National Academic Reference Standards (NARS)

Basic Sciences

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1st Edition

Table of Contents

Introduction to Basic Sciences Education

The aim of science is to understand the nature and justification of scientific knowledge. Basic Sciences including, physics chemistry, biosciences, earth science and mathematics, furnish the basis for all scientific disciplines.

Physics is concerned with the observation, understanding and prediction of natural phenomena and the behavior of man-made systems. It deals with profound questions about the nature of the universe and with some of the most important practical, environmental technology issues. Its scope is broad and involves mathematical theories, experiments and observation, computing technology, materials, nuclear energy and magnetism.

Chemistry is the science which deals with the study of atoms and molecules with a great emphasize on their structures, properties, synthesis, and how they interact with each other to create new molecules. Its range and compass are enormous, from the simplest compounds like sodium chloride up to huge and complex biological molecules such as DNA and proteins which form the basis of life itself.

The **biosciences** are the study of life and life-related topics at all levels of complexity from molecules to populations. Studies in biosciences encourage the understanding of multidisciplinary life aspects including physical and chemical nature at different

complexity. They also include biostatistics, bioinformatics and related advanced techniques.

Earth science is the science which attempts an intelligent interpretation of the phenomena resulting from the natural processes acting on and in the earth. It is a broad science and has a number of disciplines such as geology and geophysics.

Mathematics is one of the oldest and fundamental sciences. It constitutes a body of established facts, achieved by a reliable method, verified by practice, and agreed on by qualified experts. It develops investigative mathematical computational modeling and establishes new principles.

I. National Academic Reference Standards

1. National Academic Reference Standards

1.1. General Attributes of the Graduates of Basic Sciences

The graduates must be able to:

1.1.1. Recognize the role of Basic Sciences in the development of society.

1.1.2. Develop scientific approaches that meet community needs considering economic, environmental, social, ethical, and safety requirements.

1.1.3. Utilize scientific facts and theories to analyze and interpret practical data.

1.1.4. Collect, analyze, and present data using appropriate formats and techniques.

1.1.5. Postulate concepts and choose appropriate solutions to solve problems on scientific basis.

1.1.6. Apply effectively information technology relevant to the field.

1.1.7. Participate effectively in a multidisciplinary teamwork and be flexible for adaptation, decision making and working under contradictory conditions as well as exhibiting the sense of beauty and neatness.

1.1.8. Adopt self and long life-learning and participate effectively in research activities.

1.1.9. Deal with scientific data in Arabic, English or other languages.

1.2. Knowledge and Understanding

Graduates must acquire knowledge and understanding of:

1.2.1. The related basic scientific facts, concepts, principles and techniques.

1.2.2. The relevant theories and their applications.

1.2.3. The processes and mechanisms supporting the structure and function of the specific topics.

1.3. The related terminology, nomenclature and classification systems.

1.2.4. The theories and methods applied for interpreting and analyzing data related to discipline.

1.2.5. The developmental progress of the program-related knowledge.

1.2.6. The relation between the studied topics and the environment.

1.3. Practical and Professional Skills

The graduates must be able to:

1.3.1. Plan, design, process and report on the investigated data, using appropriate techniques and considering scientific guidance.

1.3.2. Apply techniques and tools considering scientific ethics.

1.3.3. Solve problems using a range of formats and approaches.
1.3.4. Identify and criticize the different methods used in addressing subject related issues.

1.4. Intellectual Skills

The graduates must be able to:

1.4.1. Differentiate between subject-related theories and assess their concepts and principles.
1.4.2. Analyze, synthesize, assess and interpret qualitatively and quantitatively science relevant data.
1.4.3. Develop lines of argument and appropriate judgments in accordance with scientific theories and concepts.
1.4.4. Postulate and deduce mechanisms and procedures to handle scientific problems.
1.4.5. Construct several related and integrated information to confirm, make evidence and test hypotheses.

1.5. General and Transferable Skills

The graduates must be able to:

1.5.1. Use information and communication technology effectively.
1.5.2. Identify roles and responsibilities, and their performing manner.
1.5.3. Think independently, set tasks and solve problems on scientific basis.

1.5.4. Work in groups effectively; manage time, collaborate and communicate with others positively.
1.5.5. Consider community linked problems, ethics and traditions.
1.5.6. Acquire self- and long life–learning.
1.5.7. Apply scientific models, systems, and tools effectively.
1.5.8. Deal with scientific patents considering property right.
1.6.9. Exhibit the sense of beauty and neatness

2. National Academic Reference Standards for Physics

Physics is the study of energy and behavior of single atom and its components. Physics is the foundation upon which the other physical sciences are based such as; astronomy, chemistry and geology. The beauty of physics lies in the simplicity of the fundamental physical theories and assumptions that can alter and expand our view of the world around us. Like all sciences, physics is based on experimental observations and quantitative measurements. The main objective of physics is to use a limited number of fundamental laws that govern natural phenomena to develop theories that can predict the results of future experiment.

Physicists are expected to become investigators in industrial or research institutions. They can also have careers as air navigators and instrument manufacturers, scientific reporters, technical consultants and university staff members. They can also be employed in information technology companies, educational institutions and health care organizations.

2.1. The Attributes of a Physicist

In addition to the general attributes of basic sciences graduates, the physics graduates must be able to:

2.1.1. Demonstrate a good basic knowledge of structural and functional aspects of physical systems at many spatial scales, from single molecule to the whole system.

2.1.2. Connect fundamental ideas about the physical behavior of matter and energy to system's structure and function.

2.2. Knowledge and Understanding

In addition to the general knowledge acquired by Basic Sciences graduates, the physics graduates must know and understand the:

2.2.1. Characteristics and physical properties of matter.

2.2.2. Static and dynamic properties of fluids.

2.2.3. The Basics of Electricity.

2.2.4. Concepts of electromagnetism.

2.2.5. Principles of heat transfer and thermodynamics.

2.2.6. Theoretical and practical aspects of optics, nuclear physics and other related branches.

2.2.7. Application of advanced physical techniques.

2.2.8. Basics and mechanisms of energy transfer.

2.3. Practical and Professional skills

In addition to the general skills acquired by Basic Sciences graduates, the physicist must be able to:

2.3.1. Apply mathematical tools and techniques to analyze and interpret experimental results.

2.3.2. Implant comprehensive physical knowledge and understanding as well as intellectual skills in research tasks.

2.3.3. Use the national standards for laboratory equipment which are essential for practical research work.

2.3.4. Present theoretical and experimental results in understandable forms such as tables and graphs.

2.4. Intellectual skills

In addition to the general skills acquired by Basic Sciences graduates, the physicist must be able to:

2.4.1. Utilize theories of physics to interpret physical phenomena.

2.4.2. Apply appropriate physical principles to create and analyze system components.

2.4.3. Choose optimum solutions for physical problems based on analytical thinking.

3. National Academic Reference Standards For Biophysics

Biophysics is an interdisciplinary science that applies the theories and methods of physical sciences to solve biological problems. Biophysicists use the ideas, instrumentation and computational models of physics to understand living systems. The biophysics shares a common interest in combining biology and physical principles applied to biological systems and medical sciences. There is a wide range of sub-disciplines of biophysics such as cell membrane biophysics, radiation and environmental biophysics, biophysics of macromolecules and sub-cellar components, nuclear magnetic resonance in medicine and biology. Biophysics studies the structure and function of proteins, nucleic acids and lipids at the molecular level. Biophysics investigates dynamics in areas such as vision, hearing and motility as well as molecular structure, signal transmission and transduction of signals in nerve and muscle. This discipline has wide industrial applications as biomaterials and in medicine as radiotherapy and radio-diagnosis.

Therefore, a wide range of careers is available to biophysicists. They can work primarily in medical and research laboratories, in educational and health institutions and in medical industries or become scientific reporters.

3.1. The attributes of a biophysicist

In addition to the general attributes of a Basic Sciences graduates, the biophysics graduates must be able to:

3.1.1. Design and conduct experiments and to analyze and interpret biophysical data.

3.1.2. Attain good basic knowledge of structural and functional aspects of biological systems from single molecule to the entire organism.

3.1.3. Connect fundamental ideas about the physical behavior of matter and energy to biological structure and function.

3.1.4. Use Mathematical framework in quantitative predictions of behavior of living systems.

3.2. Knowledge and understanding:

In addition to the general knowledge acquired by Basic Sciences graduates, the biophysics graduates must know and understand the:

3.2.1. Macromolecular structures, enzyme mechanisms, cellular behavior, excitation in nerve, muscle and visual cells.

3.2.2. Basics of hearing, vision, smelling, taste, and tactile by sense organs and its conversion into electrical impulses.
3.2.3. Conversion of chemical energy into Mechanical energy and movement by muscles.
3.2.4. Cell membrane biophysics.
3.2.5. Biological effects of radiations on Biological systems.
3.2.6. Application of advanced Biophysical and Biomedical Techniques.
3.2.7. Principles of modeling for Biological Systems.

3.3 Practical and Professional skills

The graduates of Biophysics Program must be able to:

3.3.1. Apply Mathematical methods to test, analyze and interpret Biophysical experimental results.
3.3.2. Use the national standards for laboratory equipment essential to practice research work.
3.3.3. Implant comprehensive biophysical knowledge, understanding as well as intellectual skills in research work.
3.3.4. Use computational program packages and tools in laboratory work.
3.3.5. Handle radiation sources and Biological samples safely.

3.4. Intellectual skills

The graduates of Biophysics Program must be able to:

3.4.1. Use principles of biophysics in analyzing signals originating from biological systems.

3.4.2. Choose appropriate solutions for Biophysical problems.

3.4.3. Design and apply models based on experimental data derived from Biological systems.

4. National Academic Reference Standards For Chemistry

Chemistry is the science which provides the concepts, knowledge, principles and theories necessary for the intellectual framework of understanding the properties of atoms and molecules as well as the relationship between structure and reactivity from fundamentals to the frontiers of current research. The study of chemistry focuses strongly on a wide range of analytical and practical skills required to practice the subject. Chemistry enables students to examine changes of materials during physical and chemical processes, and learn how to observe and measure results. Chemistry in turn, draws on the facts and theory of physics and mathematics as tools necessary to evaluate and express quantitative chemical information. Therefore, knowledge of the dynamic and the evolving science of chemistry is essential to the discovery, understanding and development of other sciences such as biology, medicine, pharmacy, materials science, engineering and many other related sciences.

Studying for a degree in Chemistry is a sound basis for the students where they can extend their knowledge of the subject and develop many of the scientific and employability skills which are necessary for most occupations. Therefore, chemists can have opportunities to work as scientists in research activities in governmental agencies and private laboratories. They can be employed as product developers and quality control of manufactures in the industrial sectors. Chemists can utilize their wide chemistry

knowledge and skills in other areas such as sales representative for chemical products, pharmaceuticals or laboratory equipment. In addition, chemistry graduates can be involved in educational institutions.

The Academic Reference Standards represent general expectations about the standards for the award of qualifications at the B.Sc degree in chemistry, and articulate the attributes and capabilities that the graduates should be able to demonstrate. Regardless of the institution, the undergraduates of chemistry programs should provide students with an education in the main branches of chemistry, namely:

1. Analytical chemistry: study of the structure, composition and analysis of substances,
2. Inorganic chemistry: study of non-carbon-based compounds,
3. Organic chemistry: study of carbon-based compounds,
4. Physical chemistry: application of concepts and laws to study the characteristics of atoms and molecules as well as chemical reactions,
5. Computational chemistry: study of the principles and theories of quantum mechanics.

4.1. The Attributes of a Chemist

In addition to the general attributes of the basic science graduates, the chemist must develop a group of attributes which are the ability to:

4.1.1. Design and conduct experimental work, critically evaluate the outcomes, review and report on practice.
4.1.2. Have knowledge and experience of working with relevant and advanced laboratory techniques.
4.1.3. Participate in and review quality control processes, manage risks and organize time to finish jobs.
4.1.4. Demonstrate wide background knowledge related to the different branches of chemistry.

4.2. Knowledge and Understanding

In addition to the general knowledge acquired by the basic science graduates, the chemist should be able to demonstrate knowledge and understanding of:

4.2.1. Chemical concepts, nomenclature, formulae and units.
4.2.2. Characteristics of the different states of the matter and elements including trends within the periodic table and the related theories.
4.2.3. The principles, procedures and techniques used in chemical analysis, characterization and structural investigations of different chemical compounds.
4.2.4. The major types of chemical reactions, their characteristics and mechanisms as well as their kinetics including catalysis.

4.2.5. The principles of thermodynamics and quantum mechanics including their applications in chemistry.
4.2.6. The constitution and properties of the different chemical compounds, including the main synthetic pathways and the relation between the properties of individual atoms and molecules.
4.2.7. The current issues of chemical research and technological development.

4.3. Practical and Professional skills:

The Graduates of Chemistry Program must be able to:

4.3.1. Assess risk in laboratory work taking into consideration the specific hazards associated with the use of chemical materials as well as the safe and proper operation of the laboratory techniques.
4.3.2. Conduct standard laboratory procedures involved in analytical and synthetic work.
4.3.3. Monitor by observation and measurements the chemical properties or changes, including systematic recording and technical reporting.
4.3.4. Use computational packages and tools in chemical investigations.

4.4. Intellectual skills

The Graduates of Chemistry Program must be able to:

4.4.1. Differentiate between the different states of the matter, elements and compounds based on the recognition and quantification of the properties.

4.4.2. Employ computational software's and data-processing skills in handling of chemical information and analysis of chemical data.

4.4.3. Explain concepts and determine the efficiency of chemical systems by applying mathematical expressions.

4.4.4. Analyze chemical data to identify and confirm chemical structures as well as determine chemical composition.

4.4.5. Propose and conclude mechanisms for physical and chemical processes.

5. National Academic Reference Standards For Biochemistry

Biochemistry is an advanced, interdisciplinary field that encompasses the biological sciences, chemistry and physics**.** The aim of biochemistry is the application of the concepts, theories, facts and techniques of both biology and chemistry to the study of living systems and understanding of life's processes at a molecular scale. In addition, biochemistry determines the function of cell components and explores how these components interact and integrate into biological systems and how they affect the overall functions of cells and living systems. Biochemistry is also concerned with the study of the complex cellular reactions and generation of the energy to power cellular activity, communication and co-ordination between and within cells. The study of biochemistry provides the concepts, knowledge and principles necessary for biochemist to understand how bio-molecules such as carbohydrates, proteins, nucleic acids, lipids, vitamins and hormones function in such processes. Particular emphasis is given to the chemical bases of inheritance and disease, the experimental design and the proper control of the conditions as well as the standard operation of modern techniques.

This is covered through the study of a wide variety of subjects including; chemistry, cell biology, macromolecules, molecular biology and molecular genetics as well as metabolism and

enzymology. Thus, biochemistry graduates can be employed in different public and private sectors including research centers (biotechnological, medical, forensic, fishery and agricultural), food and beverage industries, manufacturing and processing, pharmaceutical, health and beauty care organizations, pollution control, hospitals, laboratory services as well as in sales.

5.1. The Attributes of a Biochemist

In addition to the general attributes of the basic science graduates, the biochemist must be able to:

5.1.1. Be acquainted with the molecular basis and chemistry of the processes that take place in cells and organisms.

5.1.2. Work safely in a laboratory environment and possess the basic competencies necessary for a range of practical biochemical techniques.

5.1.3. Apply statistical skills in manipulation and presentation of biochemical data.

5.1.4. Analyze biochemical data to characterize biomolecules and assess the activity of biochemical processes.

5.2. Knowledge and Understanding

In addition to the general knowledge acquired by the basic science graduates, a biochemist must be able to demonstrate knowledge and understanding of:

5.2.1. The fundamentals of sciences relevant to biochemistry especially chemistry, physics and mathematics.

5.2.2. The basic knowledge of the molecular biosciences, including biochemical processes, genetics, molecular biology and cell biology.

5.2.3. The principles and limitations of practical techniques, and methods related to biochemical investigations.

5.2.4. The structures, assemblies and functions of biological macomolecules and how they conduct and control the biochemical processes.

5.2.5. Mechanisms of the key metabolic reactions involved in the biochemical processes as well as the relation between biochemistry and cellular and organismal processes.

5.2.6. The key processes involved in the control of arrangement and expression of genes.

5.2.7. The important biochemical features that distinguish plants from animals

5.3. Practical and professional skills

Graduates of Biochemistry Program must be able to:

5.3.1. Use advanced biochemical techniques and methods relevant to the molecular biosciences in a safe, logistical and ethical manner.

5.3.2. Conduct standard laboratory procedures involved in biochemical analysis and synthetic work as well as industrial applications.

5.3.3. Consider variations inherent in dealing with biological materials such as sample size, accuracy, calibration and precision.

5.3.4. Use computational packages and statistics in data handling and manipulation of biochemical information.

5.4. Intellectual skills

Graduates of Biochemistry Program must be able to:

5.4.1. Use computational soft-wares in simulation studies to understand, confirm and optimize his/her practical techniques.

5.4.2. Integrate and link information across different approaches studied in different areas of biochemistry.

5.4.3. Classify and elucidate mechanisms of biochemical processes.

5.4.4. Analyze biochemical data to identify and determine Biochemical Structures**.**

6. National Academic Reference Standards For Biological Sciences

The study of biological sciences emphasizes on understanding of life's basic processes for biological elements including respiration, metabolism, movement, sensation and digestion. In addition, biological sciences are concerned with the environmental aspects, including ecosystem composition, protection, conservation, economics, utilization, interaction, competition and breeding between the biological elements of the ecosystem. The study of biological sciences serve as basic information for a wide range of disciplines such as medicine, pharmacology, veterinary medicine, dental medicine and agriculture. It contributes effectively to the human health which is the wealth of the nation, and disease fundamentals through the study of the microorganisms together with the development of new vaccines, drugs and antibiotics.

Biological sciences of the basic science sector given under a number of specializations such as: entomology, botany and zoology. In addition to, the sub-disciplines within this area that focus on particular groups of organisms such as microbiology and other interdisciplinary specializations as biotechnology.

There are various job opportunities for biologist as researcher in academic, educational and environmental institutions. Other work opportunities are in drug, biotechnology, food, agricultural, chemical, biological supplies, forensic sectors and others.

6.1. Attributes of a Biologist

In addition to the general attributes, the graduates must be able to:

6.1.1 Understand the life's basic processes in relation to organisms and ecosystems.

6.1.2. Recognize, understand and assess different levels of organization in biological systems.

6.1.3. Identify and characterize different communities and ecosystems supporting the biological organism.

6.1.4. Be acquainted with the modern subjects and bio-techniques.

6.2. Knowledge and understanding in biological sciences

In addition to the knowledge mentioned in the general part for the Basic Sciences graduates, the Biologist must know and understand the:

6.2.1. Life of representative Taxa in different disciplines from cellular to organism.

6.2.2. Physiological aspects of organisms.

6.2.3. Taxa limit and the characteristic habitat features of representative organisms.

6.2.4. Processes and mechanisms in different ecosystems.

6.2.5. Theories applied for interpreting and analyzing biological information.

6.2.6. Complexity and diversity of organisms through the study of genetics, developmental stages and evolution.

6.3. Professional and Practical Skills

The Graduates of Biological Sciences programs must be able to:

6.3.1. Solve Biological problems by a variety of methods including computers and other recent tools.
6.3.2. Collect, record and analyze biological data using appropriate techniques in the field and laboratory.
6.3.3. Apply field and laboratory investigations of living systems in an ethical and responsible manner.
6.3.4. Select a representative sample considering its validity, accuracy and reliability during collection.

6.4. Intellectual Skills

The Graduates of Biological Sciences programs must be able to:

6.4.1. Interpret the subject-related knowledge to solve problems.
6.4.2. Formulate data and select the proper mechanism for their setting within a theoretical framework.

6.4.3. Assess the interrelationships and the impact of a specific organism on its ecosystem.
6.4.4. Evaluate the ecosystem, its conservation, economics and sustainability.
6.4.5. Interpret biological data and respond to a variety of information sources.

7. National Academic Reference Standards For Geology

Geology is the fundamental earth science which attempts an intelligent interpretation of products resulting from the natural processes acting on and in the earth. Geology is based on field observations and laboratory analysis of the natural environment including surface features, soil, surface and underground water, oceans, coasts, subsurface structures and mineral resources. Geologic phenomena originate deep within the earth's crust, and its hypotheses advanced to explain them must be based entirely upon indirect evidences. Familiarity with the present earth processes and conditions enables the geologist to reconstruct the sequence of past events and thus to interpret the history of the earth and its inhabitants. Interpretation of the earth's history requires knowledge of the materials and structure of the earth, as well as a proper conception of the agencies and processes which are continually acting on the earth.

Geology is based on different scientific disciplines such as chemistry, physics, mathematics, biology and computer science. The earliest earth history deals with the form, size and physical condition of the earth as a planet, and thus the subject matter is closely related to astronomy.

Geologists can find employment in oil and gas companies, mineral exploration, environmental organizations, regional

construction (dams, tunnels), industry, scientific research and educational institutions.

1.1. The attributes of a Geologist

In addition to the general attributes of Basic Sciences graduates, the Geologist must be able to:

1.1.1. Learn advanced subjects and think clearly about earth science related topics.

1.1.2. Design and undertake geological experimental analysis (using maps, aerial photographs, satellite images, field instruments) and assess their results.

1.1.3. Estimate, consult and assess the visibility of the applied geological environment and economical projects.

1.2. Knowledge and Understanding:

In addition to the general knowledge acquired by basic science graduates, the geology graduates must be able to know and understand the:

1.2.1. Theoretical bases, procedures and techniques used for geological field studies and related laboratory analysis.

1.2.2. Physical features and history of the earth.

1.2.3. Tectonic events, stratigraphical and structural phenomena.

1.2.4. Rock types forming the earth crust.

1.2.5. Types and distribution of economical raw materials (rocks, minerals, oil and gas).

1.3. Professional and Practical skills:

The Geology graduates must be able to:

1.3.1. Investigate prior work and references.

1.3.2. Use laboratory and field equipments safely for collecting and analyzing samples.

1.3.3. Apply scientific ethics for geological sample selection and accuracy during reporting.

1.3.4. Apply the geographical information system (GIS) in interpreting the different geological phenomena.

1.4. Intellectual skills

In addition to the general skills acquired by the basic science graduates, the Geology graduates must be able to:

1.4.1. Recognize and use the subject-related theories, concepts and principles for discussion and interpretation of geological phenomena.

1.4.2. Hypothesize a range of ideas to solve different geological problems.

1.4.3. Criticize the techniques and theories to recognize the proper applicable techniques or theories.

1.4.4. Identify and differentiate between the published geological data.

2. National Academic Reference Standards For Mathematics

Mathematics is one of the oldest and most fundamental sciences. It constitutes a body of established facts, achieved by reliable methods, verified by practice, and agreed on by qualified experts. Mathematicians advance mathematical knowledge by developing new principles and recognizing previously unknown relationships between existing principles of mathematics. Mathematicians also use theories and techniques, such as mathematical modeling and computational methods to formulate and solve practical problems. Students of mathematics programs today bring a rich diversity of experiences. This diversity challenges educators to define clear goals and standards, develop effective instructional strategies, and present mathematics in appropriate contexts. Mathematics can be offered as a single program, and also joint with other disciplines, such as statistics, computer science, physical applied mathematics, and theoretical physics.

Graduates of such programs are employed in a wide range of careers such as teaching and research jobs in a variety of educational institutions. Graduates also work with others as part of a team, in business, industry and commerce, to solve a variety of problems, such as translating mathematical situations into computational procedures, or designing mathematical models to predict the behavior of phenomena in a physical or a life science.

The standards have to be built in a framework through which it will be reflected in performances to satisfy the main aims of the program. The framework of these standards should be consistent with frameworks presented in other mathematics reform initiatives and are intended to affect every aspect of a university mathematics program.

2.1. Attributes of a Mathematician

In addition to the general attributes of Basic Sciences graduates, the Mathematics graduates must be able to:

2.1.1. Understand, recognize, and describe patterns and make abstractions about them.

2.1.2. Draw conclusions about the real world using mathematical concepts.

2.1.3. Find true statements that can be made about mathematical objects.

2.1.4. Apply techniques, tools, and formulas to understand an object's attributes.

2.1.5. Recognize and use various types of reasoning and methods of proof.

2.1.6. Create and use representations to model and interpret mathematical ideas.

2.1.7. Recognize and understand how mathematical ideas interconnect and build on one another.

2.2. Knowledge and Understanding

The knowledge and understanding standards that follow are not meant to outline a set of courses. Rather, they are strands to be included in a mathematics program in whatever structural form it may take.

In addition to the knowledge and understanding acquired by Basic Sciences graduates, Mathematicians must acquire knowledge and understanding of:

2.2.1. Numerical mathematics, and the different ways in which numerical information is used.

2.2.2. Abstract algebraic structures and their roles in solving problems expressed with symbols and in developing mathematical theories and techniques.

2.2.3. Mathematical methods and techniques that deal with differential equations and their applications.

2.2.4. Geometrical concepts, and processes used in measuring attributes of objects.

2.2.5. The concept of function, and its role in mathematical analysis.

2.2.6. Discrete mathematics, algorithms, and combinatorial abilities in order to solve problems of finite character and enumerate sets without direct counting.

2.2.7. Probability and statistical models to make inferences about real-world situations.

2.2.8. Modeling and symbolic representations of problem situations.

2.2.9. The deductive nature of mathematics, and the roles of definitions, axioms, and theorems to identify and construct valid deductive arguments.

2.2.10. Theories and applications of other mathematical trends and/or applied mathematics and/or mathematical statistical and/or computer science.

2.3. Practical and Professional skills

Graduates of Mathematics program must be able to:

2.3.1. Apply reasoning techniques to build convincing mathematical arguments.

2.3.2. Develop conjectures and draw appropriate conclusions, and test these conjectures.

2.3.3. Identify required mathematics and other technical information independently.

2.3.4. Use technology to enhance mathematical thinking and understanding.

2.3.5. Conduct independent nontrivial exploration in mathematics.

2.3.6. Develop and reinforce tenacity and confidence in their abilities to use mathematics.

2.4. Intellectual skills

Graduates of Mathematics program must be able to:

2.4.1. Formulate mathematical ideas and procedures using appropriate mathematical vocabulary and notation.

2.4.2. Construct symbolic forms of problem situations through modeling real-world situations, develop and use the models to make predictions and informed decisions.

2.4.3. Recognize, compare, and transform mathematical objects.

2.4.4. Represent, abstract and interpret problems.

2.4.5. Develop connections within branches of mathematics and between mathematics and other disciplines.

2.4.6. Utilize appropriate processes in applied mathematical studies.

2.4.7. Judge the validity of mathematical arguments and the reasonableness of results.

3. National Academic Reference Standards for Astronomy and Meteorology

Astronomy and meteorology are concerned with the observation, analysis, understanding and prediction of the observed space and climate phenomena. They deal with profound questions about the nature of the universe and with some of the most important practical, environmental and technological issues of our time. Their scope is broad and involves mathematics and theory, experiment and observations, computing, technology, materials and information theory. Physical ideas and techniques from astronomy and meteorology also drive developments in related disciplines including physics, chemistry, geology, biology, computing, engineering, mathematics, statistics and medicine. Astronomy and meteorology govern systems familiar to everyday life as well as many of the phenomena observed in the movement of stars and galaxies.

Astronomy and meteorology graduatess can have jobs in science museums, airports, planetariums and astronomy observatories. They can work also at educational and research institutions.

3.1. Attributes of Astronomists and Meteorologists

In addition to the general attributes of Basic Sciences graduates, the Astronomy and Meteorology graduates must be able to:

3.1.1. Use effectively and understand the fundamental physical laws and principles, and competence in the application of these principles to their area of study.

3.1.2. Identify the relative scientific principles and make approximations necessary to obtain solutions.

3.1.3. Evaluate the level of uncertainty in results and compare these results with expected outcomes, theoretical predictions or with published data.

3.1.4. Use the proper scientific techniques and analysis to model the studied phenomenon.

3.2. Knowledge and Understanding:

In addition to the general knowledge acquired by Basic Science graduates, the Astronomy and Meteorology graduates must know and understand:

3.2.1. The investigative experimental mathematical and computational modeling.

3.2.2. A broad base knowledge about physics and applied physics.

3.2.3. The application of the fundamental principles to related areas.

3.2.4. The bases and theories of phenomena observed in the movement of stars and galaxies.

3.2.5. The principles of meteorological predictions and the related atmospheric phenomena.

3.2.6. The universal phenomena of the space near earth.

3.2.7. The nature and characteristics of stratosphere and associated phenomena.

3.3. Practical and Professional Skills:

The graduates of Astronomy Program must be able to:

3.3.1. Use the telescope and different equipments to observe and analyze astronomical phenomena.

3.3.2. Deal with atmospheric models programs in weather forecasting.

3.3.3. Execute and report on the results of astronomical and meteorological investigations.

3.4. Intellectual Skills

The graduates of Astronomy Program must be able to:

3.4.1. Formulate and tackle scientific problems in their area of study.

3.4.2. Identify the appropriate physical and chemical principles related to the study field.

3.4.3. Use appropriate methods to analyze their data and to evaluate the level of its uncertainty.

3.4.4. Apply mathematics to describe the physical parameters of astronomical and meteorological phenomena

II. Curriculum Structure

area	Percentage	Tolerance
Basic Science	28	27-29
Humanities(including language)	6	5-7
Specialty (professional)	50	48-52
Computer and IT	6	5-7
Research and graduation project	2	1-3
Others (Discretionary)	8	7-9

III. Glossary

1. **Institution**
   A University, faculty or higher institute providing education programs leading to a first university degree or a higher degree (Master's or Doctorate).

2. **Graduates Attributes**
   Competencies expected from the graduates based on the acquired knowledge and skills gained upon completion of a particular program.

3. **National Academic Reference Standards (NARS)**

   Reference points designed by NAQAAE to outline / describe the expected minimum knowledge and skills necessary to fulfill the requirements of a program of study.

4. **Academic Standards**

   Reference points defined by an institution comprising the collective knowledge and skills to be gained by the graduates of a particular program. The academic standards should surpass the NARS, and be approved by NAQAAE.

5. Subject Benchmark Statements

Guideline statements that detail what can be expected of a graduates in terms of the learning outcomes to satisfy the standards set for the program. They enable the outcomes to be compared, reviewed and evaluated against agreed upon standards.

6. The Program

A set of educational courses and activities designed by the institution to determine the systematic learning progress. The program also imparts the intended competencies required for the award of an academic degree.

7. Intended Learning Outcomes (ILOs)

Subject-specific knowledge, understanding and skills intended by the institution to be gained by the learners completing a particular educational activity. The ILOs emphasize what is expected that learners will be able to do as a result of a learning activity.

8. Knowledge and Understanding

Knowledge is the intended information to be gained from an educational activity including facts, terms, theories and basic concepts. Understanding involves comprehending and

grasping the meaning or the underlying explanation of scientific objects.

9. Intellectual Skills

Learning and cognitive capabilities that involve critical thinking and creativity. These include application, analysis, synthesis and evaluation of information.

10. Professional and Practical Skills

Application of specialized knowledge, training and proficiency in a subject or field to attain successful career development and personal advancement.

11. General and Transferable Skills

Skills that are not subject-specific and commonly needed in education, employment, life-long learning and self development. These skills include communication, team work, numeracy, independent learning, interpersonal relationship, and problem solving... etc.

IV. References

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