computing should consider establishing formal processes for using those attributes and learning outcomes to guide reviews of their curricula and program specifications. This should also be accompanied by gradual but significant changes in the way faculties of computing teach and assess their students. This aspect of computing education needs a close focus from the deans and department chairs in order to make sound improvements in computing education in our country.

Prof. Abdullateef Haidar,

CAQAY Chairperson

Sana'a, 6 May 2018

NATIONAL ACADEMIC REFERENCE STANDARDS (NARS)

National Academic Reference Standards (NARS) are the expected minimum requirements of knowledge, competencies and skills necessary to fulfill the requirements of an academic degree.

NARS aim at providing a minimum level of reference that guides the academic community to prepare academic program specifications in a particular field or specialization. It also represents the overall expectation of academic qualifications, abilities and qualities that graduates should acquire when completing a study program.

NARS represent a threshold of standards that encourage higher levels of achievement and therefore entail educational institutions to distinguish themselves in their educational performance by developing their own Academic Reference Standards (ARS). On the other hand, ARS for educational institutions represent a higher level of requirements that educational institutions must achieve through their academic programs to ensure that their graduates are able to carry out professional or career practices successfully.

It must be pointed out here that NARS do not intend to provide a unified national curriculum for academic programs, nor do they seek to provide a list of contents for academic programs. Hence, the authors of NARS documents avoided such tasks, as they are core tasks of higher education institutions. Higher education institutions should refer to NARS documents to prepare their program specification documents that typically include programs goals, graduate attributes, learning outcomes, study plans, contents, strategies for teaching and learning, assessment methods, etc.

COMPUTING AS AN ACADEMIC DISCIPLINE

Computing means the study of computers and their applications. Therefore, computing can be defined as a means of designing and building hardware and software systems for a wide range of purposes. It includes processing, structuring, and managing various kinds of information; doing scientific studies using computers; making computer systems behave intelligently; creating and using communication and entertainment media; finding and gathering information relevant to any particular purpose and so on. On the other hand, computing is a revolutionary technology for business processes within enterprises and organizations with more complex information technology (IT) needs. It also refers to other more specific meanings, based on the context in which the term is used. For example, an information systems (IS) specialist or IT specialist will view computing somewhat differently from a software engineer. Regardless of the context, computing should be realized as a discipline rather than a profession.

The term computing applies to an increasingly diverse set of degree programs based on the foundations of Computer Science (CS). Computing has become an extremely broad designation that extends well beyond the boundaries of computer science to encompass such independent disciplines/programs as computer science (CS), software engineering (SE), information systems (IS), information technology (IT) and many others. Although these fields are interrelated, they are also quite different from each other (Computing Curricula, 2005).

The workshop, organized by CAQAY during the period from 31st Jan. to 2nd Feb., 2018, recommended that computing disciplines should be classified into four major disciplines, namely, Computer Science, Information Technology, Information Systems and Software Engineering. The Computer Engineering Discipline is not covered in this document, as it is more appropriate for such a program to be accommodated within the programs of the Faculty of Engineering.

This classification meets the standard classification of the Association for Computing Machinery (ACM) and IEEE. Such disciplines include (Computing Curricula, 2005):

1) 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.

2) Information Systems: Graduates of this discipline, called Information System specialists, should be able to analyze information requirements, work with business support applications such as payroll, accounts, inventory management, and should be able to specify and design systems which are aligned with organizational objectives.

3) Information Technology: Graduates of this discipline, called Information Technology Professionals, should be able to work effectively at planning, implementation, configuration, deployment and maintenance of an organization's computing infrastructures.

4) Software Engineering: Graduates of this discipline, called Software Engineers, should be able to understand customers/users' requirements and develop maintainable software systems. They are also expected to develop systematic models and reliable techniques for producing high quality software on time and within a budget.

5) Computer Engineering: Graduates of this discipline, called Computer Engineers, should be able to design computers, computer-based systems and networks that include both hardware and software and their integration to solve engineering problems. They also should be able to acquire and maintain preparation for professional practice in engineering.

The purpose of this document is to underline NARS for four undergraduate computing disciplines namely:

1- Computer Science

2- Information Technology

3- Information Systems

4- Software Engineering.

HISTORY OF COMPUTING EDUCATION IN YEMEN

It is essential to acknowledge the sheer importance of computer education as a top global destination for many students today due to the huge developments of science and technology that have spun out around the world in the last few decades. Obviously, this has also resulted in an increasing interest in computer education in Yemen. As a result, computer science and other interrelated departments in Yemeni universities are experiencing an explosive increase in undergraduate enrollments in demand for high-quality computing education. There is also an unprecedented demand from other disciplines for learning computing. Therefore, many higher education institutions have started new specialized computing programs in order to meet the requirements of labor market at the local and regional levels.

In fact, computing education in Yemen started traditionally as a computer science track under the department of mathematics and statistics in several universities during the 1990s. Then, it was further developed to achieve a disciplinary autonomy as computer science majors within the faculties of science or engineering. Later, with the advent of the 21st century, computer science was developed into an independent discipline which rapidly grew to include new disciplines such as information technology, information systems and software engineering. Gradually, computing has developed an interdisciplinary identity and constituted separate computing faculties that include various disciplines such as computer engineering, computer science, information technology, information systems and software engineering.

Sana'a University inaugurated computing study by initiating the program of Math & Computer in 1991/1992, and then the program of computer science under the Faculty of Science. Later, Computer Center was founded in 2004/2005. In 2007/2008, the Center was developed into a Faculty of Computer and Information Technology. Similarly, in Aden University, the first Computer Center was established in 1994; and later, it was developed into a Faculty of Computer and Information Technology in 2013/2014. In Thamar University, the computer science program was started under the Faculty of Management, Computer and information systems in 1997. In 2001/2002, it was established as a Faculty of Computer Sciences & Information Systems. Following the same tradition, Hadramout University of Science and Technology opened a Computer Science Department under the Faculty of Applied Science in 2005/2006. Then, in 2017-2018, it was established as an independent Faculty of Computer & Information Technology. Hodeidah University established its Faculty of Science & Computer Engineering in 2001; then it established a Faculty of Engineering and Information Technology in 2015/2016. In the same way, Taiz University opened a department of Computer Science in the Faculty of Applied Science in 2001, the Faculty of Engineering & Information Technology in 2003 and the Faculty of Computer and information Technology-Alturbah in 2009/2010. Today, almost all public universities are offering computing programs under either the faculties of computer and information technology or the faculties of engineering.

As far as the private sector is concerned, Queen Arwa University was the first to start a Faculty of Engineering and Computer Science in 1995/1996. The University of Science and Technology started its Faculty of Computer and Information Technology in 2011/2012. Nowadays, almost all private universities are offering computing programs under either the faculties of computer and information technology or the faculties of engineering.

Although there are many higher education institutions that offer various types of computing programs, they lack national academic reference standards while developing or reviewing their computing programs. As a result, the Council for Accreditation and Quality Assurance (CAQAY) organized a workshop on the development of "National Academic Reference Standards for Computing Programs" during the period from 31st Jan. to 2nd Feb., 2018. The workshop aimed at raising faculties and faculty members' awareness of and adherence to international standards during the process of developing and reviewing academic programs.

NATIONAL ACADEMIC REFERENCE STANDARDS FOR COMPUTING

NARS for computing studies provide students with the advanced and effective technologies that should meet the expected organization needs. These needs require an understanding and problem-solving skills for different technologies to face today and tomorrow's challenges. Therefore, the NARS for computing in this document set out generic statements which represent general expectations about standards for different bachelor degree disciplines (CS, IS, IT and SE). These statements clarify the attributes associated with the awarded degree. The graduates of these degrees should be able to involve knowledge, ways of thinking and developing to initiate and conduct activities associated with computing processes, systems, problems, opportunities, history, future impacts, ethics, etc.

The next two subsections describe general graduate attributes and intended learning outcomes for computing.

Graduate Attributes

Upon successful completion of an undergraduate computing program, the graduates will be able to:

1. Demonstrate a sound understanding of the body of knowledge in the field of computing.
2. Employ mathematics and logic in the field of computing.
3. Utilize problem-solving, critical thinking skills and techniques effectively to solve computing problems.
4. Apply and evaluate various computing tools and techniques.
5. Evaluate the current computing systems and applications based on specific criteria to meet the requirements of developing new computing systems and applications.
6. Demonstrate efficient communication, teamwork, leadership and interpersonal skills.
7. Engage in self and life-long learning personally and academically, in scientific research and career development.
8. Display commitment to professional, ethical, legal, security and social responsibilities.
9. Adhere to quality standards in computing field.

Intended Learning Outcomes

A- Knowledge and Understanding

Upon successful completion of an undergraduate computing program, the graduates will be able to:

A1. Show an understanding of the essential facts, concepts, principles and theories related to the field of computing.

A2. Demonstrate a strong knowledge in mathematics and logic needed in the field of computing.

A3. Demonstrate a profound knowledge in utilizing and adapting computing tools, techniques, practices, and methods for solving the real world computing problems.

A4. Exhibit a sound understanding of the concepts related to analysis and design, imple mentation and evaluation of secured computer-based systems.

A5. Identify user and business needs relevant to the field of computing.

A6. Demonstrate an understanding of research fundamentals in the field of computing.

B- Cognitive Skills/Intellectual Skills

Upon successful completion of an undergraduate computing program, the graduates will be able to:

B1. Critically analyze a problem using the mathematical principles, appropriate tools and techniques.

B2. Select an appropriate model/framework for solving a computing problem in hand.

B3. Compare and evaluate different alternative solutions related to a particular computing problem.

B4. Critically understand, summarize and evaluate relevant information in computing.

C- Practical and Professional Skills

Upon successful completion of an undergraduate computing program, the graduates will be able to:

C1. Evaluate quality attributes in the systems, provide suitable solutions for problems and propose appropriate implementable plans for improvement.

C2. Implement and test computer programs and applications.

C3. Use effectively operating systems, programming languages and software tools.

C4. Deploy computing tools and techniques to solve technical problems in work environment.

C5. Assess risks, their subsequent implications and safety aspects within a specific context.

D – Transferable/Generic Skills

Upon successful completion of an undergraduate computing program, the graduates will be able to:

D1. Work effectively individually or within a team, and in stressful environments.

D2. Demonstrate key skills such as creative thinking, analytical study, employment and interpersonal skills.

D3. Acquire life-long learning and professional development skills.

D4. Write and present a technical report effectively.

D5. Communicate effectively using various communication media and technologies.

D6. Demonstrate commitment to moral, ethical, legal, social norms and responsibilities in the computing practices.

NATIONAL ACADEMIC REFERENCE STANDARDS FOR COMPUTING DISCIPLINES

1- National Academic Reference Standards for Computer Science Program

I. Graduate Attributes

Upon successful completion of an undergraduate computer science program, the graduates will be able to:

1. Understand computer science concepts to start further long-life learning.
2. Apply computer science theory, mathematics, algorithms and models for analyzing, designing, implementing and evaluating computer-based systems.
3. Identify and apply relevant problem-solving and decision-making methodologies.
4. Apply acquired knowledge to plan and track progress during software development and assess their qualities.
5. Possess a solid foundation that allows and encourages them to maintain their skills as the field evolves.
6. Demonstrate the ability to evaluate the current software applications on the bases of cost effectiveness and organization requirements.
7. Display commitment to ethical, legal, security and social responsibilities as computer science professionals.
8. Demonstrate research capability, communication skills and enhance employability.

II. Intended Learning Outcomes

A- Knowledge and Understanding

Upon successful completion of an undergraduate computer science program, the graduates will be able to:

A1. Demonstrate knowledge of mathematical foundations, algorithms and computer science theory in modeling and designing computer-based systems.

A2. Identify a wide range of software and hardware components, techniques, tools and various controlling mechanisms used in computer systems.

A3. Describe the principles of various programming skills, data structures, computer organization and architecture, intelligent systems, parallel processing, distributed computing, and software de velopment process and models.

A4. Explain the fundamentals of computer networks and security, database systems, operating systems, computer-human interaction, logic, machine learning and image processing.

A5. Describe basic concepts of web applications development, mobile and multimedia applications, computer graphics, computational and compiler theory, systems programming and programming language design.

A6. Identify users and business needs relevant to computer-based systems, software applications and projects.

B- Cognitive Skills/ Intellectual Skills

Upon successful completion of an undergraduate computer science program, the graduates will be able to:

B1. Formulate and analyze problems according to analytical and mathematical models, and plan proper strategies for solutions.

B2. Explore and compare appropriate tools, techniques or models for analyzing computer systems and computer application problems.

B3. Design and develop appropriate software architecture, and software tools and components based on specific application.

B4. Analyze secured computer-based system components or software applications including web, mobile and multimedia applications to meet the criteria defined for its current use and future development.

B5. Investigate and evaluate the current system based on software components in terms of their reliability factors, risk management and safety within a given environment, and propose a variety of secured and integrated solutions based on standard measurements.

B6. Explore the impacts of computer science on individuals, organizations and society.

C- Practical and Professional Skills

Upon successful completion of an undergraduate computer science program, the graduates will be able to:

C1. Employ mathematical foundations, algorithms, programming skills, current techniques and tools in detailed design of computer-based systems and its implementation to meet desired needs.

C2. Apply appropriate theoretical knowledge, tools and techniques to specify, implement, and debug of program components.

C3. Implement an appropriate software architecture and software components interface based on applications specification design.

C4. Operate effectively on programming languages, system programs, software tools and frameworks web applications development, mobile and multimedia applications, distributed systems and other computer applications.

C5. Select available software such as APIs or open source code for constructing a rapid web application and other software applications.

C6. Build different software applications using different programming languages environments on different platforms along with suitable evaluation.

D - Transferable Skills

Upon successful completion of an undergraduate computer science program, the graduates will be able to:

D1. Work effectively individually or within a team to accomplish a common goal.

D2. Write a technical report and make an effective presentation for different audiences in different environments.

D3. Engage in research and long-life learning.

D4. Communicate effectively with specialists as well as non–specialists to solve computer science problems.

D5. Demonstrate commitment to ethical, legal, security, and social aspects and responsibilities related to the field of computer science.

2- National Academic Reference Standards for Information Systems Program

i. Graduate Attributes:

Upon successful completion of an undergraduate Information systems program, the graduates will be able to:

1- Demonstrate an understanding of organization theory, mathematical foundations and business needs.

2- Demonstrate a sound understanding of concepts of the data and information management, information systems development and organization process modeling including different phases.

3- Identify problems using modern computing technologies, and systematic tools and techniques to provide appropriate information system solutions.

4- Describe, analyze, design, evaluate and apply information system strategies for different organization levels to improve organization business processes.

5- Extract and manage knowledge and Information from information systems of organization using business intelligence, different decision-making methodologies, techniques and/or tools to improve the organization performance.

6- Monitor, control and manage ongoing information technology operations, and organizational risks and security to improve the organization performance.

7- Apply the acquired knowledge to plan, evaluate and select different alternatives among available information systems.

8- Employ efficiently project management, research capability, leadership, communication and life-long learning skills in different environments related to information system.

9- Demonstrate commitment to ethical, legal, security and social responsibilities as a professional in information systems.

I. Intended Learning Outcomes

A- Knowledge and Understanding

Upon successful completion of an undergraduate Information systems program, the graduates will be able to:

A1. Demonstrate an understanding of appropriate concepts, theories, mathematical foundations, models and techniques related to information systems.

A2. Identify various organization needs, enterprise architecture, types of information systems and strategies to monitor, control and manage organizational processes for improving organizations performance.

A3. Determine and illustrate different phases for developing information systems projects.

A4. Show a sound understanding of the principles of programming skills, data and information management and retrieval, and business intelligence.

A5. Demonstrate an understanding of Information systems strategies that are aligned with organization strategies, taking into consideration security and risk management, network principles, and business process modeling and requirements for organizations.

A6. Describe project management methods and tools, and explain infrastructures of information technologies appropriate to information systems development process and evolution.

A7. Acquire basic knowledge of different applications, human-computer interaction, web development technologies, applied operating systems and criteria related to the field of information systems.

B- Cognitive Skills\Intellectual Skills

Upon successful completion of an undergraduate Information systems program, the graduates will be able to:

B1. Analyze, evaluate and document organization needs and propose suitable information system solutions.

B2. Compare and evaluate tools, techniques, models, information technology infrastructures and standards to improve organization operations and performance.

B3. Explore suitable enterprise architectures and process reengineering to deploy organizational information systems successfully.

B4. Plan and design proper enterprise system strategies that support organization and business strategies.

C- Practical and Professional Skills

Upon successful completion of an undergraduate Information systems program, the graduates will be able to:

C1. Employ effectively principles of managerial and business concepts, information technology solutions and security to solve problems and/or take opportunities for organization.

C2. Use and manage information systems project management methods, technologies and tools effectively

C3. Use and apply effective tools, techniques and criteria to analyze, design and compare information technology solutions to enhance organization processes and performance.

C4. Implement and deploy the best information systems solutions to meet organization and business needs.

C5. Design applications using different appropriate programming tools based on different database systems and platforms.

D - Transferable Skills

Upon successful completion of an undergraduate Information systems program, the graduates will be able to:

D1. Work effectively individually or within a team.

D2. Engage in a life-long self-learning, develop leadership skills and communicate effectively with various organizational stakeholders to collect information using a variety of techniques to solve organization problems.

D3. Write and present technical reports and deliverables effectively.

D4. Demonstrate efficient skills in project management, research capability, creative thinking, and analytical and interpersonal skills.

D.5 Demonstrate commitment to professional ethics, legal and security responsibilities and other related issues.

3- National Academic Reference Standards for Information Technology Program

I. Graduate Attributes

Upon successful completion of an undergraduate Information technology program, the graduates will be able to:

1. Demonstrate knowledge of information technology discipline theoretically and practically.
2. Identify information technology problems and requirements using computational approaches, modern information technologies, tools and techniques.
3. Analyze, design and manage computing-based solutions within the context of information technology discipline to meet the organization's goals and business objectives.
4. Use the acquired knowledge to evaluate, select and manage computing technologies solutions and resources for integrating and securing various information technology solutions.
5. Follow the rules of information technology policies development and procedures during the selection, integration, and administration of computer-based systems.
6. Describe the impact of information technology competencies on individuals, organizations and society to achieve professionalism.
7. Work effectively within a team or individually in planning, implementing, deploying, configuring, maintaining, and managing practices and technology trends of organization's computing infrastructures.
8. Use efficiently project management, research capability, leadership, communication, interpersonal relationship and life-long learning skills.
9. Demonstrate commitment to ethical, legal, security and social responsibilities as professionals in information Technology.

I. Intended Learning Outcomes

A- Knowledge and Understanding

Upon successful completion of an undergraduate Information technology program, the graduates will be able to:

A1. Demonstrate an understanding of appropriate concepts, theories, mathematical foundations, models and techniques related to Information technology discipline.

A2. Identify the computing desired needs for different computer-based systems, components, processes and human factors, and consider them during the selection, integration, and administration technologies to meet the organization's goals.

A3. Demonstrate knowledge of computer and communication networks, information technology and networks security, distributed and cloud computing, and operating systems of different platforms.

A4. Explain the information technology policies and procedures, project management methods/tools, data and management information systems, network management, and system integration & architecture.

A5. Describe the principals of programming foundations, data and risk management, web and multimedia applications, system administration tools and techniques, human-computer Interaction, and professional communication.

B- Cognitive Skills\Intellectual Skills

Upon successful completion of an undergraduate Information technology program, the graduates will be able to:

B1 Propose appropriate information technology based solutions and integrate them effectively into the user and organization environment.

B2 Analyze the impacts of computing on organizational objectives and customer needs, and consider them during the analytical processing, selection, integration, configuration and administration of computer-based systems.

B3 Explore and integrate computing products and services to improve the performance of secured computing-based solutions.

B4 Evaluate the functions and related issues focusing on information technology solutions to design and develop information technology policies, tools and techniques to achieve administrative policies within a corporate environment.

C- Practical and Professional Skills

Upon successful completion of an undergraduate Information technology program, the graduates will be able to:

C1. Employ effectively the concepts, principles of computational approaches, computing systems, communication and modern technologies in the problem-solving process.

C2. Perform required information technology policies and procedures and employ technologies to achieve administrative policies within a corporate environment

C3. Use information technology infrastructure approaches and tools to specify, design, implement, develop and document appropriate solutions.

C4. Administer, control, configure and maintain the organization systems and data security to minimize and handle risks management to enhance organizational performance.

C5. Work effectively on IT-project management, programming skills, implementation or simulation tools, operating systems with different platforms, and different applications including web, mobile and multimedia applications.

D - Transferable Skills

Upon successful completion of an undergraduate Information technology program, the graduates will be able to:

D1. Work effectively within a team or individually to accomplish a common goal

D2. Engage in a life-long self-learning, time management, leadership and communicate effectively with specialists as well as non–specialists to solve organization problems.

D3. Write and present technical reports and deliverables effectively.

D4. Demonstrate efficient skills in IT-project management, research capability, creative thinking and interpersonal relationship skills.

D5. Use the governmental and environmental regulations to develop Information technology policies within an organization based on professional ethics, privacy, security and legal responsibility.

D6. Keep up with modern technologies, tools and standards to improve organization performance.

4- National Academic Reference Standards for Software Engineering Program

I. Graduate Attributes

Upon successful completion of an undergraduate Software engineering program, the graduates will be able to:

1. Demonstrate an understanding of software engineering theories, methods, tools, techniques and standards.
2. Identify software engineering problems and requirements using mathematical foundations, formal methods and computer science principles.
3. Employ and manage activities at different phases of software development life cycle to meet desired needs of clients and the wider society.
4. Analyze, design and develop software systems using appropriate methodologies, techniques, tools, models and technologies.
5. Use appropriate approaches to ensure software quality, maintainability, security and manageability of different activities.
6. Investigate and evaluate verification and validation of current software systems to improve the performance of computer-based systems.
7. Be an effective problems solver, creative thinker, alternative approaches selector to a wide range of problems in a typical software development environment.
8. Use efficiently software project management to meet and manage time, budget, and quality constraints.
9. Use efficiently research capability, work habits, leadership, communication and life-long learning skills.
10. Demonstrate commitment to ethical, legal, security and social responsibilities as professionals in software engineering.

II. Intended Learning Outcomes

A- Knowledge and Understanding

Upon successful completion of an undergraduate Software engineering program, the graduates will be able to:

A1. Demonstrate knowledge of theories, mathematical foundations, main concepts, principles, facts, and standards of software engineering discipline.

A2. Demonstrate a sound understanding of processes, tools, methods, techniques, models and technologies that provide the essence for developing high quality software.

A3. Describe the different phases of software development life cycle model.

A4. Identify basic concepts of verification, validation and user needs of software requirements for a given software project scenario.

A5. Acquire concepts of different applications, human-computer Interaction, web technologies, security, network technologies, operating systems and criteria related to the field of software engineering.

B- Cognitive Skills\Intellectual Skills

Upon successful completion of an undergraduate Software engineering program, the graduates will be able to:

B1. Explore the appropriate design solutions in one or more application domains using software engineering approaches systemically.

B2. Analyze and evaluate the current software solutions to solve software/system development problems.

B3. Distinguish between appropriate models, techniques, tools and modules of software engi neering process.

B4. Compare the important criteria for the software solution quality and metrics.

B5. Investigate and evaluate the impact of globalization on computing and software engineering.

C- Practical and Professional Skills

Upon successful completion of an undergraduate Software engineering program, the graduates will be able to:

C1. Employ effectively the principles of maths and formal methods, computer systems and modern technologies in developing software-based systems.

C2. Apply and manage validated software engineering approaches, tools and technologies to integrate appropriate solutions in one or more application domains to ensure high quality software.

C3. Employ and manage effectively activities at different phases of software development life cycle using software project management concepts, tools and techniques.

C4. Use different inspection tools to test software components, processes and systems programming in different user environments to meet the required criteria of its usage and future developments

C5. Design and conduct experiments in the construction of software systems of varying complexity.

D - Transferable Skills

Upon successful completion of an undergraduate Software engineering program, the graduates will be able to:

D1. Work effectively individually or within a team to accomplish a common goal.

D2. Write a technical report and make an effective presentation for audience in different environments.

D3. Engage in ongoing life-long learning, negotiation, effective work habits, leadership and good communication with stakeholders.

D4. Demonstrate commitment to professional development roles, ethical, legal, security, and social aspects.

D5. Demonstrate efficient skills in software project management, time management and research capability.

TEACHING AND LEARNING STRATEGIES AND ASSESSMENT METHODS

NARS approach emphasizes the importance of aligning teaching, learning and assessment with NARS to help students acquire graduate attributes and the intended learning outcomes.

Although teaching and learning strategies and assessment methods vary from one discipline to another and from an academic program to another, whatever teaching and learning strategies and assessment tools are used, they should provide students with opportunities to acquire graduate attributes and the intended learning outcomes. This requires that curricula design and delivery methods should be updated periodically to respond to new developments in the subject matter, the results of research on teaching/learning in higher education, changes in national policy, professional practices and the needs of labor market.

I. Teaching and Learning Strategies

The NARS for computing disciplines of undergraduate programs must develop a new approach that requires higher education institutions to apply appropriate teaching and learning opportunities to help students achieve academic standards. At the same time, they must have a thorough understanding of the theoretical concepts in field.

Regardless of the teaching approach adopted by a faculty, institutions of higher education should provide a great deal of active learning in which the students are actively involved in the learning process. Besides, sufficient time for directed self-learning and reflections should be allocated to encourage students to develop life-long learning habits.

Curriculum should also be designed to provide students with sufficient opportunities to acquire independent skills and to develop practical and professional skills to a level that qualifies them to obtain professional licensing. This requires sufficient practical applications and field training during long periods of their academic study.

In general, teaching and learning in computing undergraduate programs should use a variety of different approaches including:

- Lectures;
- Tutorials/seminars/workshops;
- Practical and laboratory classes;
- Group work and problem-solving learning;
- Design, implementation, and documentation projects;
- Preparation and presentation of a technical report;
- Directed self-study;
- The use of communications and information technology.

II. Assessment Methods

Assessment is recognized as an important factor in the way students learn and manage their time and show their ability to meet academic standards. Knowledge, understanding and skills are assessed according to the expected learning outcomes. A critical factor here is that the processes of assessment should be transparent.

Recently, it has been shown that there is a need for new forms of assessment. In addition to course assessments, the faculties of computing should design assessments at the program level to ensure that students are aware of academic standards.

Finally, assessments must be accurate but should not be exhausting or repetitive, as this may affect the learning process.

In general, assessment in computing undergraduate programs should use a variety of assessing methods, such as:

- Written examinations;
- Assignments including problem-solving exercises;
- Presentations;
- Individual and group project work;
- Technical or practical reports;
- Quizzes.

TERMINOLOGY

1. Higher education institutions:

These are universities, faculties, higher institutes and academies which offer academic programs that extend for a period of more than three years of study under the supervision of the Ministry of Higher Education and Scientific Research.

2. NARS:

The national academic reference standards prepared by the Council for Accreditation and Quality Assurance with the assistance of specialized experts and representatives of various beneficiary sectors to represent the minimum standards required for accreditation of academic programs.

3. ARS:

Academic standards prepared by higher education institutions, provided that they include NARS as well as a number of standards (attributes and learning outcomes) that distinguish an institution from other institutions (allowing for creativity and diversity).

4. Academic program:

A distinct and well-structured group of courses that, after successfully completed, enable students to get an academic degree associated with a Bachelor program.

5. Graduate attributes:

A set of attributes (competencies) that result from the acquisition of knowledge and skills during the study of a particular academic program, and which identify what the graduate is expected to exhibit at the end of an academic program.

6. ILOs:

Intended Learning Outcomes (ILOs) refer to the knowledge, understanding and skills that specify what a student should know, be able to do and the values to be acquired after the completion of a study unit, a course or an academic program.

7. Knowledge and understanding:

Key facts, concepts, laws, theories and techniques that the students are reasonably expected to acquire in a particular field of specialization. It also includes mental skills such as memorizing and comprehension.

8. Intellectual skills:

These are skills that the academic program seeks to help students develop, such as analysis, the ability to choose from different alternatives, discussion and reasoning skills, innovation, creative thinking and problem solving.

9. Practical and professional skills:

These are skills that enable a student to convert acquired academic knowledge into practical applications such as: ability to implement and test computer programs and applications and use effectively operating systems, programming languages and software tools.

10. Transferable skills:

These are general skills that involve several disciplines, such as communication skills, IT skills, project management skills, discussion and negotiation skills, self-marketing skills, time management skills, teamwork skills, presentation and delivery skills, and research skills.

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