

Analytical Study of Mathematics Courses at the Higher Institute of Energy

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Abstract: The great development and progress occurring in our current age at the scientific and theoretical levels depends entirely on science, mathematics, engineering and education technology. Mathematics has greatly contributed to the scientific and technological development. Today, it has become a tool for the development of thinking and realization of relationships in an integrated framework after it was seen as a mere acquisition of ordinary computational skills or it is simply arithmetic, algebra and geometry. This view of mathematics is no longer acceptable today. Because of this property of mathematics as a science, it has been reflected in its teaching as a teaching material at the Higher Institute of Energy in Kuwait, which is affiliated to the Public Authority for Applied Education and Training. Therefore, this research paper aims at achieving the objectives for developing the training process at the Higher Institute of Energy.

This research is divided into three topics as follow:

The first topic: A questionnaire to evaluate and develop mathematics curricula at the Higher Institute of Energy.

The second topic: The importance and objectives of mathematics study at the Higher Institute of Energy.

The third topic: Characterization of mathematics curricula and the skill objectives of these curricula.

Keywords: The Questionnaire – Fractions - Exponents, roots and logarithms – Equations - Ratios and Proportions - Geometric plane shapes - Factoring Algebraic Expression and Polynomial Functions - Coordinate Geometry - The coordinate system in a plane – Statistics – Trigonometry – Vectors - Complex Numbers - Derivatives & Integration.

1. INTRODUCTION

A questionnaire to evaluate and develop mathematics courses at the Higher Institute of Energy:

Mathematics courses are studied at the Higher Institute of Energy in three courses:

1. Preliminary Mathematics for new trainees.
2. Mathematics (1) for trainees at the first training semester.
3. Mathematics (2) for trainees at the second training semester.

Hence, it is a necessity to review the contents of these courses and their relevance to the training process within the Institute. For that reason, this questionnaire has been designed after the developing the mathematics course by the Committee for Restructuring Training Programs for the Preliminary Semester. The evaluation is to be established on the courses of Mathematics (1) and Mathematics (2) and their compatibility with the other training courses.

Objectives of the Questionnaire:

1. To evaluate mathematics courses in terms of their academic contents.
2. To identify the compatibility of the contents of mathematics courses with other geometric courses.
3. To address deficits in some issues of mathematics courses.

4. To describe and analyze the contents of mathematics courses in terms of their consistency and importance.
5. To develop the contents of the mathematics courses in line with training process development.

The sample of questionnaire:

The sample of the study has been selected from a number of trainers in the other disciplines rather than the trainers of mathematics in which courses they teach are related to subjects of mathematics.

Given that the Institute has five specialized scientific departments, four trainers from each scientific department have been selected to compose the total sample of 20 trainers.

Questionnaire Design:

The questionnaire is designed on three axes:

The First Axis: a questionnaire for classes and subjects of Mathematics (1).

The Second Axis: a questionnaire for classes and subjects of Mathematics (2).

The Third Axis: Benefits of other titles and subjects not included in Mathematics courses.

All of the contents of the course including chapters and subjects are inserted to be evaluated on three levels:

(Very appropriate - appropriate with modification - inappropriate).

A question has been added for each chapter of the course content, which shows in any training course that will be taught in this chapter.

2. ANALYSIS OF RESULTS

The First Axis: a questionnaire for classes and subjects of Mathematics (1).

Chapter (1): Factoring Algebraic Expression and Polynomial Functions.

It includes the following subjects (processes of factoring algebraic expression - equal polynomial function - operations of polynomial functions - theorem and root of polynomial functions).

- Roughly 40% believe that the chapter is very appropriate.
- Roughly 60% believe that the chapter is appropriate with modification.
- Roughly 100% believe that the chapter is to be taught during the first training semester.

Chapter (2): Coordinate Geometry

It includes the following subjects (slope of a line - linear equation - relationship between lines).

- Roughly 80% believe that the chapter is inappropriate.
- Roughly 20% believe that the chapter is appropriate with modification.
- Roughly 40% believe that the chapter is to be taught during the preliminary semester.
- Roughly 60% believe that the chapter is to be canceled from the course.

Chapter (3): The coordinate system in a plane.

It includes the following subjects (coordinate plane - finding the distance between two points - drawing a geometric shape and finding area - drawing graphs of functions).

- Roughly 85% believe that the chapter is very appropriate.
- Roughly 15% believe that the chapter is appropriate with modification.
- Roughly 90% believe that the chapter is to be taught during the first training semester.
- Roughly 10% believe that the chapter is taught during the preliminary semester.

Chapter (4): Statistics.

It includes the following subjects (graphical representation - measures of central tendency).

- Roughly 70% believe that the chapter is very appropriate.
- Roughly 30% believe that the chapter is appropriate with modification.
- Roughly 80% believe that the chapter is to be taught during the first training semester.
- Roughly 20% believe that the chapter is to be taught during the second training semester.

The Second Axis: a questionnaire for classes and subjects of Mathematics (2).

Chapter (1): Trigonometry

It includes the following subjects (basic angle - trigonometric ratios - Right Angle Law - Law of sines - Law of cosines - Applications in Trigonometry).

- Roughly 100% believe that the chapter is very appropriate.
- Roughly 15% believe that the chapter is to be taught during the first training semester.
- Roughly 85% believe that the chapter is to be taught during the second training semester.

Chapter (2): Vectors

It includes the following subjects (definition of vectors - finding resultant by graphing - finding the shift graphically and algebraically - vector properties).

- Roughly 85% believe that the chapter is very appropriate.
- Roughly 15% believe that the chapter is appropriate with modification.
- Roughly 25% believe that the chapter is to be taught during the first training semester.
- Roughly 75% believe that the chapter is to be taught during the second training semester.

Chapter (3): Complex Numbers

It includes the following subjects (imaginary factor – exponential powers of the imaginary factor - properties of complex numbers - applications - polar form of a complex number).

- Roughly 85% believe that the chapter is very appropriate.
- Roughly 15% believe that the chapter is appropriate with modification.
- Roughly 10% believe that the chapter is to be taught during the first training semester.
- Roughly 90% believe that the chapter is to be taught during the second training semester.

Chapter (4): Derivatives & Integration

It includes the following subjects (Rules of Derivatives- Laws of Derivatives - Derivatives Applications - Rules of Common Integration - Integration Constant - Definite Integrals).

- Roughly 80% believe that the chapter is very appropriate.
- Roughly 20% believe that the chapter is appropriate with modification.
- Roughly 100% believe that the chapter is to be taught during the second training semester.

The Third Axis: Benefits of other titles and subjects not included in Mathematics courses.

Subject: Matrices and Polynomial Functions.

- Roughly 60% believe that there is no need to teach it while about 40% agree on teaching it.
- Those who agree on teaching it believe that it is appropriate to be taught with a new mathematics course (3).

Subject: Probability Theory.

- Roughly 80% believe that there is no need to teach it while 20% agree on teaching it.
- Those who agree on teaching it believe that it is appropriate to be taught with a new mathematics course (3).

3. RECOMMENDATIONS RELATED TO THE QUESTIONNAIRE

1. By revealing findings of the questionnaire for the first semester in Mathematics (1), it is recommended to separate Factoring Algebraic Expression from Polynomial Functions to study each subject in a chapter.
2. To cancel the second chapter of coordinate geometry in Mathematics (1), provided that the subjects should be distributed as follows:
 - Linear equation to be included in the third chapter of Equations in the preliminary mathematics course.
 - The tangent slope and the linear equation to be included within the applications in the fourth chapter of derivatives & integration in Mathematics (2).
3. To fix the third chapter of coordinate system in the plane and the fourth chapter of statistics as they are in Mathematics (1).
4. By revealing findings of the questionnaire, all chapters of Mathematics (2) are to be fixed as they are without any change or modification.
5. It is recommended to create a new mathematics course (3) for the specialization of electrical departments only, in which the subject of matrices and polynomial functions and the subject of probability theory with expansion of the subject of derivatives & integration.

The second topic: Importance and Objectives of studying mathematics at the Higher Institute of Energy.

1. The importance of studying mathematics at the Higher Institute of Energy.

Mathematics is not abstract codes only, but it is a practical subject and a good tool to describe numerous natural events and situations. The examples that indicate to the penetration of mathematics in our real life are too many and cannot be limited. For example, some equations are a picture of real events used in expressing the relationship between distance, speed, and time and it has been used in expressing the relationship among other variables.

Over and above, the practical application of concepts and geometric laws is another example of the importance of that subject. Mathematics is very important in describing future events and their consequences.

In addition to these many benefits, understanding of mathematics as a science cares for studying mathematical structures and relationships among these structures, which in turn produces a mathematical beauty and a mental pleasure that urge the learner to carry on self-learning.

2. General objectives of teaching mathematics at the Higher Institute of Energy.

The general objectives of teaching mathematics are derived from the overall objective of the training process as a whole: it is to prepare an individual for public and private life in order to benefit his society and himself.

Objective setting is the key step in building, implementing and evaluating the curriculum (1). It is possible to summarize the benefits of setting objectives as mentioned by Al-Demerdash Abdul Majeed in his book "Contemporary Curricula" as follows:

1. Objectives help clarify purpose and guide efforts.
2. Objectives help coordinate efforts.
3. Objectives help select content, method and means.
4. Objectives help evaluate the curriculum, but the entire educational process.
5. Objectives help provide motivation.

Therefore, we try to reach the desired objectives in this topic at the Higher Institute of Energy through the previous points. This can be achieved through achieving the following objectives:

1. To obtain mathematical information and be familiar with the vocabulary of mathematics, including symbols, terms, shapes, graphs, etc.
2. To acquire the proper amount of mathematical skills and understand meanings behind mathematical operations.
3. To gain the mathematical knowledge necessary to understand quantitative aspects in the environment and deal with the society.
4. To get methods of mathematical thinking using mathematical techniques in research, interpretation, decision-making related to mathematical and human aspects, and development of thinking and problem solving.
5. To efficiently employ mathematics in order to form an enlightened citizen in the area of productivity and consumption and use of the mathematical language in self-expression and communication with others.
6. To benefit from mathematics in identifying the extent of its contribution to life as science, art and culture.
7. To understand the role of mathematics in scientific progress and in other subjects.
8. To understand meanings underlying mathematical operations.
9. To invest mathematical knowledge in other fields of study.

Since the objectives of teaching mathematics are multiple, complex and overlapping, so that it is difficult to separate them conclusively. In order to simplify and study mathematics, its objectives should be classified in the matter that helps select the content of the courses, teaching strategies and methods of assessment, but it is clear that the goals must be integrated.

First: Acquiring Mathematical Information.

This includes the following:

1. The concept of real numbers field.
2. Exponents, roots and logarithms.
3. Solving equations of all types
4. The concept of Ratios and Proportions.
5. Calculation of area, perimeter and volume of geometric shapes.
6. Operations of Factoring Algebraic Expression.
7. Calculations of Algebraic Expressions.
8. Some basic concepts in coordinate geometry.
9. Some basic concepts in vector geometry.
10. The concept of statistics and some preliminary concepts in the measures of central tendency.
11. The concept of trigonometry.
12. Some basic concepts in vector geometry.
13. The concept of complex numbers field.
14. Concepts of Derivatives and Integration.

Second: Acquiring Proper Amount of Mathematics Skills.

Development of mathematical skills helps shape the mathematical sense such as (skills of evaluation, mental calculation, and judging reasonableness of results).

The acquisition of a variety of methods to conduct operations help the learner to select the appropriate one according to the nature of the situation.

It also helps in developing the ability to collect, classify, represent, read, and schedule quantitative and numerical data.

The language of mathematics is used in communication about the subject and expression of life situations.

Mathematical skills are as follow:

1. To perform operations on real numbers.
2. To conduct operations on exponents and roots.
3. To use the electronic calculator.
4. To use geometric tools in vector graphing.
5. To conduct calculations for statistics.
6. To use geometric tools in graphing.
7. To perform operations on vectors.
8. To perform operations on numbers and composites.
9. To perform operations and calculations for derivatives and integration.

Third: Objectives related to methods of thinking and problem solving (acquisition of mathematical thinking methods).

These objectives can be achieved as follow:

1. To acquire proper thinking methods and their uses in solving problems such as inductive, deductive, analytical, structural and analytical methods.
2. To apply the steps of a problem-solving mathematical method by analyzing a problem and developing a solution plan to validate the correct output, and to develop the ability to use mathematical concepts and skills in dealing with new situations.
3. To use inductive and measuring methods to solve theoretical problems and apply this in practical life.
4. To understand the mathematical model and deal with it in identifying many life problems and solve them in the easiest way.
5. To obtain methods and techniques of mathematical proof and its simple logical bases.
6. To use the scientific method of thinking.
7. To create new methods to solve mathematical problems.

Fourth: Objectives related to tendencies, attitudes and values (Development of emotional aspect).

1. To trust in findings with different thinking methods.
2. To tend towards mathematics, its evaluation and the desire to learn it.
3. To assess the role of mathematical information in serving other cognitive aspects.
4. To estimate the role of mathematics in contemporary scientific and technical development.
5. To tend towards studying mathematics and enjoy solving mathematical problems.
6. To estimate the role of mathematics in solving mathematical and life situations.
7. To taste the cohesion and beauty of mathematical structure.
8. To develop some positive values, such as accuracy, order, arrangement, objectivity, perseverance and respect for others' opinions.
9. To obtain positive values such as: (accuracy, organization, perseverance, objectivity in judging attitudes, respect for others' opinions, and good use of time).
10. To taste mathematics beauty (through the discovery of patterns and models and their consistency).
11. To Develop self-esteem for mathematics efficiency.
12. To instill love of mathematics in the learner and promote his/her direction towards its learning.
13. To develop trends towards respect for professional productive work.

The Third Topic: Description of mathematics courses and skill objectives of these courses.

1. Preliminary Mathematics

Chapters	Chapter Contents	Skill Objectives
Chapter (1): Fractions	<ul style="list-style-type: none"> • Common fractions <ol style="list-style-type: none"> 1. Change an improper fraction into a mixed number. 2. Change a mixed number to an improper fraction. 3. Equivalent fractions. • Math operations in common fractions. <ol style="list-style-type: none"> 1. Add and subtract common fractions. 2. Multiply and divide common fractions. • Decimal fractions. <ol style="list-style-type: none"> 1. Convert common fractions into decimals. 2. Convert decimals into common fractions. 3. Rounding decimals. 	<ol style="list-style-type: none"> 1. The trainee performs conversion between common fractions (improper fraction, proper fraction, mixed number). 2. The trainee uses a calculator to perform mathematical operations on fractions (addition, subtraction, multiplication, division). 3. The trainee performs conversion between common fractions and decimals and vice versa. 4. The trainee approximates decimal numbers to the required part.
Chapter (2): Exponents, roots and logarithms	<ul style="list-style-type: none"> • Exponents <ol style="list-style-type: none"> 1. Exponent rules and properties. 2. Applications on Exponents. • Roots <ol style="list-style-type: none"> 1. Square root and cube root. 2. Root rules and properties. • Logarithms <ol style="list-style-type: none"> 1. Logarithm rules. 2. Decimal logarithms (Base 10) and natural logarithms (Base "e"). 	<ol style="list-style-type: none"> 1. The trainee applies exponent rules in exercises and workouts. 2. The trainee uses a calculator in exponent analysis operations. 3. The trainee applies root rules in exercises and workouts. 4. The trainee applies logarithm rules in exercises and workouts. 5. The trainee uses a calculator in calculating decimal and natural logarithms.
Chapter (3): Equations	<ul style="list-style-type: none"> • Equations with one variable. • Equations with two algebraic variables. • Quadratic equations. • Logarithmic and exponential equations. • Linear equation. 	<ol style="list-style-type: none"> 1. The trainee uses the property of additive and multiplicative correlation to solve equations. 2. The trainee uses the property of additive inverse and multiplicative inverse to equations. 3. The trainee uses a calculator in to solve equations whose coefficients are fractions. 4. The trainee uses the substitution property to solve equations with two variables. 5. The trainee uses a calculator to solve quadratic equations. 6. The trainee analyzes number exponents to solve exponential equations. 7. The trainee uses a calculator in finding logarithms to solve logarithmic equations.
Chapter (4): Ratios and Proportions	<ul style="list-style-type: none"> • Ratios <ol style="list-style-type: none"> 1. Ratios between two numbers. 2. Finding a known ratio from a known number. • Proportions <ol style="list-style-type: none"> 1. Direct proportion. 2. Inverse proportion. 3. Applications on proportion. • Percentage. 	<ol style="list-style-type: none"> 1. The trainee uses division to find the ratio between two numbers. 2. The trainee finds a known ratio from a known number. 3. The trainee uses the cross product to find the variable value in the ratio. 4. The trainee uses the set order to find a constant of proportion. 5. The trainee uses the cross product to find the variable value in the direct proportion. 6. The trainee applies the proportional division in proportion applications. 7. The trainee uses the calculator to find the percentage.

<p>Chapter (5): Geometric plane shapes</p>	<ul style="list-style-type: none"> • Finding the area of geometric plane shapes. <ol style="list-style-type: none"> 1. Rectangle 2. Square 3. Triangle 4. Circle • Finding the volume of geometric plane shapes. <ol style="list-style-type: none"> 1. Cube. 2. Cylinder. 	<ol style="list-style-type: none"> 1. The trainee uses the area rule to find the area of some geometric plane shapes. 2. The trainee uses root rules to find the side length in some geometric plane shapes. 3. The trainee uses a calculator to find the output in the area rule. 4. The trainee uses the volume rule to find the volume of some geometric plane shapes. 5. The trainee uses a calculator to find the output in the volume rule.
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2. Mathematics (1)

Chapter	Chapter Contents	Skill Objectives
<p>Chapter (1): Factoring Algebraic Expression</p>	<ul style="list-style-type: none"> • Factoring the greatest common divisor. • Factoring the difference between two cubes and their sum. • Factoring the difference between two squares and finding the solution set. • Factoring perfect squares finding the solution set. • Factoring three terms and finding the solution set. 	<ol style="list-style-type: none"> 1. The trainee uses the properties of real numbers in factoring the greatest common divisor. 2. The trainee applies different factoring rules in solving factoring problems. 3. The trainee distinguishes factoring rules according to given data. 4. The trainee applies different factoring rules in solving equations.
<p>Chapter (2): Polynomial Functions</p>	<ul style="list-style-type: none"> • Equal polynomial function. • Manipulation of polynomial functions. <ol style="list-style-type: none"> 1. Adding and subtracting polynomial functions. 2. Multiplying and dividing polynomial functions. • Theorem and root of polynomial functions. 	<ol style="list-style-type: none"> 1. The trainee learns types of polynomial functions. 2. The trainee uses equations to find polynomial functions. 3. The trainee simplifies the output of manipulation of polynomial functions. 4. The trainee uses the substitution property in finding theorem of polynomial functions. 5. The trainee uses long division to find polynomial functions. 6. The trainee uses horizontal multiplication to find polynomial functions.
<p>Chapter (3): Cartesian Coordinate Systems</p>	<ul style="list-style-type: none"> • Coordinate plane. <ul style="list-style-type: none"> - Set a known point. - Draw a straight line. - Find a midpoint of a line segment. - Find the distance between two points and the parallel of a coordinate axis. • Find the distance between any two points at the coordinate plane • Draw the geometric shape and find area and perimeter. • Draw graphs of functions. 	<ol style="list-style-type: none"> 1. The trainee finds the main axes in the coordinate system. 2. The trainee sets a known point of in the coordinate system. 3. The trainee draws a straight line in the coordinate system. 4. The trainee uses the geometric tools in drawing straight lines and shapes in the coordinate system. 5. The trainee applies the rule of midpoint of a line segment. 6. The trainee applies the rule of distance between any two points at the coordinate plane. 7. The trainee draws a geometric shape at the coordinate plane. 8. The trainee draws the functions graphically.
<p>Chapter (4): Statistics</p>	<ul style="list-style-type: none"> • Inferential Statistics • Graphical representation. <ol style="list-style-type: none"> 1. Bar Charts. 2. Frequency Polygon. 3. Pie Diagram. • Measures of central tendency. <ul style="list-style-type: none"> - Mode - Median - Mean 	<ol style="list-style-type: none"> 1. The trainee uses geometric tools in drawing graphs in statistics. 2. The trainee distinguishes between classified and non-classified data. 3. The trainee uses the rules of central tendency to find mode, median, and mean.

3. Mathematics (2)

Chapter	Chapter Contents	Skill Objectives
Chapter (1): Trigonometry	<ul style="list-style-type: none"> • Basic angle. • Trigonometric ratios. • Right Angle Law. • The Law of sines. • The Law of cosines. • Applications in Trigonometry. 	<ol style="list-style-type: none"> 1. The trainee uses the calculator to find the basic angle. 2. The trainee applies the laws of trigonometric ratios on the right- angled triangle. 3. The trainee uses the law of Pythagorean theorem to find length dimensions. 4. The trainee uses the law of sines to find triangle angles and lengths. 5. The trainee uses law of cosines to find triangle angles and lengths. 6. The trainee applies trigonometry rules to solve life problems.
Chapter (2): Vectors	<ul style="list-style-type: none"> • Definition of Vectors • Vector graphing • Fining shift algebraically and graphically • Properties of vectors 	<ol style="list-style-type: none"> 1. The trainee uses geometric tools in vector graphing. 2. The trainee performs operations to find shift and angle of shift. 3. The trainee applies the rules of vector properties to solve exercises.
Chapter (3): Complex Numbers	<ul style="list-style-type: none"> • Imaginary Factor • Exponential Powers of Imaginary Factor • Important Properties of Complex Numbers • Applications on Complex Numbers. • Polar Form of Complex Numbers 	<ol style="list-style-type: none"> 1. The trainee uses the calculator to find the value of the imaginary factor. 2. The trainee performs operations between complex numbers. 3. The trainee applies the rules of complex number properties in problem solving. 4. The trainee applies the laws of amplitude and modulus to find the polar form of complex numbers.
Chapter (4): Derivatives & Integration	<ul style="list-style-type: none"> • First Derivatives • Rules of Derivatives • Laws of Derivatives • Second Derivatives • Derivatives Applications <ol style="list-style-type: none"> 1. Tangent Equation & Perpendicular Equation 2. Time Equations <ul style="list-style-type: none"> • Common Integration • Integration Constant • Definite Integrals 	<ol style="list-style-type: none"> 1. The trainee uses the rules of derivatives to find the first derivative. 2. The trainee applies the laws of derivatives to find the second derivative. 3. The trainee uses the rules and laws of derivatives to find the tangential and perpendicular equations. 4. The trainee uses the rules and laws of derivatives to solve time equations. 5. The trainee uses the rules of common integration to set the integration constant. 6. The trainee uses the substitution property in definite integration operations.

4. CONCLUSION

After reviewing this research, it is clear that the assessment process of courses must be continuous due to the rapid technological development, which requires continuous studies to keep pace with this development. Through this research paper, it is found that the percentage of change in mathematics courses at the Higher Institute of Energy ranges between 20-30% during the previous five years.

Additionally, identification of objectives of all types, whether informative, skillful or behavioral, is the first step in building and implementing the curriculum. Therefore, this research details these objectives for each course, as successful training depends on the extent to which the trainee learns about his/her needs and motivations.

One of the advantages of this research is to set the objectives for each mathematics course at the Higher Institute of Energy that will help the trainees understand the course on one hand and help the trainers in evaluating the performance of training and evaluating of trainees on the other hand.

After introducing the topics of this research, we can summarize the main findings and recommendations as follows:

1. To adopt educational objectives of all types in all mathematics courses at the Higher Institute of Energy.
2. The objectives must be consistent with the scientific content of all mathematics courses at the Higher Institute of Energy.
3. To make appropriate modifications to the scientific content of each of mathematics courses at the Higher Institute of Energy by competent committees.
4. All mathematics or other courses at the Higher Institute of Energy should be consistent with the basic indicators of trainees' performance (KPI), as these indicators have a great role in the assessment process of trainees, which helps trainers to identify points of strengths and weaknesses of trainees.
5. There is a need to make similar studies of this research for other courses at the Higher Institute of Energy.

At the end, we must draw attention to the findings and recommendations of this research, which are only personal efforts of the researcher, which it does not necessarily reflect the view of the management of the Higher Institute of Energy. We hope to take these observations in order to develop mathematics courses at the Higher Institute of Energy and develop new foundations based on scientific standards in the description of these courses and its objectives, which in turn shall contribute to raising the trainees' scientific and training levels.

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