جـــامـــعة بـــنـــها
كلـيـــة الهنـــدســـة بـشبـــرا
برنـامج هنـــدســـة الطاقة و الطاقة المستدامة

Gap analysis between ARS of (ESE) program according NARS 2009 & NARS 2018

Content

Introduction

The academic reference standards (ARS) for Energy and sustainable energy program is a mixture of national academic reference standards (NARS) for electrical power program **&** the national academic reference standards (NARS) for Mechanical power program and the academic reference standards (ARS) for the University of Edinburgh**.** First, we will give overview about NARS 2009

1. NARS 2009 Overview

NARS 2009 provide measures for Academic community and represent general expectations about the attributes of the engineer.

The attributes of the engineer

The graduates of the engineering programs should be able to:

a) Apply knowledge of mathematics, science and engineering concepts to the solution of engineering problems.

b) Design a system; component and process to meet the required needs within realistic constraints.

c) Design and conduct experiments as well as analyze and interpret data.

d) Identify, formulate and solve fundamental engineering problems.

e) Use the techniques, skills, and appropriate engineering tools, necessary for engineering practice and project management.

f) Work effectively within multi-disciplinary teams.

g) Communicate effectively.

h) Consider the impacts of engineering solutions on society & environment.

i) Demonstrate knowledge of contemporary engineering issues.

j) Display professional and ethical responsibilities, and contextual understanding

k) Engage in self- and life- long learning.

Intended Learning Outcomes

ILOS provide measures for the academic community to describe the nature and characteristics of academic programs in certain fields of specialty.

A. Knowledge and Understanding:

The graduates of the engineering programs should be able to demonstrate the knowledge and understanding of:

A1) Concepts and theories of mathematics and sciences, appropriate to the discipline.

A2) Basics of information and communication technology (ICT)

A3) Characteristics of engineering materials related to the discipline.

A4) Principles of design including elements design, process and/or a system related to specific disciplines.

A5) Methodologies of solving engineering problems, data collection and interpretation

A6) Quality assurance systems, codes of practice and standards, health and safety requirements and environmental issues

A7) Business and management principles relevant to engineering

A8) Current engineering technologies as related to disciplines

A9) Topics related to humanitarian interests and moral issues.

A10) Technical language and report writing

A11) Professional ethics and impacts of engineering solutions on society and environment

A12) Contemporary engineering topics

B. Intellectual Skills

The graduates of the engineering programs should be able to:

B1) Select appropriate mathematical and computer-based methods for modeling and analyzing problems

B2) Select appropriate solutions for engineering problems based on analytical thinking.

B3) Think in a creative and innovative way in problem solving and design

B4) Combine, exchange, and assess different ideas, views, and knowledge from arrange of sources.

B5) Assess and evaluate the characteristics and performance of components, systems and processes.

B6) Investigate the failure of components, systems, and processes.

B7) Solve engineering problems, often on the basis of limited and possibly contradicting information

B8) Select and appraise appropriate ICT tools to a variety of engineering problems.

B9) Judge engineering decisions considering balanced costs, benefits, safety, quality, reliability, and environmental impact

B10) Incorporate economic, societal, environmental dimensions and risk management in design.

B11) Analyze results of numerical models and assess their limitations.

B12) Create systematic and methodic approaches when dealing with new and advancing technology

C. Practical and Professional Skills

The graduates of the engineering programs should be able to:

C1) Apply knowledge of mathematics, science, information technology, design, business context and engineering practice integrally to solve engineering problems.

C2) professionally merge the engineering knowledge, understanding, and feedback to improve design, products and/or services.

C3) Create and/or re-design a process, component or system, and carry out specialized engineering designs.

C4) Practice the neatness and aesthetics in design and approach.

C5) Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design experiments, collect, analyze and interpret results.

C6) Use a wide range of analytical tools, techniques, equipment, and software packages pertaining to the discipline and develop required computer programs.

C7) Apply numerical modeling methods to engineering problems

C8) Apply safe systems at work and observe the appropriate steps to manage risks.

C9) Demonstrate basic organizational and project management skills

C10) Apply quality assurance procedures and follow codes and standards.

C11) Exchange knowledge and skills with engineering community and industry

C12) Prepare and present technical reports

D. General and Transferable Skills

The graduates of the engineering programs should be able to:

D1) Collaborate effectively within multidisciplinary team

D2) Work in stressful environment and within constraints

D3) Communicate effectively.

D4) Demonstrate efficient IT capabilities

D5) Lead and motivate individuals.

D6) Effectively manage tasks, time, and resources.

D7) Search for information and engage in life-long self-learning discipline.

D8) Acquire entrepreneurial skills

D9) Refer to relevant literatures

Program Requirements

The program requirements can be classified according to the courses area as follows:

Course Area	Credit	%	Tolerance
Humanities and Social Sciences.	16	9.14	9-12%
Mathematics and Basic Sciences.	38	21.71	20-26%
Basic Engineering Sciences.	39	22.29	20-23%
Applied Engineering and Design.	38	21.71	20-22%
Computer Applications and ICT.	16	9.14	9-11%
Projects and Practice.	16	9.14	8-10%
Electives.	12	6.86	6-8%
Total	**175**	**100**	

The program requirements can be completed according to the following proposed schedule:

Term I (Fall)			**Credits**
EMP	101	Engineering Mathematics (1)	3
EMP	103	Physics (1)	3
EMP	105	Engineering Chemistry	3
EMP	106	Engineering Mechanics (1)	3
MDP	101	Engineering Drawing (1)	3
GEN	101	English Language	2
			Total 17
Term II (Spring)			**Credits**

EMP	102	Engineering Mathematics (2)	3
EMP	104	Physics (2)	3
EMP	107	Engineering Mechanics (2)	3
CPE	101	Computer Programming	3
MDP	103	Production Technology & Workshops	3
MDP	102	Engineering Drawing (2)	3
GEN	102	Engineering & Society	2
			Total 20

Term III (Fall)			**Credits**
EMP	201	Engineering Mathematics (3)	3
MDP	203	Computer Aided Mechanical Drawing	3
MPE	201	Thermodynamics	3
MDP	201	Materials Science	3
MDP	212	Manufacturing Technology	2
GEN	201	Technical Report Writing	2
			Total 16

Term IV (Spring)			**Credits**
EMP	202	Engineering Mathematics (4)	3
EMP	203	Physics (3)	3
MPE	202	Fluid Mechanics	3
MDP	204	Mechanics & Testing of Materials	3
EPM	201	Electrical Engineering I	3
GEN	202	Psychology & Organization Behavior	2
			Total 17

Term V (Fall)			**Credits**
MPE	301	Heat & Mass Transfer	3
MPE	302	Applied Fluid Mechanics	3
EPM	301	Electrical Power Engineering	3
EMP	311	Organic Chemistry	2
MDP	311	Machine Components Design	2
EPM	302	Electrical Engineering II	2
GEN	301	Leadership and communication skills	2
			Total 17

Term VI (Spring)			**Credits**
MPE	303	Measurements & instrumentation Systems	3
ESE	380	Field Training I	1
MPE	304	Applied Thermodynamics	3
ELC	301	Electronic Engineering	3
MDP	312	Theory of Machines	2
MPE	305	Numerical Methods for Engineers	3
GEN	302	Professional Ethics	2
			Total 17

Term VII (Fall)			Credits
ESE	411	Sustainable Energy Utilization	2
MDP	401	Vibration & Dynamics	3
EPM	401	Electrical Machines	3
ESE	402	Fuel & Advanced Combustion	3
ESE	XXX	Elective (1)	3
GEN	401	Legislations, contract and procurement management	2
			Total 16

Term VIII (Spring)			Credits
ESE	403	Energy & Conservation Management	3
MPE	401	Applied Heat & Mass Transfer	3
ESE	404	Bioenergy	3
ESE	405	Solar Energy	3
ESE	XXX	Elective (2)	3
ESE	480	Field Training II	1
EPM	402	Power System Analysis	3
GEN	402	Human Resources Management	2
			Total 21

Term IX (Fall)			Credits
ESE	511	Energy Economics	2
ESE	502	Wind Energy	3
MDP	501	Control Systems analysis & Design	3
ESE	503	Solar Cells Fundamentals	3
ESE	XXX	Elective (3)	3
ESE	591	Project (1)	3
			Total 17

Term X (Spring)			Credits
ESE	504	Power Stations	3
ESE	525	Computer Applications in Fluid Mechanics	2
ESE	506	Energy Storage & Transmission	3
EPM	501	Power Electronics	3
ESE	XXX	Elective (4)	3
ESE	592	Project (2)	3
			Total 17

List of Elective Courses: The student must select four courses from the following courses.

Elective Courses			Credits
ESE	410	Hydraulic and Pneumatic systems	3
ESE	411	Selected topics in sustainable energy	3
ESE	412	Air Conditioning & Refrigeration and	3

		Environmental Control	
ESE	413	Internal Combustion Engines	3
ESE	510	Energy Management	3
ESE	511	Marine Energy Systems	3
ESE	512	Geothermal Energy	3
ESE	513	Dynamic Uninterruptible Power Supply System	3

2. ARS for the University of Edinburgh (Benchmark for ESE program)

The academic reference standards for University of Edinburgh provides opportunities for students to develop and demonstrate knowledge and understanding, skills, qualities and other attributes in the following areas. The outcomes referred to the Quality Assurance Agency for higher education.

G1 Knowledge and Understanding:

They must be able to demonstrate their knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics. They must have an appreciation of the wider multidisciplinary engineering context and its underlying principles. They must appreciate the social, environmental, ethical, economic and commercial considerations affecting the exercise of their engineering judgment.

Knowledge and understanding are acquired in the courses. Students also have the opportunity to take courses from outside of the engineering subject area in Year 1 which reinforce the social, environmental, ethical, economic and commercial considerations.

G2 Intellectual Abilities:

They must be able to apply appropriate quantitative science and engineering tools to the analysis of problems. They must be able to demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs. They must be able to comprehend the broad picture and thus work with an appropriate level of detail.

Intellectual ability is applied and assessed in all courses across all years of all mechanical engineering programs.

G3 Practical skills:

They must possess practical engineering skills acquired through, for example work carried out in laboratories and workshops; in industry through supervised work experience; in individual and group project work; in design work and in the development and use of computer software in design, analysis and control. Evidence of group working and of participation in a major project is expected. However, individual professional bodies may require particular approaches to this requirement.

Practical and laboratory skills are developed in many courses from the first to the third year. Workshop skills are developed in the engineering applications programs in second and third year, and the strip-and-build exercises in Mechanical Engineering 1. Computing skills are developed across second, third and fifth year through the use of industry standard engineering software packages. The skills acquired above are applied through group projects and the individual project. Many students also exploit the skills they have developed in their Industrial/ European Placement.

G4 General transferable skills:

They must have developed transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT [information technology] facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD [continuing professional development].

Introduced in the Engineering 1 course and developed mainly through the design teaching, Honours Group Design Projects, and the Individual Project. CPD introduced to students in first year through the “Careers in the Curriculum” initiative in Engineering 1 and reinforced in Mechanical Engineering Practice 3 by external speakers and talks from the careers service. Report writing and presentational skills are developed across all years of the programs.

3. Academic reference Standards for Energy and Sustainable Energy Program designed according to NARS 2009

As we said before the (ARS) of ESE program is a mixture of (NARS) for electrical power program, the (NARS) for Mechanical power program and the academic reference standards (ARS) for the University of Edinburgh.

Attributes of ESE engineer

In addition to the general attributes of the engineer according to NARS 2009, The ESE engineer should be able to:

1. Demonstrate increased depth and coverage of knowledge and understanding of energy and sustainable energy technologies and resources management.
2. Carry out preliminary designs of fluid transmission and energy and power systems, investigate their performance and solve their essential operational problems.
3. Use energy efficiently, Operate and maintain energy systems.
4. Apply and integrate knowledge, understanding and skills of different subjects and available computer software to solve real problems in industries and power stations.
5. Lead or supervise a group of engineers or technicians and other work force.
6. Design, operate and maintain sustainable energy systems.
7. Evaluate the sustainability and environmental issues related to energy systems and apply industrial safety
8. Use the computer graphics for design, communication and visualization.

Intended Learning outcomes

In addition to general Learning Outcomes for NARS 2009 [pages 4, 5, 6], the program in Energy and Sustainable Energy Engineering must satisfy the following Learning Outcomes:

A. Knowledge and understanding:

Graduates of (ESE) program will achieve an appropriate level of technical competence in Acquiring knowledge and understanding of :

A.13) *Concepts, theories and principles of thermal and fluid processes of all energy fields

A.14) * ** Classification, construction design concepts, operation and characteristics of internal combustion engines, pumps, turbines and compressors according to current developments and technologies,

A.15) * The constraints which energy and sustainable energy engineers have to judge to reach at an optimum solution,

A.16) *Basic theories and principles of some other engineering and mechanical engineering disciplines providing support to energy and sustainable energy,

A.17) ** Classification and characteristics of electrical components in energy systems and electric power generation plants,

A.18) Classification and characteristics of fluid power systems,

A.19) Consideration of social, ethical, health, safety, and environmental issues that limit their solutions of engineering problems.

B. Intellectual skills

The Energy and Sustainable Energy Engineering program graduate should be able to

B.13) *** Apply and integrate knowledge and understanding of other engineering disciplines to support study of energy engineering and related engineering disciplines.

B.14) *Evaluate energy and sustainable energy sources, engineering designs, processes and performances and propose improvements.

B.15) *** Apply quantitative methods and computer software relevant to energy and sustainable energy engineering, in order to solve engineering problems.

B.16) ***Assess the ability to use computer programs in some courses across energy and sustainable energy engineering program.

B.17) ** Evaluate, analyse, formulate and solve problems in the field of energy and various sources of sustainable energy by using information, data and ideas from a range of sources.

B.18) Apply management and business techniques and practices appropriate to engineering industry

C. Practical and Professional Skills

The (ESE) Engineering program graduate must show ability to:

C.13) * Use basic workshop equipment safely and appropriately.

C.14) ** Examine characteristics of particular materials, energy equipment, electrical machines and perform experiments and interpret results.

C.15) *** Work in a variety of energy systems operations, maintenance and overhaul.

C.16) *Design, operate, repair and maintain energy systems for diverse applications and use appropriate codes of practice.

C.17) examine economical and commercial factors affecting the exercise of their engineering judgment.

C.18) Evaluate constraints including environmental and sustainability limitations, health, safety and risk assessment issues, and customer and user needs

C.19) Carry out preliminary designs of sustainable energy sources including solar, wind, and geothermal energy, and biotechnology and solve their operational problems.

C.20) Construct logical scientific arguments; analyze and interpret data, and design experiments to obtain primary data keeping in mind the technical uncertainty.

*NARS characterization of mechanical power engineering (August 2009).
** NARS characterization of electrical power engineering (August 2009).
*** Benchmark (The University of Edinburgh).

D. General and transferable skills

The graduates of the engineering programs mentioned in (NARS 2009) [page 6]

4. NARS 2018 Overview

Due to the special engineering education the NARS will be divided as follows:

- **Graduate Attributes:**
  - The specific qualities that distinguish the graduate engineer
- **General (Generic) competencies:**
  - General description of the Graduate
  - Common Competencies that signify all graduates
  - All graduates of any engineering faculty should be able to master
  - These compromise the basis for the development of the programs
- **Specialized (discipline specific) Competencies:**
  - Specific description of the graduates of the different specializations
  - Highly specialized competencies that all graduates of the discipline should be able to master

The attributes of the engineer

The Engineering Graduate must:

1. Master a wide spectrum of engineering knowledge and specialized skills and can apply acquired knowledge using theories and abstract thinking in real life situations.
2. Apply analytic critical and systemic thinking to identify, diagnose and solve engineering problems with a wide range of complexity and variation.
3. Behave professionally and adhere to engineering ethics and standards;
4. Work in and lead a heterogeneous team of professionals from different engineering specialties and assume responsibility for own and team performance;
5. Recognize his/her role in promoting the engineering field and contribute in the development of the profession and the community;
6. Value the importance of the environment, both physical and natural, and work to promote sustainability principles;
7. Use techniques, skills and modern engineering tools necessary for engineering practice;
8. Assume full responsibility for own learning and self-development, engage in lifelong learning and demonstrate the capacity to engage in post- graduate and research studies;
9. Communicate effectively using different modes, tools and languages with various audiences; to deal with academic/professional challenges in a critical and creative manner;
10. Demonstrate leadership qualities, business administration and entrepreneurial skills.

Competencies of engineering graduate

The Engineering Graduate must be able to:

1.Identify, formulate, and solve complex engineering problems by applying engineering fundamentals, basic science and mathematics.

2.Develop and conduct appropriate experimentation and/or simulation, analyze and interpret data, assess and evaluate findings, and use statistical analyses and objective engineering judgment to draw conclusions.

3.Apply engineering design processes to produce cost-effective solutions that meet specified needs with consideration for global, cultural, social, economic, environmental, ethical and other aspects as appropriate to the discipline and within the principles and contexts of sustainable design and development.

4.Utilize contemporary technologies, codes of practice and standards, quality guidelines, health and safety requirements, environmental issues and risk management principles.

5.Practice research techniques and methods of investigation as an inherent part of learning.

6.Plan, supervise and monitor implementation of engineering projects, taking into consideration other trades requirements.

7.Function efficiently as an individual and as a member of multi-disciplinary and multi-cultural teams.

8.Communicate effectively – graphically, verbally and in writing – with a range of audiences using contemporary tools.

9.Use creative, innovative and flexible thinking and acquire entrepreneurial and leadership skills to anticipate and respond to new situations.

10.Acquire and apply new knowledge, and practice self, lifelong and other learning strategies.

Academic reference Standards for Energy and Sustainable Energy Program designed according to NARS 2018

As we said before, the (ARS) of ESE program is a mixture of (NARS) for electrical power program, the (NARS) for mechanical power program and the academic reference

standards (ARS) for the University of Edinburgh, thus we have to modify the (ARS) of ESE program referring to NARS 2018 as follows:

Attributes of ESE engineer

In addition to the general attributes of the engineer according to NARS 2018, The ESE engineer should be able to:

11. Demonstrate increased depth and coverage of knowledge and understanding of energy and sustainable energy technologies and resources management;

12. Carry out preliminary designs of fluid transmission and energy and power systems, investigate their performance and solve their essential operational problems;

13. Use energy efficiently, operate and maintain energy systems;

14. Apply and integrate knowledge, understanding and skills of different subjects and available computer software to solve real problems in industries and power stations;

15. Lead or supervise a group of engineers or technicians and other work force;

16. Design, operate and maintain sustainable energy systems;

17. Evaluate the sustainability and environmental issues related to energy systems and apply industrial safety;

18. Use the computer graphics for design, communication and visualization.

Competencies of ESE engineering graduate

In addition to general competencies for NARS 2018 [page 18], the program in Energy and Sustainable Energy Engineering must satisfy the following competencies of Mechanical & Electrical engineering graduates:

11. # Model, analyze and design physical systems applicable to the specific discipline by applying the concepts of: Thermodynamics, Heat Transfer, Fluid Mechanics, solid

Mechanics, Material Processing, Material Properties, Measurements, Instrumentation, Control Theory and Systems, Mechanical Design and Analysis, Dynamics and Vibrations;

12. *** Classification, construction design concepts, operation and characteristics of internal combustion engines, pumps, turbines and compressors according to current developments and technologies;

13.# Plan, manage and carry out designs of mechanical systems and machine elements using appropriate materials both traditional means and computer-aided tools and software contemporary to the mechanical engineering field support to energy and sustainable energy;

14.## Select, model and analyze electrical power systems applicable to the specific discipline by applying the concepts of: generation, transmission and distribution of electrical power systems;

15. *** Apply quantitative methods and computer software relevant to energy and sustainable energy engineering, in order to solve engineering problems;

16. *** Assess the ability to use computer programs in some courses across energy and sustainable energy engineering program;

17. ***Work in a variety of energy systems operations, maintenance and overhaul;

18. Carry out preliminary designs of sustainable energy sources including solar, wind, and geothermal energy, and biotechnology and solve their operational problems.

NARS characterization of mechanical power engineering (2018)

NARS characterization of electrical power engineering (2018)

*** Benchmark (The University of Edinburgh).

6. Gap Analysis between ARS of ESE program according NARS 2009 & NARS 2018

ARS of ESE program (NARS 2009)	ARS of ESE program (NARS 2018)

The attributes of the engineer	The attributes of the engineer
The graduates of the engineering programs should be able to: a) Apply knowledge of mathematics, science and engineering concepts to the solution of engineering problems; b) Design a system; component and process to meet the required needs within realistic constraints; c) Design and conduct experiments as well as analyze and interpret data; d) Identify, formulate and solve fundamental engineering problems; e) Use the techniques, skills, and appropriate engineering tools, necessary for engineering practice and project management; f) Work effectively within multi-disciplinary teams; g) Communicate effectively; h) Consider the impacts of engineering solutions on society & environment; i) Demonstrate knowledge of contemporary engineering issues; j) Display professional & ethical responsibilities; and contextual understanding; k) Engage in self- and life- long learning. In addition to 1. Demonstrate increased depth and coverage of knowledge and understanding of energy and sustainable energy technologies and resources management; 2. Carry out preliminary designs of fluid	The graduates of the engineering programs should be able to: 1. Master a wide spectrum of engineering knowledge and specialized skills and can apply acquired knowledge using theories and abstract thinking in real life situations; 2. Apply analytic critical and systemic thinking to identify, diagnose and solve engineering problems with a wide range of complexity and variation; 3. Behave professionally and adhere to engineering ethics and standards; 4. Work in and lead a heterogeneous team of professionals from different engineering specialties and assume responsibility for own and team performance; 5. Recognize his/her role in promoting engineering field and contribute in the development of the profession and the community; 6. Value the importance of the environment, both physical and natural, and work to promote sustainability principles; 7. Use techniques, skills and modern engineering tools necessary for engineering practice; 8. Assume full responsibility for own learning and self-development, engage in lifelong learning and demonstrate the capacity to engage in post-graduate and research studies; 9. Communicate effectively using different modes, tools and languages with various audiences; to deal with academic/professional challenges in a critical and creative manner;

transmission and energy and power systems, investigate their performance and solve their essential operational problems; 3. Use energy efficiently, Operate and maintain energy systems; 4. Apply and integrate knowledge, understanding and skills of different subjects and available computer software to solve real problems in industries and power stations; 5. Lead or supervise a group of engineers or technicians and other work force; 6. Design, operate and maintain sustainable energy systems; 7. Evaluate the sustainability and environmental issues related to energy systems and apply industrial safety; 8. Use the computer graphics for design, communication and visualization.	10. Demonstrate leadership qualities, business administration and entrepreneurial skills. In addition to 11. Demonstrate increased depth and coverage of knowledge and understanding of energy and sustainable energy technologies and resources management; 12. Carry out preliminary designs of fluid transmission and energy and power systems, investigate their performance and solve their essential operational problems; 13. Use energy efficiently, Operate and maintain energy systems; 14. Apply and integrate knowledge, understanding and skills of different subjects and available computer software to solve real problems in industries and power stations; 15. Lead or supervise a group of engineers or technicians and other work force; 16. Design, operate and maintain sustainable energy systems; 17. Evaluate the sustainability and environmental issues related to energy systems and apply industrial safety; 18. Use the computer graphics for design, communication and visualization.
Intended Learning Outcomes ILOS provide measures for the academic community to describe the nature and characteristics of academic programs in certain	**Competencies of ESE engineering graduate** The ESE Engineering Graduate must be able to: 1. Identify, formulate, and solve complex engineering problems by applying engineering

fields of specialty. **A. Knowledge and Understanding:** Graduates of (ESE) program will achieve an appropriate level of technical competence in acquiring knowledge and understanding of : A1) Concepts and theories of mathematics and sciences, appropriate to the discipline; A2) Basics of information and communication technology (ICT); A3) Characteristics of engineering materials related to the discipline; A4) Principles of design including elements design, process and/or a system related to specific disciplines; A5) Methodologies of solving engineering problems, data collection and interpretation; A6) Quality assurance systems, codes of practice and standards, health and safety requirements and environmental issues; A7) Business and management principles relevant to engineering; A8) Current engineering technologies as related to disciplines; A9) Topics related to humanitarian interests and moral issues; A10) Technical language and report writing; A11) Professional ethics and impacts of engineering solutions on society and environment; A12) Contemporary engineering topics. In addition to A.13)* Concepts, theories and principles of thermal and fluid processes of all energy fields;	fundamentals, basic science and mathematics; 2.Develop and conduct appropriate experimentation and/or simulation, analyze and interpret data, assess and evaluate findings, and use statistical analyses and objective engineering judgment to draw conclusions; 3. Apply engineering design processes to produce cost-effective solutions that meet specified needs with consideration for global, cultural, social, economic, environmental, ethical and other aspects as appropriate to the discipline and within the principles and contexts of sustainable design and development; 4. Utilize contemporary technologies, codes of practice and standards, quality guidelines, health and safety requirements, environmental issues and risk management principles; 5. Practice research techniques and methods of investigation as an inherent part of learning; 6. Plan, supervise and monitor implementation of engineering projects, taking into consideration other trades requirements; 7. Function efficiently as an individual and as a member of multi-disciplinary and multi- cultural teams; 8. Communicate effectively – graphically, verbally and in writing – with a range of audiences using contemporary tools; 9. Use creative, innovative and flexible thinking and acquire entrepreneurial and leadership skills to anticipate and respond to new situations; 10. Acquire and apply new knowledge; and practice

A.14)*** Classification, construction design concepts, operation and characteristics of internal combustion engines, pumps, turbines and compressors according to current developments and technologies;

A.15)* The constraints which energy and sustainable energy engineers have to judge to reach at an optimum solution;

A.16)* Basic theories and principles of some other engineering and mechanical engineering disciplines providing support to energy and sustainable energy;

A.17)** Classification and characteristics of electrical components in energy systems and electric power generation plants;

A.18) Classification and characteristics of fluid power systems;

A.19) Consideration of social, ethical, health, safety, and environmental issues that limit their solutions of engineering problems.

B. Intellectual Skills

The Energy and Sustainable Energy Engineering program graduate should be able to:

B1) Select appropriate mathematical and computer-based methods for modeling and analyzing problems;

B2) Select appropriate solutions for engineering problems based on analytical thinking;

B3) Think in a creative and innovative way in problem solving and design;

B4) Combine, exchange, and assess different ideas, views, and knowledge from arrange of self, lifelong and other learning strategies.

In addition to the above general competencies for NARS 2018, ESE program Engineering must satisfy the following competencies of mechanical & electrical engineering graduates:

11. # Model, analyze and design physical systems applicable to the specific discipline by applying the concepts of: thermodynamics, heat transfer, fluid mechanics, solid mechanics, material processing, Material Properties, measurements, control theory and systems, instrumentation, mechanical Design and Analysis, Dynamics and Vibrations;

12.*** Classification, construction design concepts, operation and characteristics of internal combustion engines, pumps, turbines and compressors according to current developments and technologies;

13.# Plan, manage and carry out designs of mechanical systems and machine elements using appropriate materials both traditional means and computer-aided tools and software contemporary to the mechanical engineering field support to energy and sustainable energy;

14.## Select, model and analyze electrical power systems applicable to the specific discipline by applying the concepts of: generation, transmission and distribution of electrical power systems;

15. *** Apply quantitative methods and computer software relevant to energy and sustainable energy engineering, in order to solve engineering problems;

16. *** Assess the ability to use computer programs

sources; B5) Assess and evaluate the characteristics and performance of components, systems and processes. B6) Investigate the failure of components, systems, and processes; B7) Solve engineering problems, often on the basis of limited and possibly contradicting information; B8) Select and appraise appropriate ICT tools to a variety of engineering problems; B9) Judge engineering decisions considering balanced costs, benefits, safety, quality, reliability, and environmental impact; B10) Incorporate economic, societal, environmental dimensions and risk management in design; B11) Analyze results of numerical models and assess their limitations; B12) Create systematic and methodic approaches when dealing with new and advancing technology. In addition to B.13)***Apply and integrate knowledge and understanding of other engineering disciplines to support study of energy engineering and related engineering disciplines; B.14)*Evaluate energy and sustainable energy sources, engineering designs, processes and performances and propose improvements; B.15)***Apply quantitative methods and computer software relevant to energy and sustainable energy engineering, in order to solve	in some courses across energy and sustainable energy engineering program; 17. ***Work in a variety of energy systems operations, maintenance and overhaul; 18. Carry out preliminary designs of sustainable energy sources including solar, wind, and geothermal energy, and biotechnology and solve their operational problems.

engineering problems;

B.16)***Assess the ability to use computer programs in some courses across energy and sustainable energy engineering program;

B.17)**Evaluate, analyse, formulate and solve problems in the field of energy and various sources of sustainable energy by using information, data and ideas from a range of sources;

B.18) Apply management and business techniques and practices appropriate to engineering industry;

C. Practical and Professional Skills

The (ESE) Engineering program graduate must show ability to:

C1) Apply knowledge of mathematics, science, information technology, design, business context and engineering practice integrally to solve engineering problems;

C2) professionally merge the engineering knowledge, understanding, and feedback to improve design, products and/or services;

C3) Create and/or re-design a process, component or system, and carry out specialized engineering designs;

C4) Practice the neatness and aesthetics in design and approach;

C5) Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design experiments, collect, analyze and interpret results;

C6) Use a wide range of analytical tools, techniques, equipment, and software packages

pertaining to the discipline and develop required computer programs; C7) Apply numerical modeling methods to engineering problems; C8) Apply safe systems at work and observe the appropriate steps to manage risks; C9) Demonstrate basic organizational and project management skills; C10) Apply quality assurance procedures and follow codes and standards. C11) Exchange knowledge and skills with engineering community and industry; C12) Prepare and present technical reports. In addition to C.13)* Use basic workshop equipment safely and appropriately; C.14)** Examine characteristics of particular materials, energy equipment, electrical machines and perform experiments and interpret results; C.15)*** Work in a variety of energy systems operations, maintenance and overhaul; C.16)* Design, operate, repair and maintain energy systems for diverse applications and use appropriate codes of practice; C.17) examine economical and commercial factors affecting the exercise of their engineering judgment; C.18)Evaluate constraints including environmental and sustainability limitations, health, safety and risk assessment issues, and customer and user needs; C.19) Carry out preliminary designs of sustainable	

energy sources including solar, wind, and geothermal energy, and biotechnology and solve their operational problems;

C.20) Construct logical scientific arguments; analyze and interpret data, and design experiments to obtain primary data keeping in mind the technical uncertainty.

D. General and Transferable Skills

The graduates of the engineering programs should be able to:

D1) Collaborate effectively within multidisciplinary team;

D2) Work in stressful environment and within constraints;

D3) Communicate effectively;

D4) Demonstrate efficient IT capabilities;

D5) Lead and motivate individuals;

D6) Effectively manage tasks, time, and resources;

D7) Search for information and engage in life-long self-learning discipline;

D8) Acquire entrepreneurial skills;

D9) Refer to relevant literatures.


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