

**NATIONAL ACADEMIC REFERENCE STANDARDS
(NARS)
FOR ENGINEERING**

DRAFT

Preface

The National Authority for Quality Assurance and Accreditation for Education (NAQAAE) has the honour to introduce to the higher engineering education institutions in Egypt the National Academic Reference Standards (NARS).

The National Academic Reference Standards (NARS) statements provide measures for the academic community to describe the nature and characteristics of academic programmes in certain field of specialty. They also represent general expectations about the qualifications, the attributes and capabilities that the graduates of those programmes should be able to demonstrate.

NARS is followed by the NARS Characterization where more explanations for the NARS of a specific discipline are introduced. NARS Characterization part sheds the light on the university, faculty and programme general requirements.

NARS and NARS Characterization statements are used for a variety of purposes. They are the basic national references for higher education institutions when programmes are newly designed or developed in certain specialty. They provide general guidance for articulating the essential learning outcomes associated with the programme but are not a specification of their details. NARS and NARS Characterization statements allow for flexibility in the design of programmes and encourage innovation within an agreed overall framework. NARS and NARS Characterization statements also provide support to institutions in pursuit of internal quality assurance. They enable the learning outcomes specified for a particular program to be reviewed and evaluated.

Finally, NARS and NARS Characterization statements are among the external sources of information that are drawn upon for the purposes of academic review and for making judgments about threshold standards being met. Reviewers do not use NARS and NARS Characterization statements as a crude checklist for these purposes, however. Rather, they are used in conjunction with the relevant programme specifications, the institution self-evaluation document, together with primary data in order to enable reviewers to come to a judgment based on a broad range of evidence.

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Preamble

The National Academic Reference Standards (NARS) provide a means for the academic community to describe the nature and characteristics of programmes in a specific subject area. They also represent general expectations about standards for the award of qualifications at a given level in terms of the attributes and capabilities that those possessing such qualifications should have demonstrated.

The NARS also provides support to institutions in pursuit of internal quality assurance. They enable the learning outcomes specified for a particular programme to be reviewed and evaluated against agreed general expectations about standards. The NARS statements allow for flexibility and innovation in programme design and can stimulate academic discussion and debate upon the content of new and existing programmes within an agreed overall framework.

The learning outcomes are expressed for the threshold level that engineering students would be expected to have attained upon graduation. It is anticipated that there will be many programmes where this threshold level will be exceeded. Programme providers should be able to use the NARS to establish standards for a diverse range of programmes, which should encourage innovation and creativity in curriculum design.

The NARS and NARS Characterization for the engineering disciplines are introduced in a single book starting with a first section covering the Engineering in general, followed by another part dedicated to different engineering disciplines.

Glossary

Academic Standards

Academic Standards statements provide measures for the academic community to describe the nature and characteristics of academic programs in a certain field of specialty. They also represent the general expectations about the qualifications, attributes and capabilities that the graduates of those programs should be able to demonstrate.

Knowledge and Understanding

The acquired knowledge and understanding of key facts, theories, concepts, principles and techniques relevant to specialized disciplines.

Intellectual Skills

Skills that demonstrate the ability to:

- Present, evaluate, and interpret qualitative and quantitative data, to develop lines of argument and make sound judgments in accordance with basic theories, concepts and know-how within the discipline
- Solve problems, even with limited or contradictory data, taking into concern different constraints, such as economy, safety, quality, environmental impacts and ethics.

Practical and Professional Skills

Skills that demonstrate the ability to:

- Apply and adopt the knowledge and intellectual skills into professional applications
- Use tools, techniques, equipment and software relevant to the discipline
- Develop, promote and apply reliable systems of work related to the profession

General and Transferable Skills

Those general skills which are central to occupational competence in all sectors and at all levels, such as:

- personal skills
- communication
- information technology
- working with others
- improving own learning and performance

SECTION 1 | NATIONAL ACADEMIC REFERENCE STANDARDS (NARS) FOR ENGINEERING

1.1 INTRODUCTION

Engineers solve real-life problems. They find the best solutions through the application of their knowledge, experience and skills. Engineers help to define and refine the way of life by providing innovative, higher-performance, safer, cleaner or more comfortable day-use facilities for human beings. They seek improvement through the processes of invention, design, manufacturing and construction.

The products of engineering activities are intended to be sustainable. However, drawbacks are associated with such activities; for example, the water, air, environment and acoustic pollution resulting of the same engineering marvels of decades ago.

The engineer's problem-solving complexity grows as the world's social and technological problems become more closely related. For example, the problem of air pollution cannot be solved physically without considering the social, legal, political, and ethical conflicts. Moreover, the impact of the available engineering solutions on the interests of the individuals and groups should be considered.

The engineering study provides the students with the advanced, effective, technology-based education justifying the expectations of the future of science and technology. It should also provide the technical understanding and problem-solving skills which allow coping with the challenges of tomorrow.

The NARS for Engineering sets out generic statements which represent general expectations about standards for the Bachelor of Science (B.Sc.) degree in Engineering. These statements clarify the attributes associated with the award of engineering degrees:

- The awards are in accord with the frameworks for contemporary engineering education.
- The Engineering degrees address the national expectations of the graduate engineers.
- The degrees satisfy the actual and expected market needs.

According to the Accreditation Board for Engineering and Technology (ABET), Engineering is the knowledge of the mathematical and natural sciences, gained by study, experience, and practice, applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind. It is the ability to initiate and conduct activity associated with engineering processes, systems, problems, opportunities, history, future, impacts, ethics and consequences. It involves knowledge, ways of thinking and acting, and capabilities. It helps prepare individuals to make well-informed choices in their roles as consumers, workers, citizens and members of the global community.

The engineering education should achieve excellence in undergraduate and graduate education, research, public service, and advancement of the state-of-the-art within the discipline. It aims to produce able, broadly educated, highly qualified engineers and useful creative high quality research and technology through academic excellence. Moreover, it intends to challenge the students, faculty and staff to learn, grow, achieve, and serve the needs of society nationally, regionally and internationally. It means also to prepare students for a productive and rewarding career in engineering based on a strong moral and ethical foundation.

1.2 THE ATTRIBUTES OF THE ENGINEER

The engineer must have the ability to:

- a) Apply knowledge of mathematics, science and engineering concepts to the solution of engineering problems
- b) Identify, formulate and solve engineering problems
- c) Exploit the techniques, skills and up-to-date engineering tools, necessary for engineering practice
- d) Design a system, component and process to meet the required needs within realistic constraints
- e) Consider the detrimental impact of engineering solutions on society and environment
- f) Design and conduct experiments and analyze and interpret data
- g) Demonstrate knowledge of contemporary engineering issues
- h) Work efficiently within multi-disciplinary teams
- i) Display professional responsibilities and ethical, societal and cultural concerns
- j) Communicate effectively
- k) Recognize the need to engage in self- and life-long learning
- l) Manage engineering projects subjected to economic, environmental and social constraints.
- m) Fulfill requirements of potential employers.

1.3 NATIONAL ACADEMIC REFERENCE STANDARDS (NARS) FOR ENGINEERING

The academic reference standards represent the general expectations about the qualifications, attributes and capabilities that graduates of the engineering programmes must be able to demonstrate.

1.3.1 Knowledge and Understanding:

Acquiring knowledge and understanding of:

- a) Concepts and theories of mathematics and sciences, appropriate to the discipline.
- b) Basics of information and communication technology (ICT)
- c) Principles of design including elements design, process and/or a system related to specific disciplines.
- d) Methodologies of solving engineering problems.
- e) Professional ethics and socio-economical impact of engineering solutions
- f) Current engineering technologies as related to disciplines.

- g) Quality assurance systems, codes of practice and standards, health and safety requirements and environmental issues.
- h) Business and management principles relevant to engineering.
- i) Contemporary engineering topics.
- j) Topics related to humanitarian interests and moral issues.
- k) The impact of engineering solutions in a global and societal context;

1.3.2 Intellectual Skills

The ability to:

- a) Select appropriate mathematical and computer-based methods for modeling and analyzing problems.
- b) Design and/or create a process, component or system applying appropriate knowledge and principles
- c) Select appropriate solutions for engineering problems based on analytical thinking
- d) Consider the applicability, economy and risk management in design.
- e) Assess and evaluate effectively the characteristics and performance of components, systems and processes
- f) Solve engineering design and production problems, often on the basis of limited and possibly contradicting information;
- g) Analyze results of numerical models and appreciate their limitations.
- h) Maintain a systematic and methodic approach in dealing with new and advancing technology,
- i) Reach engineering judgments considering balanced costs, benefits, safety, quality, reliability, and environmental impact.
- j) Analyze systems, processes and components critically.
- k) Select and appraise appropriate ICT tools to a variety of engineering problems.

1.3.3 Practical and Professional Skills

The ability to:

- a) Integrate knowledge of mathematics, science, information technology, design, business context and engineering practice to solve engineering problems
- b) Employ computational facilities, measuring instruments, workshops and laboratories equipment to design experiments and collect, analyse and interpret results.
- c) Merge engineering knowledge and understanding to improve design, products and/or services.
- d) Apply numerical modeling methods and/or appropriate computational techniques to engineering problems
- e) Implement comprehensive engineering knowledge and understanding and intellectual skills in projects
- f) Commercialize knowledge and skills to engineering community and industry
- g) Apply safe systems at work.
- h) Prepare and present technical material.
- i) Demonstrate project management skills
- j) Appreciate the neatness and aesthetics in design and approach.

1.3.4 General and Transferable Skills

The ability to:

- a) Collaborate effectively within multidisciplinary team.
- b) Work in stressful environment and within constraints.
- c) Communicate effectively.
- d) Demonstrate efficient IT capabilities.
- e) Lead and motivate individuals.
- f) Manage tasks and resources.
- g) Search for information and adopt life-long self learning.
- h) Acquire entrepreneurial skills.

1.4 NARS CHARACTERIZATION FOR ENGINEERING DISCIPLINES

1.4.1 Indicative Curricula Content by Subject Area

Table 1: Indicative curricula content by subject area

	Subject Area	%	Tolerance
A	Humanities and Social Sciences (Univ. Req.)	11	9-12 %
B	Mathematics and Basic Sciences	21	20-26 %
C	Basic Engineering Sciences (Faculty/Spec. Req.)	21	20-23 %
D	Applied Engineering and Design	21	20-22 %
E	Computer Applications and ICT*	10	9-11 %
F	Projects* and Practice	9	8-10 %
	Subtotal	93	92-94 %
G	Discretionary (Institution character-identifying) subjects	7	6-8 %
	Total	100	100%

* This part of the curriculum may be taught as separate course and/or included in several courses and its hours should be indicated in the course specification

1.4.2 Definition of Subject Areas

A- Humanities and Social Sciences

- a) Acquiring knowledge of non-engineering fields that strengthen the consciousness of the engineer of the society and its culture, including business, marketing, wellness, ethics, law, arts, etc.
- b) The ability to consider and evaluate the impact of the technology on the society, public health and safety.
- c) The ability to appreciate and engage in social and entrepreneurial activities essential to the engineering practice and reflect on the management of the economics and social science
- d) The ability to engage in life-long learning and respond effectively to the needs of the society.

B- Mathematics and Basic Sciences

Mathematics

- a) Acquiring knowledge in mathematical and analytical methods.
- b) The ability to reason about and conceptualize engineering components, systems or processes using analytical methods as related to the discipline.
- c) The ability to analyze and model engineering components, systems and processes specific to the discipline.
- d) The skill of using probability and statistical methods

Basic Sciences

- a) Acquiring knowledge of physics, chemistry, mechanics, earth sciences, biological sciences, and other specific subjects which focus on understanding the physical world.
- b) The ability to select and apply scientific principles in practical problem solving.
- c) The ability to analyze, model and reason about engineering components, systems or processes using principles and knowledge of the basic sciences as applicable in each engineering disciplinary context.
- d) The ability to adopt scientific evidence-based techniques in problems solving

C- Basic Engineering Sciences

- a) Integrating knowledge and understanding of mathematics, physical sciences to develop basic engineering laws and concepts related to the discipline.
- b) The ability to extend knowledge and develop models and methods and use techniques, principles and laws of engineering science in order to lead to engineering applications across disciplinary boundaries.
- c) The ability to deal effectively with numbers and concepts to identify/solve complex and open ended engineering problems.

D- Applied Engineering and Design

- a) Attaining knowledge of operational practice, engineering codes and design techniques relevant to the subject
- b) The ability to apply engineering knowledge and creative, iterative and open-ended procedures when conceiving and developing components, systems and processes.
- c) The ability to integrate engineering knowledge, engineering codes, basic and mathematical sciences in designing a component, a system or a process.
- d) The ability to work under constraints, taking into account time, economy, health and safety, social and environmental factors and applicable laws.

E- Computing and ICT

- a) Attaining knowledge of ICT principles.
- b) The ability to use computers, networks and software to support engineering activity, and to enhance personal/team productivity.
- c) The ability to assess, use and validate results produced by packages and create software as required in discipline.
- d) The ability to use general ICT tools effectively.

F- Project

- a) Gaining the knowledge and experience of applying the many principles and techniques introduced in the program of study.
- b) The ability to work within defined constraints, tackle work which lacks a well-defined outcome or which has a wide range of possible answers and exhibit creativity in dealing with unfamiliar real-life problems.
- c) The ability to investigate, plan and execute technical research specific to the discipline over an extended period of time; meeting deadlines and putting technical work in a social and commercial context.
- d) The ability to work in a team, search published sources of information, interpret technical data and analyze and present findings in various ways.

G- Discretionary Subjects

- a) Attaining knowledge and understanding of subjects selected by the institution to identify its character and/or satisfy the needs of the society.
- b) The ability to recognize, appreciate and respond effectively to the needs of the society via investing the technical knowledge specific to the discipline.
- c) The ability to lead and motivate people as well as organize and control tasks, people and resources.

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SECTION 2 | NARS CHARACTERIZATION FOR AEROSPACE ENGINEERING PROGRAMS

2.1 Introduction

Aerospace engineering programs use the basic laws of physical sciences, engineering sciences, space sciences, atmospheric sciences, earth sciences, life sciences, social science, and humanities to serve mankind.

Aerospace engineers should be curious about how flying crafts in atmosphere and in space are made to work. They have a desire to solve problems and a talent for understanding the operation of mechanical, electrical and electronic devices in flying systems. Aerospace engineers conceive, plan, analyze design and direct the production and manage the operation of a wide variety of flight system such as control, aviation, propulsion, power generation, materials, structures and aerodynamic systems of flying crafts whether in atmosphere or in space. Besides, an aerospace engineer needs to have basic knowledge on atmospheric environment and space physics. Aerospace engineers analyze their design using the basic principles of motion, energy, and momentum applied to fluid mechanics, material and structure mechanics, combustion mechanics, power generation mechanics, control mechanics and thermal control mechanics besides the laboratory experiments to insure that the flying crafts or the onboard systems functions safely, efficiently, reliably, and are manufactured at a competitive cost with minimized environmental hazards.

Aerospace Engineering is a broad discipline which covers the fields of solid and fluid mechanics, aerospace structural and material mechanics, aerodynamics, thermodynamics, propulsion and power generation systems, control systems, navigation systems, engineering design, production technology, economics and management. These basic studies are devoted to acquire sufficient knowledge on mechanical properties of materials, aerospace structural design, aircraft aerodynamic design, propulsion engine design, control and aviation system design and power generation system design. It is also devoted to acquire knowledge on structural, aerodynamic control and propulsion systems measurement techniques that can be used in a variety of facets of modern society. Undergraduate educational programs in Aerospace engineering are, therefore, specifically designed to provide a wide variety of topics. These include propulsion and power generation sciences, aerodynamics, fluid and thermal sciences, material and structural sciences, automatic control, propulsion system design, structural design, aerodynamic design, control system design besides the statistical studies required to ensure product reliability, quality assurance and control.

A B.Sc. degree in aerospace engineering is designed for students who seek careers as engineers in aviation companies, aerospace industry, aerospace and aviation activities, army, consulting firms and private and governmental agencies. This degree is also appropriate for students who plan to be researchers or who intend to pursue

an advanced degree in engineering. A typical program curriculum incorporates analytical tools, creative thought and diversity of skills as well as the state of art of the profession.

Job opportunities of Aerospace engineer

Besides working directly in private and governmental aviation, aerospace companies and activities. The aerospace engineer is a fit to inter-disciplinary private and governmental companies requiring the design, manufacturing, management, development and maintenance of light structural systems, aerodynamic systems, control systems, power generation systems, environmental systems, wind and solar energy systems, flight operations and information systems.

2.2 The Attributes of Aerospace Engineer

In addition to the general attributes of engineer, the aerospace engineer must be able to:

- a) Work professionally in the design maintenance of light structures, control systems, aerodynamic systems, propulsion systems, wind and solar energy systems and the analysis of environmental systems.
- b) Use of mathematical modeling and physical sciences and systems analysis tools in components and system design.
- c) Carry-out experimental design, automatic data acquisition, data analysis, data reduction, and data presentation, both orally and in the written form.
- d) Use the computer graphics for design, communication and visualization.
- e) Manage engineering projects subjected to economic and environmental and social constraints.
- f) Use and/or develop computer software, necessary for the design, manufacturing and management of aerospace systems.
- g) Analyze multi-disciplinary mechanical, electrical hydraulic and aerodynamic systems.

2.3 NARS for Aerospace Engineering

The following academic reference standards represent the general expectation about the qualifications attributes and capabilities that the graduates of Aerospace engineering programs must be able to demonstrate.

2.3.1 Knowledge and Understanding:

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, concepts, principles and theories relevant to Aerospace Engineering;
- b) The constraints within which his/her engineering judgment will have to be exercised;
- c) Science, mathematics and the technological base relevant to Aerospace Engineering;
- d) Relevant mathematical methods and the principles of engineering science as applied to Aerospace engineering systems;

- e) A number of engineering science disciplines
- f) The role of information technology in providing support for aerospace engineers
- g) Engineering design principles and techniques.
- h) Characteristics of engineering materials
- i) Management and business techniques and practices appropriate to Aerospace industry.
- j) The professional and ethical responsibilities Aerospace engineers.

2.3.2 Intellectual Skills

On successful completion of this programme graduate must be able to:

- a) Analyze and interpret data, and design experiments to obtain new data;
- b) Design a system, component or process to meet a need;
- c) Evaluate designs, processes and products, and propose improvements;
- d) Maintain a sound theoretical approach in dealing with new and advancing technology,
- e) Assess risks, and take appropriate steps to manage those risks.
- f) Interpret numerical data and apply mathematical methods to the analysis of engineering design problems
- g) Use the principles of engineering science in developing solutions to practical aerospace engineering problems.
- h) Solve aerospace design and production problems.
- i) Create new engineering components and processes through the synthesis of ideas from a range of sources.
- j) Develop computer programs;
- k) Use computational tools and software packages pertaining to the discipline;

2.3.3 Professional & Practical Skills

On successful completion of the programmes, students must be able to:

- a) Use a wide range of analytical and technical tools, techniques and equipment, including pertinent software;
- b) Use basic workshop equipment safely;
- c) Analyze experimental results and determine their accuracy and validity;
- d) Use laboratory equipment and related computer software;
- e) Search for information
- f) Prepare engineering drawings, computer graphics and specialized technical reports.
- g) Demonstrate basic organizational and project management skills.
- h) Carry out specialized engineering designs.
- i) Use and manage the exploitation of modern CAD and CAD/CAM facilities
- j) Work as a chief engineer in the aerospace operational, maintenance and overhaul firms.

SECTION 3 | NARS CHARACTERIZATION OF ARCHITECTURAL ENGINEERING

3.1 INTRODUCTION

The discipline of architecture draws on knowledge and skills from the human and natural sciences, humanities, and fine and applied arts. It addresses the accommodation of all human activities anywhere under all conditions, understanding our place within differing physical, historical, cultural, social, political and virtual environments. Architecture proposes, forms, and transforms our built environment through an engagement with the spaces, buildings, cities and landscapes in which we live. Architectural education is therefore rich, varied and by definition interdisciplinary.

The education for architects (apart from practical experience/training/internship) should be of no less than 5 years duration, delivered on a full-time basis in an accredited/validated/recognized architectural program and University, while allowing variety in their pedagogic approach and responses to local contexts, and flexibility for equivalency.

As professionals, architects have a primary duty of care to the communities they serve. In a world where trade in professional services is rapidly increasing and architects are regularly serving communities other than their own, there is a need for standards of architectural education locally and internationally.

3.2 THE ATTRIBUTES OF ARCHITECTURE ENGINEER

Architecture graduate must have the ability to apply basics, principles, theories, objectives and methods of the following concepts and skills and applying them on various levels:

- a) Architectural design;
- b) Urban and regional planning and methods of developing, criticizing and evaluating plans at various levels of the environment;
- c) Urban design and site planning;
- d) Building technology and environmental design (acoustics, illumination, climatology, etc.);
- e) Skills required for an architect and planner such as skills of reading, understanding, analyzing, and expressing creative ideas and concepts using high quality rendered architectural, planning and working, drawings, maps, documents, 3D models, etc.;
- f) Morals of practicing the architectural profession and the role of architect and planner in creating sustainable environment appropriate to specific social, economic and cultural requisites of the society at the local, regional, national and international levels;
- g) General awareness of various types of human and cultural knowledge of life.

3.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR ARCHITECTURE ENGINEER

Architectural education ensures that graduate has knowledge and ability in architectural design, including technical systems, requirements as well as health, safety, ecology considerations. It provides understanding of cultural, intellectual, historical, social, economic, and environmental context for architecture. The graduate comprehends thoroughly the architects' roles and responsibilities in society depending on a cultivated, analytical and creative mind.

3.3.1 Knowledge and Understanding

On successful completion of the programme, graduate must be able to demonstrate knowledge and understanding of:

- a) Seeking, defining and articulating architectural and urban planning problems.
- b) The concepts, methods and techniques of the building construction processes, its stages, elements, material, etc.
- c) The concepts, methods and techniques of mechanical installations' processes including structural, water, sewage, air conditioning systems.
- d) The pattern and problems of city at the local, urban and regional levels.
- e) Significance of urban spaces and the replicable effects between man and the visual elements of the city.
- f) Recognize and appreciate history of architecture and evolution of architectural theory from the past up to recent times.
- g) The structural behavior of buildings and construction elements and materials of various construction systems.
- h) The significance of mathematics, natural sciences, engineering information in architecture and the role of the architect in simulating and modeling of physical environment and its processes; and application of such information on the built environment.
- i) Appreciate the impact of advanced building technology on design.
- j) Preliminary and final design, working drawings and details of architectural and urban planning.
- k) Recognize and appreciate ethics and morals of practicing the architectural profession.
- l) The role and responsibility of the architect and planner in creating sustainable environment suitable for the specific social, economic and cultural requisites of the society at the local, regional, national and international levels

3.3.2 Intellectual Skills

On successful completion of this programme, graduate must be able to:

- a) Think systematically along the design process, analyze architectural and urban problem, propose alternative solutions, and select the best solutions- with high concern of the history of architecture, the evolution of its theories and applications over the years.
- b) Select and use design situations and solve design problems concentrating on analyzing specific groups of needs and producing new solutions and

designs at various levels of the system of design process of architectural, urban and planning projects under the challenge of resource management and information flow of the general design system.

- c) Solve technical and structural problems of buildings and analyze their elements, details, materials and methods of execution.
- d) Select and use innovative structural models.
- e) Produce innovative design ideas and concepts.

3.3.3 Professional Skills

On successful completion of the programme, graduate must be able to:

- a) Produce manual and technical production of 3D models of architectural projects.
- b) Prepare professionally sound technical scientific reports.
- c) Present architectural projects.
- d) Prepare and interpret technical drawings (architectural, structural, mechanical, engineering, air conditioning, water, sewage, etc.)- using both manual and computer-aided drawings' techniques.
- e) Recognize different construction and finishing materials and select appropriate material for each specific purpose.
- f) Manage construction processes.
- g) Analyze, understand and make use of environmental circumstances and contexts.
- h) Design and conduct laboratory and field experiments and compare, analyze and interpret the results.
- i) Produce new architectural forms and design solutions of real societal problems.

SECTION 4 | NARS CHARACTERIZATION OF AUTOMOTIVE ENGINEERING

4.1 INTRODUCTION

Automotive Engineering deals with the engineering problems, opportunities and needs of the automotive sector and related industries. The discipline focuses on the design and manufacture of automobiles and their component parts, as well as on the integration of components into an automotive system. The automotive sector includes automobiles as well as related transportation devices like trucks and motorcycles. This sector is continually advancing and giving rise to new opportunities and challenges especially as oil reserves are drying and energy alternative sources are being continually fetched.

Many engineering companies are involved in the automotive industry and the automotive sector plays a particularly vital role in the industrial economy.

The Automotive program is aimed at students wishing to pursue a career in the automotive industry. The program enables students to develop a thorough understanding of mechanical engineering principles, while at the same time developing expertise that is uniquely automotive in nature. The program will challenge students and faculty to improve the learning process.

Based on the Mechanical Engineering program, Automotive Engineering will provide students with a broad education designed to give them the skills necessary to become professional engineers. The first two years of the program are typically the same as those of Mechanical Engineering, concentrating on basic engineering principles and including studies in mathematics and the physical sciences. Later years build upon acquired knowledge and include specialized topics such as Automotive Safety, Alternative Fuels, Advanced Manufacturing, Automotive Power Train and Vehicle Dynamics, Automotive Combustion Technology, Automotive Suspension and Undercarriage, Automotive NVH and Aerodynamics, Automotive Electrical and Electronic Systems, Advanced Materials and Joining and Vehicle Emission Control. Engineering students are also required to undertake studies in courses designed to assist them develop the communication skills necessary to work effectively.

The field of automotive engineering is dependent on the application of computers in analysis, design, manufacturing, and operation of facilities. The program must demonstrate that graduates are competent in the application of computer technologies commonly used in industry, governmental service, and private practice associated with mobility and material requirements. Graduates must also demonstrate proficiency in the application of probability and statistics to the solution of mobility problems.

Graduates must have a working knowledge of the design, manufacture, and maintenance of major subsystems and technologies associated with mobility. However, in the field of automotive engineering, management and technology are

often inextricably intertwined. The program must demonstrate that graduates have developed the ability to apply modern and effective management skills in identification and investigation of problems, analysis of data, synthesis and implementation of solutions, and operations of facilities.

Career Opportunities

The Automotive Engineering program introduces principles covering a wide range of relevant areas, which allows graduates to be well prepared for careers in the automotive and other high-tech industries. However, being based on a Mechanical Engineering degree, graduates in Automotive Engineering will retain flexibility in the choice of engineering industry for their careers. In most cases graduates will also be able to work wherever mechanical engineers are employed.

4.2 THE ATTRIBUTES OF AUTOMOTIVE ENGINEER

The objectives of the undergraduate programs in Automotive Engineering are to provide an inclusive curriculum that allows all students to learn and progress unhindered through the program, and to develop graduates who are able to:

- a) Apply fundamental engineering science and engineering practice in the creation of engineering systems and utilize a system approach to design and operational performance.
- b) Have advanced and internationally recognized skills, (scientific knowledge, problem solving, IT, analytical and communication skills and flexibility in addition to in-depth technical competence) necessary for a successful career in Automotive Engineering.
- c) Locate, analyze evaluate and synthesize information from a wide variety of sources in a planned and timely manner.
- d) Contribute as effective members of multi-disciplinary and multi-cultural teams with the capacity to be a leader or manager as well as effective team members with skills a high order in interpersonal understanding, teamwork and communication.
- e) Have a commitment to continuous learning and the capacity to maintain intellectual curiosity throughout life and are able, by self directed study, to remain up to date with developments in their profession.
- f) Apply effective, creative and innovative solutions, both independently and cooperatively, to current and future problems and are able to guide developments in the profession.
- g) Understand the context in which they work (economics, finance, teamwork, competition) while remaining committed to the highest standard of professional endeavor, not losing sight of the need for technical excellence and environmental responsibility.
- h) Communicate with government and the community on engineering issues.
- i) Be familiar with current best practice in the Automotive engineering.
- j) Apply engineering techniques taking account of a range of commercial, industrial, environmental, ethical and social constraints.

4.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR AUTOMOTIVE ENGINEERS

The following academic reference standards represent the general expectations about the qualifications attributes capabilities that the graduates of Automotive programmes must be able to demonstrate.

4.3.1 Knowledge and Understanding

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Knowledge and understanding of the mathematical base, fundamental principles and concepts at an appropriate level and relevant to the core modules of the programme.
- b) A detailed knowledge and understanding of the themes and specialist subjects of the programme set in the context of engineering practice;
- c) Knowledge of analytical methods relevant to the core modules of the programme.
- d) Knowledge of design relevant to the core modules of the programme;
- e) Knowledge of business enterprise and management skills at an appropriate level and relevant to initial employment as a professional engineer who has the qualifications of the programme.
- f) Awareness of the professional and ethical responsibilities of an engineer.

4.3.2 Intellectual Skills

The ability to:

- a) Apply fundamental principles and concepts to the analysis and design of automotive engineering systems and the solution of engineering problems, at an appropriate level and relevant to the core modules of the programme.
- b) Apply project management knowledge and skills relevant to the qualifications of the programme, in an automotive engineering context
- c) Search for information in support of problem solving, design and development, followed by critical evaluation of alternatives and performance data.
- d) Produce solutions to automotive engineering problems in a creative and innovative way, taking account of industrial and commercial constraints.
- e) Apply management principles relating to engineering systems, computer systems development, quality improvement and assurance.
- f) Analyse and evaluate performance of engineering systems studied in their individual project.

4.3.3 Practical skills

The ability to:

- a) Using test & measurement equipment and conducting experimental laboratory and practical development work.
- b) Experience at an appropriate level to use computer-aided design and analysis packages relevant to the programme.

- c) Manipulate, sort and present data using modern IT aids.

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**SECTION 5 | NARS CHARACTERIZATION OF BIO AND
MEDICAL ENGINEERING**

Under Preparation

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SECTION 6 | NARS CHARACTERIZATION OF CHEMICAL ENGINEERING

6.1 INTRODUCTION

Chemical Engineering is a broad and versatile profession concerned with the development and application of processes in which chemical or physical changes of materials are involved. This branch of engineering is based on the sciences of chemistry, physics, mathematics, and the biosciences and is guided by the principles of economics. The work of the chemical engineer may be in research, development, design, sales, production, or in the engineering and management of process plants. These functions can be performed in a wide variety of areas, such as the chemical process industries, the petroleum and related (coal and shale) industries, pollution control, nuclear energy, etc.

Chemistry occupies a central position in modern science. The behavior of atoms and molecules underpins our understanding of almost all phenomena in the world. However, the manufacture of products applying this fundamental understanding of chemistry is quite different from the laboratory scale, and this is where chemical engineers apply their skills. Chemical Engineers are involved in developing new processes, synthesizing new products and optimizing the performance of existing process systems. Qualified chemical engineers can choose from a wide variety of career opportunities including plant management, research, commissioning, process safety, environmental protection, process control, consultancy or marketing and sales.

The headline of the brochure for the American Institute of Chemical Engineers states that chemical engineers are responsible for the production of items, “from microchips to potato chips.” Chemical engineers work in the chemical, fuel, aerospace, environmental, food, and pulp and paper industries, among many others. Chemical engineering is a problem-solving profession with a practical bias; expect to answer the question “how” more than any other. Chemical engineers translate the discoveries chemists make into real-world products. If a chemist invents a better fertilizer, for example, a chemical engineer might design the method to make mass production of that fertilizer possible.

Chemical engineers may work in:

Chemical engineers apply the principles of chemistry to solve problems involving the production or use of chemicals and bio-chemicals. They design equipment and processes for large-scale chemical manufacturing, plan and test methods of manufacturing products and treating byproducts, and supervise production. Chemical engineers also work in a variety of manufacturing industries other than chemical manufacturing, such as those producing energy, electronics, food, clothing, petrochemicals, petroleum refining, pharmaceuticals and paper. They also work in health care, biotechnology, and business services. Chemical engineers apply

principles of physics, mathematics, and mechanical and electrical engineering, as well as chemistry. Some may specialize in a particular chemical process, such as oxidation or polymerization. Others specialize in a particular field, such as nano-materials, or in the development of specific products. They must be aware of all aspects of chemicals manufacturing and how the manufacturing process affects the environment and the safety of workers and consumers.

Within these industries, chemical engineers rely on their knowledge of mathematics and science, particularly chemistry, to overcome technical problems safely and economically. And, of course, they draw upon and apply their engineering knowledge to solve any technical challenges they encounter.

Specifically, chemical engineers improve food processing techniques, and methods producing fertilizers, to increase the quantity and quality of available food. They also construct the synthetic fibers that make our clothes more comfortable and water resistant; they develop methods to mass-produce drugs, making them more affordable; and they create safer, more efficient methods of refining petroleum products, making energy and chemical sources more productive and cost effective.

Chemical engineers also develop solutions to environmental problems, such as pollution control and repudiation. And they process chemicals, which are used to make or improve just about everything around. Chemical engineers face many of the same challenges that other professionals face, and they meet these challenges by applying their technical knowledge, communication and teamwork skills; the most up-to-date practices available; and hard work.

NARS Characterization for chemical engineering is framed so as to:

Promote diversity of provision and encourage institutions to explore new ways to enhance the knowledge and awareness of their students about the broad features of chemical engineering and inspire a sense of excitement of this rapidly developing discipline.

6.2 THE ATTRIBUTES OF CHEMICAL ENGINEERS

In addition to the general attributes of an engineer, the chemical engineer must be able to:

- a) Build upon sound foundation in mathematics and other request science
- b) Utilize and manage resources creatively through effective analysis and interpretation.
- c) Recognize the potential and applicability of computer based methods in chemical engineering design.
- d) Draw upon a basic knowledge of chemical process industries.
- e) Address the issues of process dynamics and control in plant operation.
- f) Plan and execute research work, evaluate outcomes and draw conclusions.
- g) Relate chemical reactions and their characteristics to process industries.
- h) Engage in safe laboratory practice.
- i) Apply knowledge and skills to respond to the recent technological changes.
- j) Identify and control the impact that chemical engineering has on society from an environmental, economic, social and cultural point of view.
- k) Recognize the challenging role and responsibilities of the professional engineer, while abiding by the ethics of the profession.

6.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR CHEMICAL ENGINEERS

6.3.1 Knowledge and Understanding:

- a) Students must have a knowledge and understanding of:
- b) Mathematical methods appropriate for application in engineering design.
- c) **The principles of physics, chemistry and mechanics; and applications in chemical engineering.**
- d) **The fundamentals, basic characteristics and features of organic and inorganic reactions, and their application in chemical process industries including petroleum refining, natural gas processing, petrochemicals industry, electrochemistry, fertilizers and ceramics, etc.**
- e) The characteristics of the different states of matter and interfaces between them.
- f) The conventional procedures of chemical analysis and characterization of common engineering materials and components.
- g) The principles of chemical engineering including chemical reaction equilibrium and thermodynamics; mass and energy balance; transport processes; separation processes, mechanical unit operations and process control.
- h) The principles of ICT relevant to chemical engineering.
- i) General principles of design techniques specific to particular products and processes including reactor and vessel design.
- j) Risk and hazards in chemical plants and employing safe engineering practice.
- k) Environmental impact of various industries, waste minimization and treatment of industrial facilities.
- l) Professional and ethical responsibilities including awareness of the global and social context of engineering and state-of-the-art technology.
- m) Project management, process design and simple economic calculations applicable in chemical engineering plants.

6.3.2 Intellectual Skills

On successful completion of the program students must be able to:

- a) Integrate processing steps into a sequence and apply analysis technique such as energy and mass balance.
- b) Summarize and select the appropriate techniques relevant to different industries.
- c) Employ scientific evidence based methods in solving chemical engineering problems.
- d) Collect data, draw simplified equipment flow sheets, charts and curves and interpret data derived from laboratory observation.
- e) Synthesize new processes or products through utilization and effective management of available resources.
- f) Identify and control the impact that chemical engineering has on society from an environmental, economic, social and cultural point of view, taking into account technical risk assessment.

6.3.3 Professional and Practical Skills

On successful completion of this program students must be able to:

- a) Perform complete mass and energy balances for chemical engineering plants.
- b) Apply the principles of chemical equilibrium and process thermodynamics to systems with chemical reactions.
- c) Identify major problems and conduct troubleshooting in chemical engineering plants.
- d) Use chemical engineering IT tools and programming in design.
- e) Demonstrate a comprehensive understanding of design methodologies related to chemical engineering and apply and adapt them to unfamiliar situations, with special consideration given to state-of-the-art technologies.
- f) Determine the characteristics and performance of measurement and control systems.
- g) Employ principles and concepts of transport phenomena in problem solving.**
 - h) Conduct cost estimation for various industries.
- i) Undertake the safe handling of chemical materials, taking into account their physical and chemical properties, including risk assessment of any specific hazards associated with their use.
- j) Undertake experimental work and practical testing, using standard chemical engineering laboratory procedures or through simulation and applying technical analysis and critical evaluation of results.
- k) Effectively integrate presentation techniques and the information to be presented for maximum impact.
- l) Work with minimum supervision, exhibiting self and life-long learning skills.
- m) Demonstrate effective numerical and computation skills including error analysis, estimations of orders of magnitude, correct choice of units, and different methods for prosecution of data.
- n) Demonstrate project management skills.

SECTION 7 | NARS CHARACTERIZATION OF CIVIL ENGINEERING

7.1 INTRODUCTION

Civil Engineering is the profession that provides the community with a wide range of civil works and structures for better and easier living conditions. Civil engineering programmes use mathematics, natural sciences, engineering and human sciences to provide easier life for mankind.

Civil engineer is responsible among his community, industry or society for establishing the safe, economic, healthy and convenient accommodation for every individual in the society.

Civil engineer selects, plans, and designs roadways that provide –from an engineering perspective- suitable, safe, secure and economic traffic means for all user groups. He is capable too of providing the suitable water resource for communities and making the adequate design of water and sewerage networks and public works' installations. In addition to managing construction sites, the civil engineer can design and supervise construction of all sorts of buildings such tower buildings, bridges, harbors and airports, that are required for the development, welfare and independence of the society.

Civil engineer takes the responsibility of planning and designing the adequate structures for protection against the dangers of unexpected floods, storms and wave actions. He can also select and design the adequate repair procedures for structures of all types.

Civil engineer is capable of permanently providing the community with every new and up-to-date development in all civil engineering branches through long life learning.

Civil engineer may work as planner, designer, construction supervisor, construction manager and consultant for private and governmental firms in disciplines involving structures of all types, building materials, geotechnics and foundations, roadways and traffic engineering, surveying works, environmental engineering, water and sewerage networks, treatment plants, water resources, hydrology, irrigation and water control structures.

7.2 THE ATTRIBUTES OF A CIVIL ENGINEER

In addition to the general attributes of engineer, the civil engineer must be able to:

- a) Act professionally in design and supervision of civil engineering disciplines.
- b) Use the codes of practice of all civil engineering disciplines effectively and professionally.

- c) Design, construct and protect all types of excavations and tunneling systems for different purposes.
- d) Manage construction sites.
- e) Select appropriate building materials from the perspective of strength, durability, suitability of use to location, temperature, weather conditions and impacts of seawater and environment.
- f) Select and design adequate water control structures, irrigation and water networks, sewerage systems and pumping stations.
- g) Define and preserve properties (lands, real estates) of individuals, communities and institutions, through different surveying and GIS tools.
- h) Plan, design, construct, operate, control and carry out maintenance of all types of roadways and traffic means.
- i) Design and construct structures for protection against dangers of unexpected natural events such as floods and storms.
- j) Lead and supervise a group of designers and site or lab technicians

7.3. NATIONAL ACADEMIC REFERENCE STANDARDS FOR CIVIL ENGINEER

7.3.1 KNOWLEDGE & UNDERSTANDING

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, concepts, principles and theories relevant to civil engineering.
- b) Natural sciences, mathematical methods and principles of civil engineering sciences as applied to civil engineering systems.
- c) Engineering principles in the fields of reinforced concrete and metallic structures analysis and design, geotechnics and foundations, hydraulics and hydrology, water resources, environmental and sanitary engineering, roadways and traffic systems, surveying and photogrammetry.
- d) Properties, behavior and fabrication of building materials. Pro
- e) Up-to-date technology relevant to civil engineering disciplines.
- f) Projects' and construction management, including planning, finance, bidding and contracts.
- g) Procedures and quality systems.
- h) Codes of practice in civil engineering disciplines and the regulatory framework in design and practice.
- i) Professional and ethical responsibilities that should be taken by civil engineer.
- j) Broad education necessary to understand the impact of civil engineering solutions on the environment.

7.3.2 Intellectual Skills

On successful completion of this programme graduates must be able to:

- a) Adopt, create and innovate thinking in solving problems, and in designing systems, components and processes.
- b) Demonstrate a high level of competence in identifying, defining and solving civil engineering problems.
- c) Adopt appropriate mathematical principles, natural sciences, technology, computing methods, design techniques and codes of practice in civil

- engineering disciplines, for modeling, analyzing and solving engineering problems.
- d) Apply appropriate structural analysis and codes of practice in designing reinforced concrete and metallic structures of all types
 - e) Apply appropriate geotechnical techniques and codes of practice to determine levels, types and design systems of building foundations, tunnels and excavations.
 - f) Define, plan, conduct and report management techniques.
 - g) Assess and evaluate different techniques and strategies for solving engineering problems.
 - h) Apply engineering principles, theories and sciences in solving environmental and socioeconomic problems.
 - i) Solve engineering problems, on the basis of limited and possibly contradictory information.
 - j) Maintain a sound theoretical approach in dealing with new and advancing technology.
 - k) Select and apply appropriate IT tools to a variety of engineering problems
 - l) Assess and analyze risks, and take appropriate steps to manage them

7.3.3 Professional & Practical Skills

On successful completion of this programme graduates must be able to:

- a) Use laboratory and field equipment competently and safely.
- b) Observe record and analyze data in laboratory as well as in the field.
- c) Demonstrate basic organizational and construction management skills.
- d) Use appropriate specialized computer software, computational tools and packages.
- e) Prepare technical drafts and finished drawings both manually and using CAD.
- f) Prepare quantity surveying reports.
- g) Give technical presentations.
- h) Refer effectively to relevant literature

SECTION 8 | NARS CHARACTERIZATION OF COMPUTER ENGINEERING

8.1 INTRODUCTION

Computer engineering (CE) is a discipline that embodies the science and technology of design, construction, implementation, and maintenance of software and hardware components of modern computing systems and computer-controlled equipment. Computer engineering has traditionally been viewed as a combination of both computer science (CS) and electrical engineering (EE). Computer engineering is a field that experiences effects from rapid technological development in different real life applications. Computer engineering programs use basic mathematics, sciences, engineering and electronics, physical and human sciences to provide new computer technologies and systems that make human applications easier, more productive, faster and also enjoyable to use.

A computer engineer is a person trained to be proficient in the design and implementation of computer systems, both hardware and software. Essentially, one must be able to design digital control circuitry and program it to function in the proper manner. To perform these tasks, one must usually be knowledgeable and capable in mathematics and sciences. However, pure theory is not enough to make a person a good computer engineer. Real world experience through practice of engineering concepts is also very important and can distinguish between a computer engineer and another.

Computer engineer must possess a considerable knowledge of mathematics. He must also possess knowledge of physics and other experimental sciences, general engineering and the systems that are employed in the field of computer engineering in order to be able to operate those systems. An obvious knowledge requirement for the computer engineer is knowledge of computers and electronics, since a computer engineer must understand how electronics and computers work in order to perform their job in a proper manner.

Computer engineer should be capable of permanently providing the society with every state-of-the-art developments in computer technologies and their applications to real life systems through life-long learning.

Computer Engineer may work in:

Private and governmental firms and agencies, where it is required to design, manufacture, operate, develop or maintain computer systems or computer-controlled systems. He/She may also work as a computer network engineer.

8.2 THE ATTRIBUTES OF A COMPUTER ENGINEER

Computer engineering is a field that requires many skills. In addition to the general attributes of an engineer, the computer engineer must be able to:

- a) Apply knowledge of computing, mathematics, physics and logical skills appropriate to the computer engineering discipline;
- b) Analyze a problem, and identify and define the computing requirements appropriate to its solution;
- c) Design, implement and evaluate a computer-based system, process, component, or program to meet desired needs;
- d) Use general computer and software tools professionally;
- e) Analyze operations, realize requirements and constraints of projects and, consequently, achieve an appropriate cost effective design.
- f) Perform troubleshooting in computer systems.
- g) Exhibit competency in English as a second language as suitable for the discipline
- h) Demonstrate inductive reasoning abilities, figuring general rules and conclusions about seemingly unrelated events
- i) Analyze the local and global impact of computing on individuals, organizations and society;
- j) Use current advanced techniques, skills, and tools necessary for computing practices.

8.3 NATIONAL ACADEMIC REFERENCE STANDARDS (NARS) FOR COMPUTER ENGINEERING PROGRAMS

8.3.1 KNOWLEDGE & UNDERSTANDING

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, concepts, principles and theories relevant to computer engineering;
- b) Relevant mathematical methods, physical laws and the principles of electronic engineering science as applied to computer engineering systems;
- c) Engineering principles in the fields of logic design, circuit analysis, machine and assembly languages, computer organization and architectures, memory hierarchy, advanced computer architectures, embedded systems, signal processing, operating systems, real-time systems and reliability analysis.
- d) Quality assessment of computer systems;
- e) Principles of design specific to computer engineering;
- f) Broad general education necessary to understand the impact of computer engineering solutions in a global and societal context;
- g) Related research methods and approaches to create more advanced products.

8.3.2 Intellectual Skills

On successful completion of this program graduates must be able to:

- a) Demonstrate a high level of competence in identifying, defining and solving computer engineering problems;
- b) Select and apply appropriate mathematical tools, computing methods, design techniques and tools in computer engineering disciplines, for modeling and analyzing computer systems;

- c) Evaluate different techniques and strategies for solving computer engineering problems;
- d) Maintain a sound theoretical approach in dealing with new and advancing technology;
- e) Select and apply appropriate IT tools to a variety of computer engineering problems.

8.3.3 Professional & Practical Skills

On successful completion of this program graduates must be able to:

- a) Use laboratory and field equipment competently and safely;
- b) Observe, record and analyze data in laboratory as well as in the field;
- c) Use appropriate specialized computer software, computational tools and packages;
- d) Write computer programs.
- e) Integrate technical professionalism and societal and ethical responsibility

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Section 9 | NARS Characterization of Electrical Power Engineering

9.1 Introduction

Electrical power and machines engineering discipline is that main branch of electrical engineering which concerns with generation, transmission, distribution, utilization, and control of electric energy. The vast electrical power systems which expand over each nation in the world and interconnection networks among neighboring countries are considered the largest and most complex man-made systems. Proper planning, design, implementation, operation and control of these large-scale electrical power systems require advanced engineering knowledge and techniques. Electrical generators are used in power stations to convert thermal or hydraulic energy into electrical energy. Electric motors are the essential parts for driving all kinds of machines in industrial plants and are also used for driving electric transport systems. Electrical transformers can change voltage levels, thus facilitate electrical power transmission over long distances. Modern power electronics and automatic control techniques are extensively employed in electrical power and machines systems for improving performance, operation and control.

The electrical power and machines engineering program consists of two main fields, namely electrical power engineering subjects and electrical machines engineering subjects. These are essentially supported by two main topics: automatic control engineering and power electronics subjects. Other essential subjects in the program include electrical circuits, electronic circuits and devices, electromagnetism, energy conversion, measurements and computer programming. Basic subjects in the program include mathematics, physics, materials engineering, workshop technology, laboratories, management and environmental issues. The electrical power and machines engineering program should be characterized by the following properties:

- To provide students with a wide and comprehensive introduction to basic sciences and mathematics with a thorough understanding of the fundamental knowledge necessary for engineering studies.
- To provide students with basic engineering skills of drawings, workshop technologies, laboratories and practical field training.
- To provide students with the required depth in electrical power and machines engineering subjects necessary for performing engineering jobs.
- To provide students with essential knowledge of highly interest for future postgraduate studies and research in the field of electrical engineering.
- To provide students with principals of engineering design skills including creative ideas, project innovation, practical synthesis and management.
- To provide students with a necessary environment to work both individually and within groups, thus developing their communications skills.

The educational objectives of electrical power and machines engineering program should be designed to produce engineers who are ready to contribute effectively to the advancement of electrical engineering profession and to accommodate the needs

of local and global industries. Specific educational objectives may be summarized as follows:

- To prepare undergraduate students who will be able to create new ways to meet society's needs through the applications of fundamentals of engineering sciences to practical problems using design, analyses and syntheses of electrical components, circuits, and systems. Thus, becoming successful engineering problems solvers, life long learners, innovators, and professionals in the field of electrical power and machines.
- To prepare engineers who will become leaders in the electrical power and machines engineering profession, and be able to shape the social, intellectual, business and technical activities.
- To prepare engineers who will be able to work on electrical power and machines systems including the design and realization of such systems.
- To insure that students are exposed to elements of social sciences, humanities and environmental studies so that they understand the necessities for professionalism, ethical responsibilities and the needs to function in multidisciplinary teams.
- To prepare students to express themselves effectively in both oral and written communication.
- To prepare students for engineering analyses and problem solving using appropriate mathematical and computational methodologies.
- To teach students to use experimental and data analysis techniques for electrical power and machines engineering applications.
- To provide students with awareness of tools and skills necessary for participating effectively in building a strong national economy and to meet current and future modern industry needs.
- To provide various industries by highly qualified electrical power and machines engineers who have a broad knowledge of electrical engineering and related principles, theories and applications.

COMMUNITY DEVELOPMENT

Electrical energy is the most essential part for all phases in modern societies. Electrification has made large-scale manufacturing possible, encouraged the growth of cities, modern farming, and magnified our ability to communicate. One measure of the nation's development is the yearly electrical energy consumption per capita. Modern life in every where in the world depends mainly on electrical energy. Electricity is required to drive machines in all industries, agriculture equipment, electrical transportation, and home appliances. Electrical lighting is used in streets, and residential, public, commercial and industrial buildings. Electrical power and machines engineers serve the society by providing electrical energy with high quality, safety and reliability at any time and any place throughout the country.

JOB OPPORTUNITIES FOR GRADUATES

As electricity is needed in all places in the society, electrical engineers are required in every place of our life. Typical job opportunities for electrical power and machines engineers are as follows:

- Electrical distribution companies
- Electrical generation companies
- Electrical power stations

- Electrical transmission company and energy control centers
- Ministry of electricity and energy and associated organizations
- New and renewable energy authority
- Oil and Petrochemicals sectors
- Electrical equipment and components factories
- Electronics industries
- Under ground and other transportation organizations

9.2 THE ATTRIBUTES OF ELECTRICAL ENGINEERS

In addition to the general attributes of engineer, the civil engineer must be able to:

- a) grasp concepts quickly are essential.
- b) Design and supervise the construction of systems to generate, transmit, control and use electrical energy.
- c) Design and develop heavy equipment, such as generators, motors, transmission lines and distributing systems.
- d) Design components, systems and processes to serve economic or social needs;
- e) Plan and manage engineering activity
- f) Assess the impact of engineering work on society, the economy and the environment
- g) Communicate effectively, both orally and in writing, with fellow professionals and laypersons;

9.3 NATIONAL ACADEMIC STANDARDS FOR ELECTRICAL POWER ENGINEERS

9.3.1 KNOWLEDGE AND UNDERSTANDING

Electrical power and machines engineering graduates must have the following knowledge and understanding:

- a) Principles of mathematics necessary to study and understand performance and behavior of electrical components and systems.
- b) Principles of sciences (physics and chemical engineering) relevant to electrical engineering.
- c) Basic engineering sciences and technology.
- d) Analytical and computer methods appropriate for electrical power and machines engineering.
- e) Design methods and tools for electrical power and machines equipment and systems.
- f) Principles of operation and performance specifications of electrical and electromechanical engineering systems.
- g) Fundamentals of engineering management and ethical responsibilities of electrical engineer.

9.3.2 Intellectual Skills

Electrical power and machines engineering graduates must be able to:

- a) Solve problems, including those that have no unique solution;

- b) Identify and formulate engineering problems and apply their knowledge of mathematics, sciences and engineering tools along with creativity skills to solve problems in the field of electrical power and machines engineering.
- c) Interpret numerical data and apply mathematical methods to the analysis of engineering design problems
- d) Assess risks, and take appropriate steps to manage those risks.

9.3.3 Professional and Practical Skills

Electrical power and machines engineering graduates must be able to:

- a) Design and perform experiments, as well as analyze and interpret experimental results related to electrical power and machines systems.
- b) Test and examine components, equipment and systems of electrical power and machines.
- c) Integrate electrical, electronic and mechanical components and equipment with transducers, actuators and controllers in creatively computer controlled systems.
- d) Specify and evaluate manufacturing of components and equipment related to electrical power and machines.
- e) Apply modern techniques, skills and engineering tools to electrical power and machines engineering systems.

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Section 10 | NARS Characterization of Electronic Engineering

10.1 INTRODUCTION

Electronics becomes more and more influential on the human society. The reason for this is that almost all electronic products are produced in huge quantities so interfering with every one's life. In addition, electronic subsystems become part of almost any industrial product nowadays. Beside the basic laws of physical sciences, mathematics, and basic engineering sciences, electronics engineering programs combine electronic engineering principles and traditional computer science with good practice in design and project management applied to technically demanding problems. Graduates will be well qualified to play a disciplined and innovative part in research and development across the IT and Electronics sector.

An electronics engineer should have strong background in basic science and basic mathematics and be able to use these tools in their own engineering field. He should employ necessary techniques, hardware, and communication tools for modern engineering applications. He also should be able to work in a multi-disciplinary environment, and follow and contribute to the developments in their own field recognizing the significance of lifelong learning.

Electronics engineering is a broad discipline that covers the fields of integrated electronic circuits, electronic data storage, high-speed computing, communications, signal processing, microwave, wave propagation and antenna, optoelectronics, automation, automatic control and monitoring systems, circuit analysis, network analysis, digital signal processing, and microprocessors.

Programs of electronics engineering are designed to strike a balance between theoretical and laboratory experience and to impart fundamental and practical understanding of the principles required for a successful career in electronics engineering. This requires a solid core of foundation courses in physics, mathematics, computer science, and general engineering, which is also essential for lifelong learning. Concentration courses in Electronics Engineering (that integrate theory and laboratory wherever possible) cover electromagnetic, wave propagation and antenna, circuits, electronics, power electronic devices, digital logic design, computers, programming, computer networks, signal processing, optoelectronics and communications. Courses of interest are electric machinery, power system, classical control, modern control, industrial electronics circuits, digital control techniques, robotics, mechatronics, biomedical systems and modern automation systems. The capstone senior thesis and industrial internship are also required. State-of-the-art electronics engineering elective courses provide seniors and advanced undergraduates.

Graduates who followed one of electronics engineering programs are careered into jobs including manufacturers of mobile phones, telephone centrals, computers,

antenna and radar systems, industrial control, home appliances, biomedical engineering, networking companies, communication systems, and integrated circuits. Others have joined research groups in university and industry, the public service, and the teaching professions.

10.2 THE ATTRIBUTES OF AN ELECTRONICS ENGINEER

In addition to the general attributes of engineer, the civil engineer must be able to:

- a) Apply basic knowledge and concepts of mathematics and sciences and engineering principles to electronics systems.
- b) Be able to communicate effectively, both orally and in writing.
- c) Have the ability to design and execute an individual project.
- d) Be able to understand environmental, economics and community impacts on development.
- e) Have the relevant mathematical and computational skills.
- f) Participate in and lead quality improvement projects.
- g) Know the technology required to design, build, operate and maintain electronic systems, analog or/and digital, and all types of computers.
- h) Manipulate with the electronic circuits, all the way from the discrete components level, circuits' analysis and design, to the troubleshooting with emphasis on electronic power devices.
- i) Realize control theory and measurement systems for industrial variables, signal conversion, conditioning and processing.
- j) Deal with the computers hardware, software, operating systems and interfacing.
- k) Know the field of digital and analog communication, mobile communication, coding, and decoding.
- l) Familiarize her/him-self with the nano-technology that will invade the electronics world in the future.
- m) Be able to understand communication systems, signal processing, and optoelectronics.

10.3 NATIONAL ACADEMIC REFERENCE STANDARDS (NARS) FOR ELECTRONIC ENGINEERING

10.3.1 Knowledge and Understanding:

On successful completion of the programs, graduates must be able to demonstrate knowledge and understanding of

- a) Basics of mathematical techniques to help model and analyze systems, and use mathematics as a tool for communicating results and concepts;
- b) Elementary science underlying electronic engineering systems and information technology;
- c) Basics of design and analyzing electronic engineering systems, while considering the constraints of applying inappropriate technology and the needs of commercial risk evaluation;
- d) Managing and practicing business, including finance, law, marketing and quality control;
- e) The professional and ethical responsibilities of engineer
- f) Analyzing and design of electronic circuits and components;

- g) Analyzing and design of control systems with performance evaluation;
- h) Biomedical instrumentation;
- i) A range of programming languages and environments;
- j) Broad lines of industrial process engineering;
- k) Communication systems
- l) Coding and decoding techniques
- m) Microwave applications
- n) Antenna and wave propagation
- o) Nanotechnology application
- p) Usage of optical fiber
- q) Methods of fabrication of Integrated circuits
- r) Analysis of signal processing
- s) Optical communication systems

10.3.2 Intellectual Skills

On Successful completion of the programmes, graduates must be able to:

- a) Select and apply appropriate scientific principles, mathematical and computer-based methods for analyzing general electronic engineering systems.
- b) Initiate creative thinking for resolving and developing innovative solutions for the practical industrial problems.
- c) Organize tasks into a structured form.
- d) Understand the evolving state of knowledge in a rapidly developing area.
- e) Transfer appropriate knowledge and methods from one topic to another.
- f) Plan, conduct and write a report on a project or assignment.
- g) Prepare an oral presentation.
- h) Approach the suitable tools for solving problems to tackle any practical problems in the electronics field.
- i) Analyze, interpret, and explain data and design experiments to obtain new data
- j) Develop computer programs.
- k) Select and apply appropriate IT tools to a variety of engineering problems.

10.3.3 Practical Skills

On Successful completion of the programmes, graduates must be able to:

- a) Use appropriate mathematical methods or IT tools.
- b) Program a computer to solve problems.
- c) Use relevant laboratory equipment and analyze the results correctly.
- d) Troubleshoot, maintain and repair almost all types of electronic systems using the standard tools.
- e) Synthesis and integrate electronic systems for certain specific function using the right equipment.
- f) Design, build and test a system.
- g) Use appropriate analysis and design tools.
- h) Explain appropriate specifications for required devices.
- i) Use appropriate tools to measure system performance.
- j) Program a computer to solve problems.
- k) Utilize project management methods.
- l) Present work both in written and oral form.

Section 11 | NARS Characterization of Industrial Engineering

Under Preparation

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Section 12 | NARS Characterization of Marine Engineering and Naval Architecture

12.1 INTRODUCTION

Marine engineering and naval architecture program concerns with the design, repair and operation for all floating units at sea, lakes and rivers. It depends mainly on the basic sciences, physical, engineering and human sciences connected with the transportation of human and cargo by sea, lakes or rivers in the most easy and safe way.

The sailing or floating vehicles with crew onboard are units with all facilities to sustain life, such as food, electrical and mechanical power, fresh water, sewage plant and recreation areas.

The marine engineer and naval architect should be capable of understanding the nature of floating units and their building and design methods. He/she should also be familiar with the working principals of all machineries and equipment on board these units. This requires the sufficient knowledge about mechanical, structural and electrical engineering.

A B.Sc. degree in marine engineering and naval architecture is designed for students who seek careers in shipbuilding and repair industry (such as shipyards) ,naval yards, classification societies, surveyors as well as marine engineers on board ships, offshore drilling rigs, navy force, ports and maritime transport companies. This degree is also appropriate for students who plan to be researchers or who intended to pursue an advanced or specialized degree in engineering.

A typical program curriculum incorporates analytical tools, creative thoughts and diversity of skills as well as the state of the art of the profession.

Marine and naval architecture engineers may work in ship building and repair yards, ports, navy, classification societies, and onboard ships (sea going and inland units) and floating units such as offshore drilling rigs.

12.2 THE ATTRIBUTES OF A MARINE AND NAVAL ARCHITECTURE ENGINEER

In addition to the general attributes of engineer, the marine and naval architecture engineer must be able to:

- a) Work professionally in the marine and naval systems design and manufacturing
- b) Use of mathematics and physical sciences and system analysis tools in ship's hull design in addition to propulsion and auxiliary machineries and equipment
- c) Understand and apply of all the International Conventions and national maritime laws in ship design and operation
- d) Choose the adequate building materials from the prospect of strength, durability, suitability and environmental conditions

- e) Use of computer graphics for design, communication and visualization
- f) Use of the industry standard software packages (hull, nesting, piping, ..etc) CAD/CAM and develop what is necessary to design and build marine systems.
- g) Managing the shipbuilding projects taking into consideration the economic , environmental, and social constrains
- h) Preserve clean and healthy environment during building and operating the floating units

12.3 NARS FOR MARINE ENGINEERING AND NAVAL ARCHETICTURE

The following academic reference standards represent the general expectation about the qualifications attributes and capabilities that the graduates of Marine engineering and naval architecture programs must be able to demonstrate.

12.3.1 Knowledge and Understanding:

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, concepts, principles and theories relevant to Marine Engineering;
- b) The constraints within which his/her engineering judgment will have to be exercised;
- c) Science, mathematics and the technological base relevant to Marine Engineering;
- d) The impact of engineering solutions in a global and societal context;
- e) Relevant contemporary issues;
- f) Relevant mathematical methods and the principles of engineering science as applied to Marine engineering and naval architecture systems;
- g) A number of engineering science disciplines such as Mechanical, Electrical and structural Engineering;
- h) The role of information technology in providing support for Marine engineers
- i) Engineering design principles and techniques;
- j) Characteristics of engineering materials;
- k) Management and business techniques and practices appropriate to engineering industry.
- l) The professional and ethical responsibilities of engineers.

12.3.2 Intellectual Skills

On successful completion of this programme graduate must be able to:

- a) Create and innovate in solving problems, and in designing systems, components and processes;
- b) Apply the appropriate tools from mathematics, science and technology and coupling these with know-how drawn from the experience of the profession;
- c) Solve engineering ship design and shipbuilding problems, often on the basis of limited and possibly contradicting information;
- d) Analyze and interpret data, and design experiments to obtain new data;
- e) Analyze results of numerical models and appreciate their limitations.
- f) Design a marine system, component or process to meet a need;
- g) Evaluate designs, shipbuilding processes and propose improvements;

- h) Maintain a sound theoretical approach in dealing with new and advancing technology,
- i) Take a holistic approach, applying professional judgments, balancing costs, benefits, safety, quality, reliability, and environmental impact.
- j) Assess risks, and take appropriate steps to manage those risks.
- k) Interpret numerical data and apply mathematical methods to the analysis of engineering design problems
- l) Use the principles of engineering science in developing solutions to practical Marine engineering and naval architecture problems.
- m) Analyze systems, processes and components.
- n) Solve ship design and shipbuilding problems.
- o) Select and apply appropriate IT tools to a variety of engineering problems.
- p) Create new engineering components and processes through the synthesis of ideas from a range of sources.
- q) Refer to professional scientific literature effectively;
- r) Develop computer programs;
- s) Use computational tools and packages pertaining to the marine discipline;
- t) Apply numerical modeling methods and/or appropriate computational techniques to engineering problems

12.3.3 Professional & Practical Skills

On successful completion of the programmes, students must be able to:

- a) Use a wide range of analytical and technical tools, techniques and equipment, including pertinent software;
- b) Use basic workshop equipment safely;
- c) Use laboratory equipment to obtain data;
- d) Understand and apply safe systems of work;
- e) Analyze experimental results and determine their accuracy and validity;
- f) Use laboratory equipment and related computer software;
- g) Research for information
- h) Prepare engineering drawings, computer graphics and specialized technical reports.
- i) Demonstrate basic organizational and project management skills.
- j) Carry out specialized engineering designs.
- k) Use and manage the exploitation of modern CAD and CAD/CAM facilities
- l) Work as a chief engineer in the shipbuilding, maintenance and ship operation;

SECTION 13 | NARS CHARACTERIZATION OF MECHANICAL AGRICULTURE ENGINEERING

13.1 INTRODUCTION

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12.2 THE ATTRIBUTES OF MECHANICAL AGRICULTURE ENGINEER

In addition to the general attributes of engineer, the mechanical applications in agriculture engineer should be able to:

- a) Apply theories and concepts of chemistry, physics, mathematics, thermodynamics and engineering principles to analyze the agricultural mechanization and processing systems and components.
- b) Apply and integrate knowledge, understanding and skills of different subjects to solve real problems related to agriculture mechanization equipment and applications and food industries.
- c) Design and implement projects in the fields of agriculture mechanization and food processing subjected to economic, environmental and social constraints.
- d) Analyze interdisciplinary mechanical, electrical, hydraulic and civil systems.
- e) Use and/or develop computer software related to farm machinery and processing equipment and processes.
- f) Adapt with technological evolutions.
- g) Communicate with others, present ideas and findings and lead a group.
- h) Design and conduct experiments, perform measurements, analyze findings and write a technical report.
- i) Work in teams of different disciplines.
- j) Develop economic solutions.

12.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR MECHANICAL APPLICATIONS IN AGRICULTURE ENGINEERING PROGRAMMES

The following academic reference standards represent the general expectations about the qualifications attributes capabilities that the graduates of the mechanical engineering applications in agriculture programmes should be able to demonstrate.

12.3.1 Knowledge and Understanding:

On successful completion of the programme, graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, fundamentals concepts, principles and its applications in Agricultural mechanization and processing.

- b) Essential fundamentals of basic agricultural sciences related to engineering activities (soil and land, plant production, animal production and food processing).
- c) Concepts and theories of basic science, mathematics and technology related to applications of Mechanical Engineering in Agriculture.
- d) Contemporary issues in agricultural mechanization and agricultural products processing.
- e) The basic theories and fundamental of other engineering disciplines providing supports to the mechanical engineering applications to agriculture.
- f) Engineering design principles and methodology and their application in agricultural mechanization equipment.
- g) Environmental and economical constraints within which the engineering decision on solution has to be made.
- h) Business, management and planning techniques and practices appropriate to mechanical engineering applications in agriculture.
- i) The professional and ethical responsibilities of the discipline.
- j) Characteristics and properties of soil and materials.
- k) The concepts of information technology providing support to the discipline.
- l) The impact of the discipline's solutions in a global and societal context.

12.3.2 Intellectual Skills

On successful completion of this programme, graduate should be able to:

- a) Solve engineering problems and design agricultural mechanization and processing systems, equipment components and elements.
- b) Apply the appropriate tools from mathematics, basic science, agriculture basic science, technology and the know-how gained from the professional experience to analyze agricultural mechanization and processing problems to meet certain needs.
- c) Solve agricultural mechanization and food processing problems often on the basis of limited and probably contradictory information .
- d) Analyze and interpret data, and design experiments to obtain new data.
- e) Evaluate discipline's designs, processes and performances and propose improvements.
- f) Maintain a sound theoretical approach in dealing with a new and advancing technology.
- g) Use appropriate computational tools and packages to solve mechanical and agricultural engineering problems.
- h) Assess risks , and consider appropriate steps to manage them.
- i) Innovate new engineering components and processes using ideas from a range of sources.

12.3.3 Professional and practical skills

On successful completion of the programme, graduates should be able to:

- a) Use a wide range of analytical and technical tools, techniques equipment including pertinent software.
- b) Use basic workshop and farm tools and equipment safely and appropriately.
- c) Use laboratory and field equipment and instruments to obtain data.
- d) Analyze experimental results and determine their accuracy and validity.

- e) Prepare engineering drawings, computer graphics and specialized technical reports.
- f) Search for information about mechanical engineering and its applications in Agriculture.
- g) Use computational tools and packages and write computer programmes pertaining to agricultural mechanization and food processing.
- h) Demonstrate basic organizational and project managing skills.
- i) Carryout specialized engineering design.
- j) Work in operation and maintenance of plants.

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SECTION 14 | NARS CHARACTERIZATION OF MECHANICAL DESIGN AND PRODUCTION ENGINEERING

14.1 INTRODUCTION

Mechanical engineers should be curious about how things are made and work. They have a desire to solve problems and a talent for understanding the operation of mechanical devices. Mechanical engineers conceive, plan, design and direct the production, distribution and operation of a wide variety of devices, machines and systems, environmental control and materials processing, transportation and handling. Design and production mechanical engineers analyze their design using the principles of motion, energy, and momentum to insure that the product functions safely, efficiently, reliably, and manufactured at a competitive cost with minimized environmental hazards.

Mechanical engineering; design and production, is a broad discipline which covers the fields of solid and fluid mechanics, thermodynamics, engineering design, production technology, economics and management. Basic studies are devoted to mechanical properties of materials, machine design, dynamics and control, instrumentation, fundamentals of fluid flow, energy and power systems. Mechanical Engineering covers the design, analysis, testing and manufacturing of products that are used in every facet of modern society. Undergraduate educational programs in mechanical engineering design and production are, therefore, specifically designed to provide a wide variety of topics. These include power systems, fluid and thermal sciences related to discipline, automatic control, reliability, quality assurance and control, mechanical design and manufacturing.

A B.Sc. degree in design and production mechanical engineering is designed for students who seek careers as engineers in industry, army, consulting firms and private and governmental agencies. This degree is also appropriate for students who plan to be researchers or who intend to pursue an advanced degree in engineering. A typical program curriculum incorporates analytical tools, creative thought and diversity of skills as well as the state of art of the profession.

Design and production mechanical engineer may work in:

Private and governmental firms, where it is required to design, manufacture, operate, develop or maintain mechanical systems and equipment such as; industrial machinery, automotive, aerospace, power generation and air conditioning equipment.

14.2 THE ATTRIBUTES OF MECHANICAL DESIGN AND PRODUCTION ENGINEER

In addition to the general attributes of engineer, the design and production engineer must be able to:

- a) Work with mechanical design and manufacturing systems.
- b) Use of mathematics and physical and engineering sciences and systems analysis tools in components and machines and produce design and manufacture.
- c) Use different instruments appropriately and carry-out experimental design, automatic data acquisition, data analysis, data reduction and interpretation, and data presentation, both orally and in the written form.
- d) Use the computer graphics for design, communication and visualization.
- e) Use and/or develop computer software, necessary for the design, manufacturing and management of industrial systems and projects.
- f) Analyze multi-disciplinary mechanical, electrical, thermal and hydraulic systems.
- g) Lead or supervise a group of designers or technicians and other work force.

14.3 NARS FOR MECH. ENGINEERING DESIGN & PRODUCTION

The following academic reference standards represent the general expectation about the qualifications attributes and capabilities that the graduates of Mechanical design and production engineering programs should be able to demonstrate.

14.3.1 Knowledge and Understanding:

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Concepts, principles and theories relevant to Mechanical Engineering and manufacture;
- b) Science, mathematics and the technological base relevant to Mechanical Engineering;
- c) The constraints within which his/her engineering judgment will have to be exercised;
- d) The specifications, programming and range of application of CAD and CAD/CAM facilities
- e) Relevant contemporary issues in mechanical engineering.
- f) Basic electrical, control and computer engineering subjects related to the discipline
- g) The role of information technology in providing support for mechanical engineers
- h) Engineering design principles and techniques.
- i) Characteristics of engineering materials
- j) Management and business techniques and practices appropriate to engineering industry.

14.3.2 Intellectual Skills

On successful completion of this programme graduate must be able to:

- a) Adopt creative and innovative thinking in solving problems, and in designing products, systems, components and processes;
- b) Apply the principles of mathematics, science and technology in problem solving scenarios in mechanical engineering;
- c) Analyze and interpret data, and design experiments to obtain primary data;

- d) Design systems, components or processes to meet specific needs;
- e) Evaluate and appraise designs, processes and products, and propose improvements;
- f) Assess risks, and take appropriate steps to manage those risks.
- g) Interpret numerical data and apply analytical methods for engineering design purposes
- h) Use the principles of engineering science in developing solutions to practical mechanical engineering problems.
- i) Solve mechanical and product design in engineering problems.
- j) Create new engineering components and processes through the synthesis of ideas from a range of sources.
- k) Use computational tools and software packages pertaining to the discipline and develop required computer programs;

14.3.3 Professional & Practical Skills

On successful completion of the programmes, students must be able to:

- a) Use a wide range of analytical and technical tools, techniques and equipment, including pertinent software;
- b) Prepare engineering drawings, computer graphics and specialized technical reports and communicate accordingly.
- c) Carry out specialized engineering designs.
- d) Employ the traditional and modern CAD and CAD/CAM facilities in design and production processes
- e) Use basic workshop equipment safely;
- f) Understand and apply safe systems at work;
- g) Analyze experimental results and determine their accuracy and validity;
- h) Use laboratory equipment and related computer software;
- i) Demonstrate basic organizational and project management skills.
- j) Operate and maintain mechanical equipment.
- k) Refer to relevant literature effectively;

SECTION 15 | NARS CHARACTERIZATION OF MECHANICAL POWER AND ENERGY ENGINEERING

15.1 INTRODUCTION

Mechanical Power and Energy Engineering gains importance progressively due to the increased level of prosperity and technology that consume extra power. This discipline is mainly concerned with thermo-fluid sciences that are the basis for energy conversion and power generation. In addition, Mechanical Power and Energy engineers are concerned with other important issues like the pollution control, energy management, heating, ventilation and air-conditioning, transport phenomena, combustion, fluid flow,...etc.

The development of mechanical power engineering has been fundamental to the advancement of civilization. Mechanical Power Engineering is the science and technology of energy and its conversion to mechanical power. This includes the major flow and combustion processes occurring in different systems.

Energy takes a number of different forms, such as mechanical energy, electrical energy, nuclear energy, chemical energy, kinetic energy, and solar energy. Energy is used to do the work, and the relationship between work and energy (or heat) is called thermodynamics.

Applied thermodynamics deals with such special applications of energy transfer as power generation, refrigeration and gas compression. The energy transfers are made during processes which use certain fluid contained in or flowing through a system.

The techniques for calculating and evaluating internal combustion engine performance, combustion and emissions processes and design features represent one of major subject of the mechanical power engineering.

A basic knowledge of the principles of energy; its use, its transfer, and its conversion from one form to another is also one of the important subjects in mechanical power engineering. It requires understanding of different subjects such as physics, chemistry, turbo-machinery, and mathematics.

As the population of the world grows and as fuels become scarcer, it becomes more and more important for man to be able to control energy consumption to a high level; first, to obtain higher efficiencies from heat or power cycles ; second, looking for alternative fuels (cheap, less polluted, high heat release); third, need to remove pollutants formed during processes of energy conversion; and forth, apply safety measures. Moreover, aeronautical and space developments of recent decades have brought special challenges; achieving high heat release, working with special materials and suppressing acoustic interaction. It is a challenge now for mechanical power and energy engineers to search for alternative fuels as a new source for

energy, to link between chemical, physical and thermo-fluid properties to energy transfer characteristics in different applications such as power stations, turbo-machinery, vehicles, boilers, gas and steam turbines. Moreover, it is very important to model energy transfer processes aiming at obtaining high efficiency and less pollutants.

It is thus a mandatory to encourage a diversity of subjects provision, to encourage institutions to explore new ways of enhancing knowledge and understanding of students, and to instill a sense of excitement of their students

Mechanical Power and Energy Engineers help to:

- Develop power stations, boilers, gas or steam turbine, internal combustion engines, refrigeration systemsetc.
- Develop safety control system in the above equipment.
- Enhance the liquid, vapor and gas network piping and ducting systems.
- Develop methods for reducing the pollutant emissions from different systems.
- Improve the maintenance and the performance of the combustion equipment, turbo-machinery and refrigeration systems.

Mechanical Power and Energy Engineers may work in:

- Processing or user industries.
- Power stations and petrochemical plants.
- Management in industries.
- Establishments concerned with cars, ships, energy generation or aerospace and refrigeration and air conditioning.
- Safety and environmental concerns.
- Research

15.2 THE ATTRIBUTES OF A MECHANICAL POWER AND ENERGY ENGINEER

In addition to the general attributes of engineer, the Mechanical Power/Energy engineer must be able to:

- a) Apply theories and concepts of chemistry, physics, mathematics and thermodynamics and engineering principles to mechanical power systems.
- b) Apply and integrate knowledge, understanding and skills of different subjects to solve real problems in industries.
- c) Design and execute a project in the field of mechanical power engineering.
- d) Evaluate the sustainability and environmental issues related to mechanical power systems.
- e) Use mathematical and computational skills in solving mechanical power engineering problems.
- f) Use energy efficiently.
- g) Adapt with technological evolutions.
- h) Apply industrial safety.
- i) Communicate with others, present ideas and findings and lead a group
- j) Develop economic solutions.
- k) Take the duties and responsibilities entitled to professional engineers.

15.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR MECHANICAL POWER AND ENERGY ENGINEERS

The following academic reference standards represent the general expectations about the qualifications attributes capabilities that the graduates of mechanical power and energy programmes should be able to demonstrate.

15.3.1 Knowledge and Understanding:

On successful completion of the programme graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, fundamentals, concepts, principles and theories relevant to Mechanical Engineering;
- b) The constraints which mechanical power and energy engineers have to judge to reach at an optimum solution.
- c) Concepts and theories of basic sciences, mathematics and the technological base relevant to Mechanical Power and Energy Engineering.
- d) Business and management techniques and practices appropriate to mechanical power and energy engineering applications.
- e) The professional and ethical responsibilities of mechanical power and energy engineers.
- f) The impact of mechanical power and energy engineering solutions in a global and societal context.
- g) Mechanical power and energy engineering contemporary issues.
- h) Relevant mathematical and numerical methods and the principles of engineering and mechanical engineering sciences as applied to mechanical power and energy engineering systems.
- i) The basic theories and principles of some other engineering and mechanical engineering disciplines providing support to mechanical power and energy disciplines.
- j) The role of information technology in providing support for mechanical power and energy engineers.
- k) Engineering design principles and techniques and their applications to mechanical power and energy engineering.
- l) Characteristics and properties of materials relevant to mechanical engineering applications.

15.3.2 Intellectual Skills

On successful completion of this programme student must be able to:

- a) Solve engineering problems and design mechanical power and energy systems, components and elements in a creative and innovative attitude.
- b) Apply the appropriate tools from mathematics, science, technology, and the know-how gained from the professional experience to analyze mechanical engineering design problems to meet certain needs.
- c) Solve mechanical engineering problems, often on the basis of limited and possibly contradictory information.
- d) Analyze and interpret data, and design experiments to obtain new data.
- e) Evaluate mechanical power and energy engineering designs, processes and performances and propose improvements.

- f) Maintain a sound theoretical approach in dealing with new and advancing technology.
- g) Assess risks, and consider appropriate steps to manage them.
- h) Use the principles of engineering sciences in developing solutions to practical mechanical engineering problems.
- i) Create new engineering components and processes through the synthesis of ideas from a range of sources.
- j) Analyze the results of numerical models and acknowledge their limitations.

15.3.3 Professional & Practical Skills

On successful completion of the programmes, graduates must be able to:

- a) Use a wide range of analytical and technical tools, techniques and equipment including pertinent software.
- b) Use basic workshop equipment safely and appropriately.
- c) Analyze experimental results and determine their accuracy and validity.
- d) Prepare engineering drawings, computer graphics and specialized technical reports.
- e) Refer to scientific literature effectively.
- f) Use computational tools and packages and write computer programs pertaining to mechanical power and energy engineering.
- g) Apply numerical modeling methods and/or appropriate computational techniques to engineering problems.
- h) use appropriate computer software and laboratory equipment.
- i) Search for information.
- j) Demonstrate basic organizational and project management skills.
- k) Carryout specialized engineering design.
- l) Work in mechanical power and energy operations, maintenance and overhaul.

SECTION 16 | NARS CHARACTERIZATION OF MECHATRONICS ENGINEERING

16.1 INTRODUCTION

Mechatronics is about today's world. It's where electronics, computers and mechanics converge to bring the automated devices we use in our every day lives, both in the home and at work. As society advances technologically, demands have been increasing for mechanical devices with embedded electronics, sensors, actuators and related systems.

Mechatronics engineering is strongly based on Mechanical Engineering, but is a distinctly different discipline. The program provides an interdisciplinary, tightly focused approach to designing automated devices, preparing professionally trained Mechatronics engineers who can have an immediate impact in industry.

Mechatronics Programs combine core undergraduate courses in mechanical, selected electronics and software engineering with several option-specific courses in an interdisciplinary approach. Graduates enjoy professional skills in classical machine design and analysis, as well as electronic instrumentation, computer control systems, and software engineering.

As such, Mechatronics Program Graduates are concerned with the design, automation and operational performance of electro-mechanical systems. They typically use their skills and knowledge about mechanical and electronic processes as well as computers to develop new solutions to industrial problems. In addition, they often become involved in providing technical advice or assistance relating to the creation of new products.

Career Opportunities

Mechatronics engineers work with the electronic and computer control systems which nearly all machinery relies on for efficient and reliable operation. They are employed by product developers and manufacturers, large and small, by the mining industry, by the aerospace and defense sectors, and by the government and industry research groups. Wherever there is potential for improvement through the integration of computer and electrical hardware with mechanical systems there is a need for mechatronic engineers. As more industries seek to apply the evolutionary advances in computers, electronics, sensors, and actuators to improve their products, processes and services, the demand for Mechatronic Engineers is forecast to be high and ever increasing.

16.2 THE ATTRIBUTES OF MECHATRONICS ENGINEER

In addition to the general attributes of an engineer, the program aims at preparing students for a professional or research career in mechatronics which involves aspects of machines and processes with electronics and computing (such as robotics, industrial control and automation systems). Successful integration of material from these disciplines is an essential part of the program, as the following list of academic objectives shows:

- a) Use of mathematics, physical science and systems analysis tools in components and system design.
- b) Students will learn engineering sciences and demonstrate the application of this knowledge to electro-mechanical systems.
- c) Solve problems through course sequences focused on specific, relevant mechatronics topics leading to good working knowledge of fundamentals in mechanics, electronics, computers and software
- d) The program will provide students with practical design experience.
- e) Analyze inter-disciplinary mechanical, electrical and hydraulic systems.
- f) Work within, lead or supervise groups of fellow engineers and technicians.
- g) The program will challenge students and faculty to improve the learning process.
- h) Students will develop high generic skills: spoken, visual and written communication
- i) Graduates should have wide choices leading to specialization in mechanics, electronics, design, computer software or other areas
- j) Students will be prepared to engage in lifelong self learning process throughout their career.

16.3 NARS FOR MECHATRONICS PROGRAM

In addition to the general attributes of the engineer, The graduates of Mechatronics programs must be able to demonstrate.

16.3.1 Knowledge and Understanding:

On successful completion of the programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Basic science and engineering fundamentals;
- b) Fundamentals of problem identification, formulation and solution in the areas of Mechatronics;
- c) The approach to design and operational performance;
- d) Social, cultural, global and environmental responsibilities of the professional engineering, and the need for sustainable development;
- e) The principles of sustainable design and development;
- f) Professional and ethical responsibilities and commitment to them; and

16.3.2 Intellectual Skills

On successful completion of this programme graduate must be able to:

- a) Apply knowledge of basic science and engineering fundamentals;
- b) Undertake problem identification, formulation and solution;
- c) Utilize a systems approach to design, analysis and development and practical investigations;
- d) Apply the principles of sustainable design and development;
- e) Full awareness of the needs to undertake lifelong learning, and capacity to do so.

16.3.3 Professional & Practical Skills

On successful completion of the programmes, students must be able to:

- a) Compete, in-depth, in at least one engineering discipline;
- b) Manage field problem, identification, formulation and solution;
- c) Utilize practical systems approach to design and performance evaluation;
- d) Apply the principles of sustainable design and development;

DRAFT

SECTION 17 | NARS CHARACTERIZATION OF METALLURGICAL ENGINEERING

17.1 INTRODUCTION

Historically, the development and advancement of societies have been intimately tied to the members' ability to produce and manipulate materials to fulfill their needs. In fact, early civilizations have been designated by the level of their materials development (Stone Age, Bronze Age, and Iron Age). Furthermore, it was discovered that the properties of a material could be altered by heat treatments and by the addition of other substances. At this point, materials utilization was totally a selection process. Thus, tens of thousands of different materials have evolved with rather specialized characteristics that meet the needs of modern and complex society; these include metals, plastics, glasses, and fibers. Materials that are utilized in high-technology (or high-tech) applications are sometimes termed advanced materials. Advanced materials include semiconductors, biomaterials, and what may term "materials of the future" (that is, smart materials and nano-engineered materials).

Until very recent times the general procedure utilized by scientists has been to begin by studying large and complex structures, and then to investigate the fundamental building blocks of these structures that are smaller and simpler. This approach is sometimes termed "top down" science. However, with the advent of scanning probe microscopes, which permit observation of individual atoms and molecules. It has become possible to manipulate and move atoms and molecules to form new structures and, thus, design new materials that are built from simple atomic-level constituents (i.e., "materials by design"). This ability to carefully arrange atoms provides opportunities to develop mechanical, electrical, magnetic, and other properties that are not otherwise possible. This is called the "bottom-up" approach, and the study of the properties of these materials is termed "nanotechnology"; the "nano" prefix denotes that the dimensions of these structural entities are on the order of a nanometer (10^{-9} m).

Metallurgical Engineering (as a branch of materials engineering) is the science and technology of processing materials to extract, refine and recycle metals. These processes include the development and use of metals and alloys that have specific physical and mechanical properties. Extractive metallurgy is the practice of separating metals, usually in the form of a metal oxide, from their ores, and refining them into pure metals. In order to convert a metal oxide to a metal, the metal oxide must be reduced either chemically or electrolytically.

Metallurgy, in production engineering, is concerned with the production of metallic components for use in consumer or engineering products. This involves the production of alloys, shaping, heat treatment and the surface treatment of the product. The task of the metallurgist is to achieve required design criteria, such as cost, weight, strength, toughness, hardness, corrosion resistance and performance under different working conditions.

Metals are shaped by processes such as casting, forging, rolling, extrusion, sintering, metalworking, machining and fabrication. With casting, molten metal is poured into a shaped mould. In forging, a red-hot billet is hammered into a final shape. In rolling, a billet is passed through successively narrower rollers to create a final sheet. In extrusion, a hot and malleable metal is forced under pressure through a die, which shapes it before it cools. With sintering, a powdered metal is compressed into a die at high temperature. Metallurgy is also applied to electrical and electronic materials whereas metals such as aluminum, copper, tin and gold are used in power lines, wires, printed circuits boards and integrated circuits.

Metallurgists are studying correlations between processing, structure, properties and performance. Structure related to sub-atomic structure, atomic structure, and microstructure examinations. Great correlations revealed between microscopic examination as well as failure mode analysis for metals and alloys. Optical and electron microscopes and mass spectrometers are some examples of tools used for microscopic examination of metals. Metallurgists are also studying crystallography, the effects of temperature and heat treatment on the component phases of alloys and the properties of those alloy phases. The metals properties (macroscopic) are tested using different testing machines and devices. The tests revealing tensile strength, compressive strength, hardness, creep strength, fatigue strength and other properties.

The central themes are:

- (i) How to extract, purify and shape metals and alloys.
- (ii) The link between structure (on length scales from sub-nm to mm) and chemical, physical and mechanical properties.
- (iii) How to control microstructure through processing that can be used to optimize engineering performance. Modeling is increasingly used to predict both microstructure and properties.
- (iv) Protection of metallic structures against corrosion and degradation.

Metallurgical engineers help to:

1. Extract and develop the metals and alloys required for new products.
2. Develop protection methods against degradation.
3. Find better and low-cost manufacturing routes and enhance the performance of existing metals and alloys.
4. Consider the environmental impact and sustainability of their products.
5. Discover how to optimize the selection of materials and create sophisticated databases from which properties and service behavior can be predicted.

Metallurgical engineers may work in:

- Extraction of metals and alloys.
- Manufacturing, processing or user industries.
- Research.
- Production.
- Management or sales.
- Mass-produced artifacts such as: Cars, tableware, or building materials or specialist products such as those needed for micro-electronics, sports equipment, replacement body parts, energy generation or aerospace.

NARS Characterization is Framed so as to:

- Encourage diversity of provision and
- Encourage institutions to explore new ways of enhancing the knowledge and understanding of their students and instilling a sense of the excitement of this rapidly developing discipline.

17.2 THE ATTRIBUTES OF A METALLURGICAL ENGINEER

In addition to the general attributes of engineer, the metallurgical engineer must be able to:

- a) Acquire knowledge of basic principles of metallurgy, supported by the necessary background science.
- b) Apply advanced science and engineering principles to metallurgical systems.
- c) Have an integrated understanding of the scientific and engineering principles underlying the four major elements of the field of Metallurgical Engineering; processing, structure, properties and performance, related to metallurgical systems appropriate to the field.
- d) Apply and integrate knowledge from each of the four elements of the Metallurgical Engineering to solve materials selection and design problems.
- e) Acquire key practical skills and competence.
- f) Have the ability to design and execute an individual project.
- g) Have an awareness of the importance of metals and alloys to industry and society.
- h) Have an awareness of sustainability and environmental issues.
- i) Use the relevant mathematical and computational skills in solving metallurgical engineering problems.

17.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR METALLURGICAL ENGINEER

The following academic reference standards represent the general expectation about the qualifications attributes and capabilities that the graduates of Metallurgical engineering programs should be able to demonstrate.

17.3.1 Knowledge and Understanding

Programmes graduates must be able to demonstrate knowledge and understanding of:

- a) Basic topics related with metals and alloys.
- b) The role of information technology in providing support for metallurgical engineers.
- c) Engineering principles relevant to materials selection.
- d) Processing of metals and alloys.
- e) The materials aspects of design.
- f) The professional and engineering responsibilities of metallurgical engineers.
- g) Organisations, their internal structures and management, including the management of human resources, financial resources and operations.

17.3.2 Intellectual Skills

On successful completion of this programme student must be able to:

- a) Select and identify an appropriate material and manufacturing route for the design of a component;
- b) Utilize materials engineering principles to develop new materials/processing routes for improved performance of engineering systems.
- c) Solve typical materials engineering problems.
- d) Select and apply appropriate IT tools to a variety of materials problems.
- e) Select materials from an environmentally appreciative viewpoint.
- f) Interpret numerical data and apply mathematical methods to the analysis of materials engineering and management problems.

17.3.3 Practical Skills

On successful completion of the programmes, graduates must be able to:

- a) Use appropriate mechanical testing, corrosion testing, optical, X-ray, and electron metallographic, and chemical analysis methods for metals and alloys.
- b) Use appropriate computer software for design and modeling exercises.
- c) Evaluate and present practical data in a suitable format.
- d) Explain experimental results in terms of theoretical mechanisms and concepts.
- e) Propose and assess options for the improvement of operations.

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SECTION 18 | NARS CHARACTERIZATION OF MINING ENGINEERING

18.1. Introduction to Mining Engineering

Mining may be defined as the act, process or work of extracting minerals or coal from their natural environment and transporting them to the point of processing or use. Mining techniques are applied to extracting metallic minerals such as ores of gold, copper, lead or zinc, to fuels such as uranium, coal, anthracite, lignite, oil shale's and tar sands and to nonmetallic minerals, such as limestone, sand and gravel, clay, sulfur, salts and ornamental stones. These are just a few of the many minerals extracted by mining processes.

The demand for minerals and fuels continues to grow with increasing population and an ever-increasing standard of living. To meet this demand, mining has been characterized not only by growth along traditional lines but also by exploitation of new sources of minerals, or sources in new ways, reflected in such developments as underwater mining, extraction of minerals from seawater, the mining of in-situ retorting of rock for oil and underground gasification of coal.

Mining engineering is concerned with the proving (along with geology), planning, developing, extraction and processing of ores containing valuated minerals or metals. It is one of the most critical contribution to social and economic life.

The essence of mining in extracting mineral from the earth is to drive or construct an excavation, a means of entry from the existing surface to the mineral deposit. If the excavation is entirely open to or operated from the surface, it is called a surface mine. If the excavation consists of openings for human entry driven below the surface, then it is an underground mine.

Mining is not done in isolation, nor is it an entity unto itself. It is preceded by geologic investigations that locate the deposit and economic analysis that prove it financially. Following extraction of the mineral or ore, the run of mine material is generally prepared or beneficiated in procedures termed mineral processing. The product of those processes may be undergoing further concentration, refinement, or fabrication during conversion, smelting or refining to provide consumer products. The end step in converting a useful mineral into a usable product is marketing.

Mining techniques also are applied to the removal of earth or rocks for military or civil purposes. In military or civil mining the objective is to produce a stable opening of desired size, orientation, and permanence. Examples are vehicular tunnels, storage reservoirs, waste disposal chambers, archaeological excavations and military installations. They are excavated using methods that are borrowed from mining. Since the objective is the excavation or opening itself rather than the material extracted, however, other kinds of conditions or circumstances may govern, such as time, shape, or life.

Mining, mineral processing and their supporting activities involve most of the engineering disciplines, science and others. Consequently, the information needs of the mining engineer truly can be termed special. In his profession, the mining engineer needs knowledge of civil, mechanical, electrical and metallurgical engineering and geology and chemistry. A person may become a mining engineer by education followed by experience in the field. The mining engineer can devote a portion of his career or all of to a specialized type of mining or to a phase of mining activity.

To become a mining engineer require gaining a thorough knowledge of general engineering principles followed by studying courses specific to mining and mineral processing. These courses are designed to cover a wide and diverse range of subjects in order to meet the challenge that will be faced in the mining industry.

Careers in Mining Engineering:

The modern mining industry is a high technology business; mining today involves automated equipment, computer-aided design and control systems; and an industry committed to safety and environmental responsibility.

Mining Engineers work to discover, evaluate, recover and process mineral deposits from the earth and ocean floor. The majority are employed in either the design or supervision of mineral extraction and processing systems. They may also go into such related work as environmental control, safety, research or education. Some mining engineers, along with geochemists, geophysicists and geologists, work in mineral exploration; others work with metallurgical and other engineers to appraise new ore deposits. They study rock formations and water, soil and plant characteristics for signs of mineral or ore deposits.

Employment as an engineer in a producing mine is only one of the many career opportunities following a B.Sc. in Mining Engineering. Specialist consulting firms, construction engineering and surveying companies, government agencies, mining equipment suppliers and financial organizations are some of the businesses in which mining engineers are found. The mining engineering graduate is qualified also for positions in supervision and research. The possibility of rapid career advancement in the mining industry is high due to the small scale of many mining operations.

NARS Characterization for mining engineering is framed so as to:

Promote diversity of provision and encourage institutions to explore new ways to enhance the knowledge and awareness of their students about the broad features of chemical engineering and inspire a sense of excitement of this rapidly developing discipline.

18.2. THE ATTRIBUTES OF MINING ENGINEERS

In addition to the general attributes of an engineer, the mining engineer should have:

- a. an ability to apply knowledge of mathematics, science and engineering,
- b. an ability to design and conduct experiments, as well as to analyze and interpret data,

- c. an ability to design a system, component, or process to meet desired needs,
- d. an ability to function on multi-disciplinary teams,
- e. an ability to identify, formulate, and solve engineering problems,
- f. an understanding of professional and ethical responsibility,
- g. an ability to communicate effectively,
- h. the broad education necessary to understand the impact of engineering solution in a global and societal context,
- i. a recognition of the need for, and an ability to engage in lifelong learning,
- j. a knowledge of contemporary issues, and
- k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

18.3. NATIONAL ACADEMIC REFERENCE STANDARDS FOR MINING ENGINEERING

18.3.1 Knowledge and Understanding

Students should have knowledge and Understanding of:

- a) Mathematical methods appropriate for application in engineering design.
- b) The principles of physics, chemistry, geology and mechanics and applications in engineering.
- c) Principles and techniques of mineral exploration and valuation.
- d) Explosives and blasting techniques applied for both mining and civil engineering purposes.
- e) Surveying and remote sensing techniques applied for the planning, design and layout of surface and underground mining workings.
- f) Rock mechanics and engineering principles and applications for rock stability, tunneling, supporting, drilling and slope design.
- g) Planning and design of surface and underground mining operations.
- h) Systems and industrial engineering skills for optimization of the mining process and reliability.
- i) Chemical and environmental engineering skills for reclamation, mineral processing and environmental management.
- j) Business and management principles and applications for mine finance, economic forecasting and mine operation.
- k) Environmental impact assessment of mining and control of mine climate through the application of mine ventilation and air conditioning techniques.
- l) Principles and applications of mineral processing techniques for design of mineral up-grading flow sheets.
- m) Risk, hazards, industrial hygiene, health and safety.
- n) Professional and ethical responsibilities, codes of practice and legislative framework of the mining industry.

18.3.2 Intellectual Skills

On successful completion of the program students should be able to:

- a) Apply knowledge of mathematics, science and engineering,
- b) Design and conduct experiments, as well as to analyze and interpret data.

- c) Design a system, component, or process to meet desired needs,
- d) Function in multidisciplinary teams,
- e) Identify, formulate and solve engineering problems,
- f) Understanding of professional and ethical responsibility,
- g) Communicate effectively,
- h) Understand the impact of engineering solutions in a global and societal context,
- i) Recognize the need for and an ability to engage in a lifelong learning,
- j) A knowledge of contemporary issues, and
- k) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

18.3.3. Professional and Practical Skills

Currently, the definition of mining engineering is perceived to be narrow. However, a student trained in mining engineering actually possesses skills that can be applied in a wide variety of industries, including civil engineering, oil and gas, defense, and others. Mining engineers must be experts in many of the techniques critical to activities in these industries such as tunneling, slope stability, drilling and other processes. Mineral processing engineering lets the students possess skills that can be applied to chemical materials, ceramic engineering, and related fields. Mining education should communicate the diverse career that mining engineers have available.

On successful completion of this program students should be able to:

- a) Identify and formulate problems from a verbal or written statement including defining objectives and constraints,
- b) Simulate and model mining engineering systems and using computer programming and information technology techniques for dealing with mining systems,
- c) Apply of modern science and engineering in the discovery, development, exploitation, and use of natural mineral deposits.
- d) plan and design of mines taking into account economic, technical and geologic factors,
- e) Supervise the operations of extraction, processing and sometimes the primary refinement, of the raw material.
- f) balance the constant demand for low cost materials to meet social needs with additional societal demands for a clean and safe environment,
- g) Plan, design and operate mineral processing flowsheets for the up-grading of mineral products to satisfy the industrial requirement.
- h) implement the safety regulations and industrial hygiene precautions during the execution of mining operations, including risk assessment of any associated specific hazards,
- i) Adapt to unforeseen changes in markets, regulations, or other factors impacting the business of mining.
- j) Apply of geologic data, techniques and principles for the location, planning, design, constructions, operation and maintenance of engineering structures. This work also includes site characterization and environmental remediation.

- k) apply the geophysical survey measurements and interpret the results in terms of geologic features of the economic deposit sought during the exploration for minerals,
- l) Operate standard mining instrumentation and equipment such as that used for exploration, rock characterization, stoping, ventilation, transportation, drainageetc.
- m) Plan and execute surveying works using modern equipment and contouring and mapping software.
- n) Conduct economical analysis, cost estimation and feasibility studies of mining projects.
- o) Plan, schedule and manage the mining operations using the modern techniques of projects management and scheduling.

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SECTION 19 | NARS CHARACTERIZATION OF NUCLEAR AND RADIATION ENGINEERING

19.1 INTRODUCTION

The definition of engineering is as applicable to nuclear as it is to other disciplines: “Engineering is applied science concerned with using the earth’s resources for supplying human needs in the form of structures, machines, transportation, etc.” Nuclear engineering is concerned with the engineering aspects of the uses of nuclear processes for supplying human needs. Nuclear processes cover a wide range of technology, all the way from the splitting of heavy atoms (fission), to the joining of light elements (fusion), to generate electricity, to the use of radiation for medical or industrial diagnostics. The career opportunities for nuclear engineers are equally broad.

The undergraduate education of a nuclear & radiation engineer provides the knowledge to perform a great variety of engineering assignments. Compared with the more traditional disciplines, the nuclear engineer is a cross between mechanical engineer and physicist. The mechanical engineering aspect appears because of the heavy emphasis on thermal hydraulics in the proposed curriculum. The physics aspect appears because the nuclear engineering student must understand modern and nuclear physics in order to understand core and radiation physics.

The undergraduate nuclear engineering student must solve complicated problems requiring the extensive use of computers. This provides the capability to tackle complicated problems that extend beyond the field of nuclear engineering. In essence, the nuclear engineer should graduate with the technical foundation to solve or contribute to the solution of a broad range of technical problems – with particular strength in nuclear phenomena.

Nuclear & Radiation Engineer may work in:

Atomic Energy Authority, at the existing research reactors besides the various labs of different nuclear applications. The Nuclear Power Plant Authority. The Nuclear Safety Center. Different industrial facilities utilizing radioisotopes in their diagnostics and quality control. All different medical establishments applying nuclear medicine in patients' examination and treatment.

19.2 THE ATTRIBUTES OF A NUCLEAR & RADIATION ENGINEER

In addition to the general attributes of an engineer, the nuclear & radiation engineer must be able to:

- a) Use mathematics, physical sciences and system analysis tools in monitoring and surveillance of nuclear reactors.
- b) Safe handling of radioactive materials and equipments.
- c) Design and develop experimental setups for the application and measurements of radioisotopes in industry, agriculture, medicine, and other applications.

- d) Use existing computer codes for the analysis of nuclear systems.
- e) Develop computer software for the reactor safety analysis as well as for the evaluation of the radiation effects on materials.
- f) Simulating nuclear processes and building experimental setups to monitor system performance.
- g) Manage projects utilizing radiation and radioisotopes subjected to economic, environmental, and social constraints.
- h) Lead or supervise a group of technicians in the nuclear field.

19.3 NARS FOR NUCLEAR & RADIATION ENGINEERING

The following academic reference standards represent the general expectations about the qualifications attributes and capabilities that the graduates of Nuclear & Radiation engineering programs should be able to demonstrate.

19.3.1 Knowledge and Understanding:

On successful completion of the programs, graduates must be able to demonstrate knowledge and understanding of:

- a) Essential facts, concepts, principles, and theories relevant to Nuclear & Radiation Engineering;
- b) Science, mathematics, and technological base relevant to Nuclear & Radiation Engineering;
- c) The impact of nuclear engineering solutions in a global and societal context;
- d) Relevant contemporary issues;
- e) Relevant mathematical methods and principles of engineering and physical science as applied to Nuclear & Radiation Engineering;
- f) The environmental effects of nuclear reactors and radiations;
- g) The role of information technology in providing support for nuclear & radiation Engineers;
- h) Engineering design principles and techniques;
- i) Characteristics of engineering materials and the effects of radiation on materials properties and performance;
- j) The professional and ethical responsibilities of engineers.

19.3.2 Intellectual Skills

On successful completion of this program, graduates must be able to:

- a) Apply appropriate tools of mathematics, physics, and technology to simulate problems in nuclear and radiation applications;
- b) Solve problems related to nuclear safety and analysis;
- c) Simulate and design experimental setups, analyze and interpret the obtained data and scale it up to the real systems;
- d) Use computer packages to analyze nuclear systems;
- e) Maintain a sound theoretical approach in dealing with new and advancing technology;
- f) Evaluate and assess the effects of radiation on environment and public at large;
- g) Use the principles of engineering and physical science to develop solutions to applied problems using radiation;

- h) Analyze different components of a nuclear power plant and innovate new approaches to develop them;
- i) Innovate new applications of radioisotopes in industry, medicine, etc.;
- j) Design radiation monitoring and measuring systems;
- k) Develop computer programs to simulate existing problems;
- l) Apply numerical modeling methods for system analysis.

19.3.3 Professional & Practical Skills

On successful completion of this program, graduates must be able to:

- a) Use a wide range of analytical and technical tools, techniques, and equipments, including pertinent software;
- b) Operate and monitor performance of nuclear reactors;
- c) Use radiation measuring and monitoring equipments;
- d) Use laboratory equipments to obtain and analyze data;
- e) Use and develop computer codes;
- f) Innovate new techniques for the applications of radioisotopes;
- g) Use scientific literature efficiently;
- h) Develop new techniques in materials analysis and characterization;
- i) Apply radiation monitoring and protection techniques for the safety of the environment;
- j) Improve performance of existing nuclear systems.

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**SECTION 20 | NARS CHARACTERIZATION OF
PETROLEUM PRODUCTION ENGINEERING**

Under Preparation

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**SECTION 21 | NARS CHARACTERIZATION OF PRINTING
ENGINEERING**

Under Preparation

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SECTION 22 | NARS CHARACTERIZATION OF TEXTILE ENGINEERING

22.1 INTRODUCTION

Textile engineering is considered one of the engineering fields that expand to cover the sciences necessary to provide society with its fundamental needs of textiles as well as the other textile industrial products.

The present industrial boom is coped with the utilizing of textiles in industrial, medical and smart textiles. This requires an engineer with a wide knowledge of several basic sciences (physics, chemistry, math, polymers...) as well as awareness of the machine design, operating systems of production lines, quality control, environmental protection and material usage & waste recycling.

Textile engineering includes the processing of synthetic fibers, controlling their chemical morphology, and producing them with different scales down to nanometer scale.

Textile Engineering incorporates several specialties and links with other engineering fields due to the wide range of knowledge which should be covered by the textile engineer; study of fibers and their properties related to chemistry, physics and polymer science while the textile machine design is related to the mechanics, engineering design, automatic control, and understanding of computer technology.

TEXTILE ENGINEER MAY WORK IN:

plants of man-made fiber production, yarn production, weaving production, knitting production, non-woven production, garment production, textile machines manufacturing, finishing & dyeing sectors, fabric & apparel design centers, textile research centers, textile testing and quality control centers.

22.2 THE ATTRIBUTES OF A TEXTILE ENGINEER

Beside the general attributes of other engineers, the textile engineer must be capable to:

- a) Work professionally in all the textile disciplines.
- b) Utilize knowledge in physics, chemistry, and mathematics in designing and operating different processing systems.
- c) Perform the effective plans to use resources, raw materials, personnel, and machines to achieve the production target.
- d) Improve the production plans and safely protecting the stored raw materials inventory and semi-manufactured products as well.
- e) Plan and apply the changes in machines, production lines, and technological operating systems.

- f) Manage the quality assurance and create effective procedures to supervise the production quality.
- g) Design tools to protect environment internally and externally of the production locations.
- h) Lead and supervise group of labors and technicians.
- i) Plan, organize, direct and control the production processes.
- j) Develop equipment maintenance schedules and recommend the replacement of machines.

22.3 NATIONAL ACADEMIC STANDARD REFERENCE (NARS) FOR TEXTILE ENGINEERING

The academic standards of the textile engineering graduates are as follows:

22.3.1 KNOWLEDGE AND UNDERSTANDING

Textile engineering graduates must be able to prove their capability of knowing and understanding the following:

- a) The intellectual, theoretical and engineering module that has relation with the textile engineering field.
- b) The relevant basic sciences required to determine the basic engineering principles in textile engineering.
- c) Description of the methodologies to solve engineering problems.
- d) Properties of the textile materials
- e) Technologies of textile productions.
- f) Systems of quality assurance for processing operations and final products.
- g) Role of information technology and its application in textile industry.
- h) Management systems and their application in textile industry.
- i) Knowledge necessary to analyze the impact of textile engineering in global and social contest.
- j) Related scientific research techniques & approaches.
- k) Professional and ethical responsibilities of textile engineers.

22.3.2 Intellectual skills:

By the accomplishment of the academic program successfully the graduates must have the ability of:

- a) Creative thinking in system design and production operation components.
- b) Using technological science aided by personnel expertise acquainted to analyze engineering problems.
- c) Selecting and applying suitable mathematic tools, computing methods, design techniques in textile engineering disciplines for modeling and analyzing textile engineering problems.
- d) Designing new products and performing the required production experiments.
- e) Finding the optimum means of solving production problems.
- f) Proper dealing with the updated technology.
- g) Achieving the balance between production cost, quality and environmental effect of production operations.
- h) Using engineering techniques to solve production problems.
- i) Making use of specialized scientific reference in an effective way.

- j) Utilizing software in developing and controlling of production and its quality.
- k) Analyzing products and designing of ideal systems for its production.
- l) Evaluating designs, processes and products and proposing improvements.

22.3.3 Professional practical skills

By the accomplishment of the academic program successfully the graduates must be able to:

- a) Manipulate safely & correctly the laboratory instrumentations and production machines.
- b) Perform laboratory experiments, records & analyze data, and write technical reports.
- c) Plan and design production processes necessary for different textile products.
- d) Show essential skills in personnel management.
- e) Effectively use computer and software for design and processing operations.
- f) Search for engineering information through different media and apply them in solving textile problems.
- g) Demonstrate basic organizational and project management skills.
- h) Use appropriate specialized computer software packages for textile engineering applications.
- i) Present technical reports using multimedia applications.

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