Republic of Yemen

Ministry of Higher Education & Scientific Research

Council for Accreditation & Quality Assurance

National Academic Reference Standards (NARS)

Undergraduate Engineering Programs

May 2018

First Edition

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 engineering.

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 key attributes of tomorrow's engineering graduates, and 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 engineering programs.

In this changing world of globalization and digitalization, engineering faculties have to produce graduates who are relevant in the 21st Century which is marked by rapid development in technology, knowledge explosion, borderless economic and business operations and many other complex problems of the new millennium. Therefore, the graduate attributes presented in this document and the learning outcomes derived from them as well as teaching and assessment methods provide faculties of engineering deans, department chairs and faculty members with a frame of reference for reviewing their curriculum. If the design, content, and implementation of faculties of engineering curricula are guided by the set of graduate attributes and learning outcomes presented in this document, these faculties will certainly produce well-prepared, self-motivated and responsible engineers who can assume their expected professional duties in solving the community problems and face engineering challenges of the 21st century.

The Council recognizes that faculties of engineering have to respond to unprecedented changes in the methods of engineering education. We hope that faculties of engineering will respond to the intent of this document with some sense of urgency. Faculties of engineering 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 engineering teach and assess their students. This aspect of engineering education entails a special attention from the deans and department chairs in order to make sound improvements in engineering 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 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 specification documents 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 program of study.

NARS represent a threshold of standards that encourage higher levels of achievement and therefore require 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 are 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 intended 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 that because it is the core task of higher education institutions. In turn, 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.

A BRIEF HISTORY OF UNDERGRADUATE ENGINEERING EDUCATION IN YEMEN

Engineering education is one of the most in-demand college degrees in Yemen. It has started to be offered in Yemeni universities lately compared to other Arab countries. The first faculty of engineering was established in 1978 in Aden University. Then, the second faculty was established in Sana'a University in 1983/1984. Since then, all public universities have established their Engineering faculties. Similarly, almost all private universities are offering engineering or technology programs at present.

Given the current challenges in engineering practice, as well as the requirements on engineering graduates, engineering education in Yemen conspicuously needs to be transformed from the current practice. It is actually facing a major challenge resulting from the successive developments associated with the information and communication revolution that have changed the classical methods of education. Since the last decades of the 20th Century, the explosion in technological development has resulted in rapid changes and novel challenges throughout the world. Subsequently, there has been great developments in engineering education. However, our universities hang on to past practices and the way our engineering students are taught has hardly changed. To remain relevant in the 21st Century, engineering education has to rise up to the challenge and transform the curricula as well as the way engineering programs are delivered. We will soon find ourselves alone outside the squadron, if we do not respond to these changes. We also live in a globalized world, a world where teachers and textbooks are no longer the only source of knowledge. The emergence of the Internet has made it easier to access information. On the Internet, students may be able to obtain up-to-date information that might not have been received by their teachers.

In examining the current situation in the faculties of engineering in all Yemeni universities, we find that those faculties are graduating annually groups of students in the undergraduate programs. However, one may ask if these graduates achieve all the academic and professional requirements or not.

Moreover, the curricula of the majority of engineering programs in Yemen are still traditional in nature. They are, unfortunately, not aligned to support the attainment of the required graduate attributes and learning outcomes. Besides, they have not gone through any fundamental revisions for more than a quarter of a century. Thus, the revision of the current engineering curricula is a must, as we are in urgent need to keep abreast with the new developments in engineering education and the labor market. Above all, there is a lack of national academic reference standards to refer to during the process of program revision. This certainly calls for a need to develop national academic reference standards in engineering education in Yemen.

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 UNDERGRADUATE ENGINEERING PROGRAMS

I. GRADUATE ATTRIBUTES

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

1. Apply knowledge of mathematics, sciences and engineering.
2. Design systems, components and processes to meet the desired needs within realistic constrains.
3. Design and conduct experiments safely and analyze and interpret data properly.
4. Identify, formulate and solve fundamental engineering problems using different techniques, skills and appropriate engineering tools.
5. Carry out a search of literature, use databases and analyze the results to come up with valid conclusions.
6. Work productively and communicate effectively in teams.
7. Engage in lifelong learning and commit to professional ethics.
8. Consider the impact of engineering solutions on society and environment.

II. LEARNING OUTCOMES

A.Knowledge and Understanding

Upon successful completion of the undergraduate engineering education programs, the graduates will be able to demonstrate understanding of:

A1. Mathematics and science related to engineering.

A2. Principles of design including elements design, process and/or a system.

A3. Methodologies of solving engineering problems, data collection and interpretation.

A4. Characteristics of engineering materials related to the discipline.

A5. Necessary knowledge for sustainable development.

A6. Knowledge and understanding of engineering management principles.

A7. Professional ethics and its impact on engineering practices.

A8. Knowledge of societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

A9. Basics of information and communication technologies.

B. Cognitive / Intellectual Skills

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

B.1 Identify, formulate and solve engineering problems using established methods.

B.2 Analyze engineering systems, products, processes and methods.

B 3 Select appropriate methods for solving engineering problems based on analytical thinking.

B. 4 Design and conduct appropriate experiments, interpret data and draw conclusions.

B. 5 Think creatively and innovatively in solving problems and design process.

B. 6 Incorporate economic, social and environmental dimensions as well as management in design.

C. Practical and Professional Skills:

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

C 1. Use laboratory and workshop equipment safely to generate valuable data.

C 2. Implement a designed process, a component or a system to meet the desired needs within realistic constrains.

C 3. Use techniques, equipment and computing tools efficiently.

C 4. Employ basic knowledge of project management skills and quality assurance procedures.

C 5. Perform feasibility studies and prepare budgets and management for engineering projects.

D. General and Transferable Skills

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

D1. Work productively as an individual and as a member of a team.

D2. Communicate effectively both orally and in written forms.

D3. Effectively manage tasks, time and resources.

D4. Apply ethical principles and commit to professional ethics.

D5. Engage in independent lifelong learning.

D6. Deliver presentations to different kinds of audiences.

D7. Prepare and present effective technical reports.

D8. Conduct searches of literature and use databases and other sources of information.

D9. Master Arabic and English technical writings.

1. National Academic Reference Standards for Civil Engineering Program

I. Graduate Attributes

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

1. Use knowledge of mathematics and sciences related to civil engineering.
2. Carry out a search of literature and use information resources effectively.
3. Use different technologies, techniques and tools related to civil engineering.
4. Conduct, analyze, and interpret experiment results.
5. Conduct professionally the design, supervision, construction, protection & maintenance of civil engineering systems such as structures, water resources & sanitary, transportation systems, geotechnics, construction materials, surveying, hydraulic structures and environment.
6. Use the codes of practice and ethics of all civil engineering disciplines effectively and professionally considering quality, safety and sustainability.
7. Demonstrate capability to manage all stages of design, construction and maintenance of all types of construction systems.
8. Conduct feasibility studies, evaluate various alternatives, and select the optimal solutions within realistic constraints considering the impact of engineering solutions on society and environment.
9. Select appropriate construction materials that meet various conditions and design criteria.
10. Work independently and function effectively within a team as a member, leader or supervisor.
11. Engage in life-long learning and continuous improvement.
12. Communicate effectively in written, oral and graphical forms.

II. Learning Outcomes

A. Knowledge and Understanding:

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

A1. Apply mathematics, science and engineering principles, techniques and tools in the field of civil engineering subject areas.

A2. Describe the basic elements and concepts of analysis and design for civil engineering systems such as structures, water resources and sanitary projects, highways and bridges, geotechnics, construction materials, surveying, hydraulic structures and environment

A3. Show an understanding of construction and project management, procurement procedures and civil engineering practices, codes, standards, quality assurance and ethics.

A4. Describe the procedures of laboratory tests and the properties and behavior of construction materials.

A5. Describe the role of the professional engineer and the impact of engineering solutions on society, including safety, environmental -issues, cultural heritage, traditional practices and ethics

B. Cognitive/Intellectual Skills

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

B1. Demonstrate competence in identifying, defining, analyzing and designing engineering systems.

B2. Interpret the results of the analysis, design, and laboratory tests in accordance with the codes of practice in civil engineering.

B3. Link civil engineering problems in the field with theoretical principles and select optimum solution.

B4. Evaluate innovatively different systems, models, techniques and strategies for solving engineering problems.

B5. Incorporate the economic, social, and environmental issues as well as management in design in civil engineering.

C. Practical and Professional Skills

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

C1. Use laboratory and field equipment competently and safely and record, analyze and validate relevant data.

C2. Design and implement efficiently laboratory experiments, prepare reports and graphical interpretations in accordance with the codes and standards using relevant IT tools.

C3. Design and construct a civil engineering system, component, and process meeting codes, standards and desired needs to solve engineering problems.

C4. Professionally plan, manage, supervise and evaluate engineering projects.

C5. Conduct condition assessments of civil engineering systems and prepare rehabilitation and repairing plans.

C6. Perform feasibility studies, budgets and project briefs for civil engineering projects to establish options for decision-making.

D. General/ Transferable Skills

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

D1. Communicate effectively using written, oral and graphical forms and present ideas clearly and objectively and defend them.

D2. Engage in life-long learning and conduct searches of literature and use information resources.

D3. Commit to professional and ethical responsibility in conducting work.

D4. Work productively and efficiently individually or as a member of a team.

D5. Efficiently self-manage workloads, tasks, time and resources.

2- National Academic Reference Standards for Architectural Engineering Program

I. Graduate Attributes

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

1. Think creativity and innovatively to lead the design and planning processes.
2. Apply knowledge of mathematics, science and traditional and contemporary architecture in the related engineering or fine arts fields.
3. Design/ plan systems, components and processes of built environment to meet the desired needs of human.
4. Gather and analyze literature, information and databases to make the appropriate decisions to solve the various design problems.
5. Reconcile the divergent design determinants and sustainability requirements to differentiate between alternative design solutions using appropriate techniques, skills, tools and engineering software.
6. Manage sites and work in teams as member/ leader.
7. Plan continuous rehabilitation and development.
8. Consider relevant rules, regulations, and ethics of the profession.
9. Demonstrate an understanding of construction systems, building materials and characteristics of architectural and urban heritage in local and global culture.

II. Learning Outcomes

A.Knowledge and Understanding:

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

A1. Use knowledge of mathematics and basic sciences in architecture.

A2. Describe the methodologies of solving various design and planning problems

A3. Explain the principles and foundations of design, planning and other various applications

A4. Consider the cultural, technical, social, environmental, economic and professional issues related to architecture and urbanization.

A5. Describe the principles of management, implementation, methods of construction, techniques, characteristics of building materials and traditional and modern building legislation.

A6. Adhere to the principles and applications of sustainability.

A7. Explain the theories and history of architecture and urban planning.

B. Intellectual/ Cognitive Skills

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

B1. Engage imagination, think creatively, be innovative, and provide design leadership.

B2. Gather information from a variety of sources, define problems, get ideas, apply analysis and critical judgment, and select appropriate strategies for design process.

B3. Act with knowledge of historical and cultural precedents in local and world architecture, to inspire design concepts.

B4. Act with knowledge of the fine arts as an influence on the quality of Architecture design and planning with society, clients, users, natural systems, built environments and technical competence in the use of building.

C. Professional and Practical Skills

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

C1. Prepare and present building design projects of diverse scale, complexity, and type in a variety of contexts, using a range of media, and in response to a brief.

C2. Employ basic knowledge of architectural engineering management and quality assurance procedures.

C3. Investigate critical appraisal and select the alternative structural, constructional and material systems relevant to architectural design.

C4. Prepare designs that will meet building users' requirements and comply with rules, appropriate performance standards and health and safety requirements.

D. General / Transferable Skills

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

D 1. Work productively as an individual and as a member/ leader and a member within a multidisciplinary team.

D 2. Communicate effectively orally and in written forms.

D 3. Manage tasks, time, resources and fundamental cost in a stressful environment.

D 4. Apply ethical principles and commit to professional ethics.

D 5. Develop self-independent and life-long learning skills.

D 6. Deliver presentations to different kinds of audiences.

D 7. Prepare and present effective technical reports.

D 8. Conduct searches of literature, database and other sources of information.

D 9. Respond to the needs and aspirations of building users.

3- National Academic Reference Standards for Mechanical Engineering Program

I. Graduate Attributes

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

1. Describe mechanical engineering fundamentals and apply appropriate mathematical methods, tools and techniques for the analysis and solution of mechanical engineering problems.
2. Identify, formulate, analyze, and be creative and innovative in developing alternative solutions for mechanical engineering problems in order to reach substantiated conclusions.
3. Carry out investigations of engineering problems using methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.
4. Design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.
5. Apply and extend appropriate techniques, resources, and modern engineering tools to mechanical engineering activities with an understanding of the associated limitations.
6. Work productively, communicate effectively, and undertake lifelong learning.
7. Analyze and evaluate the impact of mechanical engineering systems or processes on the environment society, and economic systems.
8. Perform feasibility studies, prepare budgets, and manage mechanical engineering projects.
9. Apply professional ethics, accountability, and equity to Mechanical Engineering discipline.

II. Learning Outcomes

A.Knowledge and Understanding:

Upon successful completion of an undergraduate Mechanical Engineering Program, graduates should be able to:

A1. Demonstrate knowledge and understanding of fundamentals of mathematics, science, and engineering relevant to the mechanical engineering discipline.

A2. Explain the general principles of design, design techniques, and characteristics of engineering materials and components.

A3. Consider the impact of mechanical engineering solutions on global, economic, environmental, and societal contexts.

A4. Explain professional and ethical responsibilities.

A5. Show an understanding of engineering management principles.

B.Cognitive/Intellectual Skills:

Upon successful completion of an undergraduate Mechanical Engineering Program, graduates should be able to:

B1. Apply the principles of mathematics, science and engineering to solve problems related to mechanical engineering applications.

B2. Design, analyze and evaluate the mechanical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability factors.

B3. Identify, formulate, and solve mechanical engineering problems in creative and innovative ways.

B4. Design and conduct experiments, as well as analyze and interpret data to reach valid results and conclusions in the field of mechanical engineering.

C. Practical and Professional Skills:

Upon successful completion of an undergraduate Mechanical Engineering Program, graduates should be able to:

C1. Use various techniques, skills, equipment and modern engineering tools and methods (i.e., CAD/CAE/CAM packages, manufacturing methods, materials development) for solving mechanical engineering problems and practices.

C2. Test hypotheses, conduct experiments, analyze data and present results for various mechanical systems.

C3. Work effectively with a wide range of issues (aesthetic, economic, environmental, legal, and social) that shape engineering decision-making.

C4. Use and calibrate the laboratory and workshop equipment within standards, codes, rules and regulations of industrial safety.

C5. Perform feasibility studies, prepare budgets and apply operations management knowledge and skills in manufacturing and multidisciplinary engineering projects.

D. General and Transferable Skills:

Upon successful completion of an undergraduate Mechanical Engineering Program, graduates should be able to:

D1. Perform searches of literature, use databases, as well as, evaluate information and evidence from various sources.

D2. Show capability to work in stressful environments, work productively within a team and possess leadership skills.

D3. Manage tasks, time, processes and resources of mechanical engineering systems effectively.

D4. Engage in life-long learning.

D5. Communicate effectively both orally and in writing technical reports.

4- National Academic Reference Standards for Electrical Engineering Program

I. Graduate Attributes

Upon successful completion of an Electrical Engineering program, graduates should be able to:

1. Apply knowledge of basic science and mathematics including probability and statistics, differential and integral calculus, linear algebra and discrete mathematics.
2. Analyze, design and conduct experiments of electrical and electronic systems and interpret data.
3. Apply control theory and measurement principles for electrical and electronic engineering systems.
4. Manipulate the computer hardware, software and programming languages.
5. Design and develop analog and digital systems and products.
6. Carry out a search of literature and use databases and analyze results to come up with valid conclusions.
7. Work productively and communicate effectively in teams.
8. Engage in lifelong learning and commit to professional ethics.
9. Consider the impact of electrical engineering solutions on society and environment.

II. Learning Outcomes

A.Knowledge and Understanding:

Upon successful completion of an undergraduate Electrical Engineering program, graduates should be able to:

A1. Explain the principles of physics and mathematical concepts including probability and statistics, differential and integral calculus, linear algebra and discrete mathematics

A2. Show an understanding of theories for logical design, electrical and electronic circuits, measurement instruments, signals and systems processing.

A3. Explain the fundamentals and applications of microprocessors, control systems and artificial intelligent.

A4. Describe engineering management principles.

A5. Adhere to professional ethics and impacts of electrical engineering solutions on society, economics and environment.

A6. Explain health, safety, legal and cultural issues and the consequent responsibilities relevant to professional electrical engineering practice.

A7. Master the basics of information and communication technologies.

A8. Write Arabic and English technical reports.

B.Cognitive / Intellectual Skills

Upon successful completion of an undergraduate Electrical Engineering program, graduates will be able to:

B1. Identify and analyze electrical and electronics engineering problems using established methods.

B2. Select appropriate methods for solving electrical and electronics engineering problems based on analytical thinking.

B3. Design and conduct appropriate experiments, interpret data and draw conclusions.

B4. Think creatively and innovatively in solving problems and design processes.

B5. Incorporate economic, social and environmental dimensions as well as management in design.

C.Practical and Professional Skills

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

C1. Use electrical, electronics, logic and computer laboratory to generate valuable data.

C2. Use appropriate techniques, workshop equipment and computing tools efficiently.

C3. Employ basic knowledge of project management skills and quality assurance procedures.

C4. Perform feasibility studies and prepare budgets for engineering projects.

D.General and Transferable Skills

Upon successful completion of the undergraduate Electrical Engineering program, the graduates will be able to:

D1. Work productively as an individual and as a member of a team / multi-disciplinary team.

D2. Communicate effectively both orally and in written forms.

D3. Effectively manage tasks, time and resources.

D4. Apply ethical principles and commit to professional ethics.

D5. Engage in independent lifelong learning.

D6. Deliver presentations to different kinds of audiences.

D7. Prepare and present effective technical reports.

D8. Conduct searches of literature and use databases and other sources of information.

5- National Academic Reference Standards for Computer Engineering Program

I. Graduate Attributes

In addition to the general attributes of the Electrical Engineering program graduates, the Computer Engineering graduates should be able to:

1- Design, implement and evaluate the components (hardware and software) of computer-based systems.

2- Employ modeling and simulation tools to monitor computer systems.

II. Learning Outcomes

A. Knowledge and Understanding

In addition to the knowledge and understanding of electrical engineers, the graduates of Computer Engineering program should be able to demonstrate an understanding of:

1. the theories and fundamentals of computer organization & architectures, digital systems, embedded systems and computer networks.
2. fundamental of data structures and algorithms, software engineering methodologies and data mining.
3. concepts of hardware description language, programmable logic platform, operating systems, robotics and interfacing.
4. basics of information security, compilers, multimedia processing, data communication systems and internet technologies.

B.Cognitive/ Intellectual Skills

In addition to the intellectual skills of Electrical Engineers, the graduates of Computer Engineering program should be able to:

1. Select the appropriate computing methods, techniques, skills and tools to analyze and solve computer engineering problems.
2. Design hardware and software systems, and users interface based on problem specifications.

C.Practical and Professional Skills

In addition to the practical and professional skills of Electrical engineers, the graduates of Computer Engineering program should be able to:

1. Implement and operate digital systems, control systems, networks, microprocessors, embedded systems and hardware-software interfacing.
2. Employ modeling and simulation tools to illustrate the computer architecture & organization, embedded systems and robotics.
3. Operate effectively on programming languages, system programs, software tools and frameworks, web applications development, multimedia processing, distributed systems, AI systems.

D.General and Transferable Skills

The same as the general and transferable skills of the Electrical Engineering program graduates.

6- National Academic Reference Standards for Communication and Electronics Engineering Program

I. Graduate Attributes

In addition to the general attributes of an electrical engineer, the graduates of Communication and Electronics Engineering program should be able to:

1. Design, operate and maintain digital and analog communication, mobile communication, coding, and decoding systems.
2. Analyze, design and implement communication networks and communication transmitter and receiver.
1. Design, implement, maintain and evaluate the electronic systems.

II. Learning Outcomes

A. Knowledge and Understanding

In addition to the knowledge and understanding of electrical engineers, the graduates of Communication and Electronic Engineering program should demonstrate knowledge and understanding of:

1. Principles of control systems with performance evaluation.
2. Basics of electromagnetics, digital electronics, hardware description language, programmable logic platform, embedded systems, communication systems, communication networks, optical communication systems and optical fiber.
3. Operations of coding and decoding techniques
4. Principles and applications of Microwave, antenna, wave propagation and digital image processing.

B.Cognitive/ Intellectual Skills

In addition to the intellectual skills of electrical engineers, the graduates of Communication and Electronic Engineering program should be able to:

1. Analyze and test networks, communication systems, mobile communication, microwave, optical, coding, and decoding systems.
2. Evaluate the communication systems designs and make improvements;
3. Synthesize new processes through utilization and effective management of available resources.

C.Practical and Professional Skills

In addition to the practical and professional skills of electrical engineers, the graduates of Communication and Electronic Engineering program should be able to:

1. Implement and operate digital systems, control systems, networks, microprocessors and embedded systems.
2. Apply computer programming and simulation tools for the design and diagnostics of digital & analog communication, mobile communication, coding, decoding, and electronic systems.
3. Operate communication systems in the practical field.
4. Use relevant laboratory equipment and analyze the results correctly.
5. Use appropriate tools to measure and improve communication system performance.

D.General and Transferable Skills

The same as the general and transferable skills of the Electrical Engineering program graduates.

7- National Academic Reference Standards for Electrical Power and Machines Engineering Program

I. Graduate Attributes

In addition to the practical and professional skills of electrical engineers, the graduates of Electrical Power and Machines Engineering program should be able to:

1. Design and manage the construction of power generation and distribution systems.
2. Plan and develop the control and protection of power systems and electrical machines.
3. Evaluate and test the electrical machine performance with its power electronics drive devices.
4. Analyze the load demand and determine the appropriate electric type system for it.

II. Learning Outcomes

A. Knowledge and Understanding

In addition to the knowledge and understanding of electrical engineers, the graduates of Electrical Power and Machines Engineering program should demonstrate knowledge and understanding of:

1. fundamentals of power systems distribution and conversion.
2. fundamentals of PLC control system, electrical machines, power electronic and machine drive.
3. principles of traditional and renewable energy generation systems and their feasibility.
4. computation of load power and load energy consumption.

B. Cognitive/ Intellectual Skills

In addition to the intellectual skills of electrical engineers, the graduates of Electrical Power and Machines Engineering program should be able to:

1. Design power generation and transmission systems.
2. Design and develop the control and protection of power systems.
3. Design and develop the drive of electrical machine.
4. Analyze the performance of electric power generation, control and distribution systems.

C. Practical and Professional Skills

In addition to the practical and professional skills of electrical engineers, the graduates of Electrical Power Engineering program should be able to:

1. Implement experiments as well as analyze and interpret experimental results related to electrical power and machine systems.
2. Apply modern program simulation tools in electrical power, power electronic machines, and machine drives.
3. Test and examine the different motors, drives equipment and protection systems.
4. Use PLC control systems to monitor the industrial machines.
5. Administrate and supervise the construction of power generation and transmission systems.

D. General and Transferable Skills

The same as the general and transferable skills of the Electrical Engineering program graduates.

8- National Academic Reference Standards for Mechatronics Engineering Program

I. Graduate Attributes

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

1. Apply knowledge of mathematics, physics and basic sciences to demonstrate the application of this knowledge to electromechanical systems.
2. Identify, formulate, and analyze problems related to mechatronics engineering to find solutions using appropriate techniques, skills, engineering tools, and implemented prototypes.
3. Design mechatronics systems and components to meet the desired specifications within realistic constraints.
4. Conduct experiments safely in measurements, actuating, control and robotic systems and present results effectively.
5. Investigate and analyze the inter-disciplinary characteristics of mechanical, electrical, pneumatic and hydraulic systems.
6. 6. Consider the impact of engineering solutions in societal and environmental contexts for sustainable development.
7. Carry out searches of literature in mechatronics engineering and use databases to come up with valid information.
8. Perform business studies relevant to applications of mechatronics.
9. Apply ethical principles and commit to professional ethics and responsibilities.
10. Function and communicate effectively in multidisciplinary teams and engage in life-long learning.

II. Learning Outcomes

A. Knowledge and Understanding:

Upon successful completion of an undergraduate Mechatronics Engineering program, graduates should be able to:

A1. Use knowledge of mathematics, physics and basic engineering sciences (electrical, mechanical and computer sciences) in the field of mechatronics.

A2. Describe the principles of mechatronics system and component design.

A3. Identify necessary knowledge and theoretical concepts of robotics and mechatronics systems for sustainable development.

A.4. Respond to professional ethics and responsibilities in mechatronics practices.

A.5. Reflect the impacts of effective electromechanical solutions on society and environment.

A.6. Use different methodologies for data collection and interpretation in solving engineering problems.

B. Cognitive/ Intellectual Skills:

Upon successful completion of an undergraduate Mechatronics Engineering program, graduates should be able to:

B1. Identify, formulate and solve mechatronics problems using suitable methods.

B2. Categorize mechatronics systems and components based on their features.

B3. Integrate components from different domains to construct useful mechatronics products.

B4. Consider social development issues in designing mechatronics projects.

B5. Compose and develop innovative solutions for practical industrial problems.

B6. Analyze problems related to dynamics, instrumentation, and computer-aided design and manufacturing using appropriate mathematical and computer models.

C. Practical and Professional Skills:

Upon successful completion of an undergraduate Mechatronics Engineering program, graduates should be able to:

C1. Conduct experiments safely to verify theoretical concepts related to electrical, mechanical, control and embedded systems.

C2. Implement and develop automatic systems using electrical/electronic devices and machinery equipment.

C3. Identify, formulate and solve engineering problems using appropriate tools and computer software.

C4. Perform feasibility studies and prepare budgets and management for mechatronics projects.

C5. Use standard approaches while designing and integrating electromechanical systems.

D. General and Transferable Skills:

Upon successful completion of an undergraduate Mechatronics Engineering program, graduates should be able to:

D1. Conduct a search of literature and use databases and other sources of information.

D2. Demonstrate personal commitment to tasks and effectively manage time and resources.

D3. Cooperate in work as a part of a team coherently and share learned knowledge successfully.

D4. Assess technical reports, discuss ideas, and justify results creatively through different forms.

D5. Manage and evaluate the acquisition of new knowledge as part of life-long learning strategy.

D6. Demonstrate an awareness of ethical principles and issues.

D7. Work in stressful environments considering safety regulations.

TEACHING AND LEARNING STRATEGIES AND ASSESSMENT TOOLS

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 even 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 sensitive to the requirements of those graduate attributes and learning outcomes, i.e., they should match them. Teaching and learning strategies as well as assessment tools must be updated periodically to respond to developments in the subject matter, the results of research about teaching and learning in higher education, changes in national policy, professional practices and the needs of employers.

A. Teaching and Learning Strategies

The introduction of NARS in higher education curriculum development is a new approach that requires higher education institutions to apply appropriate teaching and learning opportunities to help students achieve academic standards and to demonstrate that all their graduates are able to achieve those standards.

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, enough time for directed self-learning and reflections should be allocated to encourage students to develop lifelong 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 undergraduate engineering education programs should use a variety of teaching methods, such as:

- Active Lectures (supported with discussions),
- Hands-on laboratory work,
- Independent learning and work,
- Group learning and Problem-based learning,
- Field classes,
- Independent applications of engineering analysis,
- Seminars, journal clubs and workshops,
- The use of communication and information technology,
- Computer and web-based learning,
- Case studies,
- Design work and projects especially towards the end of the programs and should be built on earlier learning,
- Industry visits,
- Directed self-study.

B. Assessment Tools

Assessment is the means by which students' ability to meet academic standards is measured and should also be a key part of the learning process. This requires - in addition to course assessments - faculties of engineering to design assessments at the program level to ensure that students are meeting academic standards. In addition, the assessment tools must be credible and consistent.

On the other hand, NARS require an emphasis on rigorous assessment of practical and professional skills to identify those who are not yet qualified for the profession. The ways to achieve this may vary, but should always include direct and frequent observations of students during practical applications and field training.

It should also be noted that while it may be difficult to assess professional attitudes directly, the impact of attitudes on students' behavior should be assessed by observing their behavior over a period of time.

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

In general, assessment in undergraduate engineering education programs should use a variety of teaching methods, such as:

- Short essays,
- Written assessments, such as multiple choice questions (MCQs),
- Faculty assessment by structured observation through checklists and rating scales,
- Multi-source assessments, such as, student self-assessment and peer assessment,
- Simulations, such as, computer-based clinical scenarios,
- Multi-competency comprehensive assessments, such as, objective structured clinical exams (OSCE),
- Practical assessment,
- Project reports,
- Laboratory reports,
- Essays,
- Case studies,
- Presentations,
- Work samples, such as, portfolios.

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:

AA distinct and well-structured group of courses that, after successfully completed, enable students to get an academic degree associated with an academic program (BA / BSc, MSc, PhD).

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 diagnose diseases, write medical prescription, manage water resources, or accomplish an engineering design.

10. Transferable skills:

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

REFERENCES

Australian Universities Quality Agency (AUQA) (2009), Setting and Monitoring Academic Standards for Australian Higher Education: A discussion paper, AUQA, Melbourne.

Magdy A. Kassem (2009). National Authority for Quality Assurance and Accreditation of Education. National Academic Reference Standards (NARS). Egypt, 1st Edition.

Ministry of Higher Education, Syrian Arab Republic (2009). The Development and Implementation of National Academic Reference Standards. Ministry of Higher Education of the Syrian Arab Republic in Association with the British Council and the Upgrading of Higher Education Scheme (European Union Project).

NAAB (2014). Conditions for Accreditation, The National Architectural Accrediting Board, Inc.; Approved on July 18th, 2014.

NAQAAE (2007). Guidelines for dev0c[[[[eloping National Academic Reference Standards (NARS) for Higher Education in Egypt National Authority for Quality Assurance and Accreditation of Education, Egypt.

NAQAAE (2009). National Academic Reference Standards (NARS) for Engineering – National Authority for Quality Assurance and Accreditation of Education (NAQAAE), Egypt.

QAA (2002). Subject Benchmark Statements: Engineering, www.qaa.ac.uk, accessed on 28 May 2017.

QAA (2011). The UK Quality Code for Higher Education, www.qaa.ac.uk, accessed on 28 May 2017.

RIBA (2014). Procedures for validation and validation criteria for UK and international courses and examinations in architecture, RIBA Education Department.

UIA (2002). UNESCO-UIA, Validation System for Architectural Education. UIA.

TEAM MEMBERS

It is essential to acknowledge that the preparation of this document was made possible through a support from the Dutch Project and the University for Science and Technology.

Prepared by:

1- Prof. Dr. Hassan Abdulmogni
2- Dr. Abdusalam Althawr
3- Dr. Ahmed Hamid Ali
4- Prof. Dr. Ahmed Alwathaf
5- Dr. Abdulaziz Mohammed Said
6- Dr. Tarek Abdullah Barakat
7- Prof. Dr. Eng. Mohammed Ahmed Al-Bukhaiti
8- Assoc. Prof. Dr. Khalil Abdullah Al-Hatab
9- Dr. Eng. Abdulsalam Naji Al-Mekhlafi
10- Dr. Eng. Hamoud Abdulsalm Al-Nehari
11- Dr. Mohammed Ali Naeem
12- Dr. Samira Saleh Al Shawesh
13- Prof. Dr. Mohammed Ahmed Salam
14- Dr. Ahmed Mohammed Yafa'a
15- Dr. Naji Hamud Al Ashwal
16- Dr. Mohammed Abdullah Al Olofi
17- Dr. Mohammed Ali Hankal
18- Dr. Amin Mohammed Al Kustaban
19- Dr. Abdulmalik Ibrahim Momin
20- Dr. Mohammed Ali Al Yadoumi
21- Dr. Dr.Hatem Abdo Ali Al Dois
22- Farouk Abdu Al Fuhaidy

Workshop Participants:

In addition to the list of faculty members above, the following members have participated in the workshop:

1- Dr. Mohammed Al Haify
2- Dr. Zamzam Mubarak
3- Dr. Khaleel Al Khateeb
4- Dr. Ahmed Hamid
5- Dr. Ali Al Kawzy
6- Dr. Ahmed Hassan
7- Dr. Abdel Jabbar Al Ayany
8- Dr. Ali Al Hamdy
9- Dr. Mohammed Essa
10- Dr. Abdulltif Musleh

University Review:

Leading academic professors working at the following universities provided some reviews and comments: Sana'a University, Thamar University, Ibb University, Dar El Salam University, University of Science and Technology.