Bachelor program,
Instrumentation Engineering (INEN) program, "General and Applied Mathematics" department

Course Unit Title	**Applied Mathematics**
Course Unit Code	VTSS-B03
Type of Course Unit	Compulsory
Level of Course Unit	First cycle Barchelor
National Credits	4
Number of ECTS Credits Allocated	5
Theoretical (hour/week)	1
Practice (hour/week)	1
Laboratory (hour/week)	-
Year of Study	2st year
Semester when the course unit is delivered	4
Course Coordinator	Afruz Niftaliyeva
Name of Lecturer (s)	Afruz Niftaliyeva
Name of Assistant (s)	-
Mode of Delivery	Face to Face
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

Applied mathematics involves the application of mathematics to problems which arise in various areas, e.g., science, engineering or other diverse areas, and/or the development of new or improved methods to meet the challenges of new problems.

Objectives of the Course:

The program provides courses which complete the basic mathematical competences, covering all the main areas of Mathematics (Mathematical Logic, Algebra, Geometry, Mathematical Analysis, Mathematical Physics, Statistics, Numerical Analysis, Optimizations, Foundations of Mathematics). Then, the student has a choice of courses focused in areas where the support of advanced mathematical methods is fundamental in recent scientific researches and developing technologies. These courses cover topics such as the theory of formal languages, discrete methods in Mathematics, the applications of data analysis, bioinformatics and information systems for understanding stuctures in big data systems and networks, the techniques for modeling, analyzing and simulating complex dynamic systems, discrete event systems and nonlinear control systems. The student is trained to the interaction with specialists working in the scientific and technological areas where the support of advanced mathematical tools is required. The acquired skills include the ability of retriving methodological information from the advanced mathematical literature. Students interested in Education can complete the program with courses focused in the foundational and educational aspects of Mathematics.

Learning Outcomes

At the end of the course the student will be able to		Assessment
1.	The participants have a thorough knowledge and an in-depth understanding of mathematical terms and methods.	1,3
2.	Students can apply these methods to mechatronics tasks.	1,2,3
3.	Students have an analytical mindset required to solve engineering problems.	2,3
4.	Students are able to formulate technical relationships in mathematical language, to solve problems numerically and to critically evaluate the results.	2,3

Assessment Methods: 1. Final Exam, 2. Presentation, 3. Midterm exam

Course's Contribution to Program

		CL
1	Identify, formulate, and solve complex mechatronics engineering problems properly applying the principles, methods, techniques and tools of engineering, science, and mathematics.	5
2	Ability to analyze a problem identify algorithmic principles, and computer simulation techniques in the modelling and design of computer-based systems.	3
3	Get problem-solving skills needed for making decisions in uncertain situations.	3
4	Acquire an understanding ethical and social issues responsibilities and the relationships between product development, product manufacturing and product use in environment-related fields.	3
5	Design systems, components, or processes meeting specified needs for broadly defined engineering problems and to penetrate products, processes, and methods of the disciplines of	3

	mechatronics engineering.	
6	Analyze situations and problems, define interfaces between different technologies and implement them in different applications	3
7	Combine theory and practice to analyze engineering issues basing on methodical research methods as well as understand applicable techniques and methods.	3
8	Ability to work in design, implementation, and integration of engineering applications, such as electronic, mechanical, electromechanical, control and computer systems that contain software and hardware components, including sensors, and controllers.	3
9	Apply principles of mechanical and electrical engineering to the practice of engineering, robotics, mechatronics, and related industries.	2
10	Be able to take responsibility in industrial and public projects in the field of industrial manufacturing, research, and development.	3

CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)

Course Contents

Week	Chapter	Topics	Exam
1	Textbook 1, Chapter 1	**First-order differential equations** Basic concepts about differential equations of the first order. General solution of a first order differential equation. Cauchy problem. Cauchy`s theorem. Differential equations with separated and separable variables. Homogeneous equations.	
2	Textbook 1, Chapter 2	**First-order differential equations resolved with respect to the derivative** A first order linear differential equation. Bernoulli equation. Exact first-order equations.	
3	Textbook 1, Chapter 4	**Higher order differential equations** Basic concepts about differential equations of the higher orders, boundary value problem and Cauchy problem. Cauchy`s theorem. Reduction of order.	
4	Textbook 1, Chapter 4	**Higher order linear homogeneous differential equations** Higher order linear homogeneous differential equations and linear differential operator. Construction of a general solution of linear homogeneous differential equation. Characteristic equation of linear homogeneous differential equation with constant coefficients. Construction of a general solution depending on the roots of the characteristic equation.	
5	Textbook 1, Chapter 5	**Higher order linear non-homogeneous differential equations with constant coefficients** Finding a solution of a linear non-homogeneous differential equation of higher order with constant coefficients by the method of variation of parameters and by the method of undetermined coefficients.	
6	Textbook 1, Chapter 6	**System of differential equations** Basic concepts. Cauchy`s theorem. Linear system of differential equations. Solving a linear system of differential equations with constant coefficients.	
7	Textbook 1, Chapter 7	**Mathematical physics equations** Basic concepts and definitions. Solution of equations, initial and boundary conditions. Classification of mathematical physics equations.	Midterm
8	Textbook 1, Chapter 8	**Problems of mechanics leading to equations of hyperbolic type** Equation of vibrating string. Initial and boundary conditions for equation of vibrating string. Solution of equation of free vibrations of a bounded string by the D`Alembert`s method and Fourier method.	
9	Textbook 1, Chapter 10	**Physical problems leading to equations of parabolic type. Boundary value problems for equations of elliptic type.** Heat equation and its solution by Fourier method. Boundary value problem for Laplace`s equation. Solution of the Dirichlet problem for a circle by Dirichlet method.	
10	Textbook 2, Chapter 13	**Functions of a complex variable, their derivative and integral** Functions of a complex variable, limit, continuity and derivative. The Cauchy-Riemann conditions. Integration of complex variable functions. Cauchy theorem.	

11	Textbook 2, Chapter 14	**Expansion of functions of a complex variable in power series. The residues of functions** Expansion of function of a complex variable into Taylor and Laurent series. Calculating the residues of functions. Using residues in calculation some integrals.	
12	Textbook 10, Chapter 1	**Events and their probabilities** Combinatorics. Random events, their types and operations on them. Classical, geometrical and statistical definition of probabilities and their properties. The conditional probability. Probability multiplication rules.	
13	Textbook 10, Chapter 2	**Independent events and trials** Dependent and Independent events. A complete group of events. Total probability formula. Bayes' formula. Bernoulli's formula. Poisson`s distribution.	
14	Textbook 10, Chapter 3	**Random variable and numerical characteristics of random variables** Probability distribution function of the random variable and its properties. Discrete and continuous distributions. Expectation (the mean value), variance of random variable and their properties. Standard deviation.	
15	Textbook 10, Chapter 4	**Elements of mathematical statistics** Basic problems and content of mathematical statistics. Concepts of the general and sample population. Numerical characteristics of the sample. Estimate, accuracy in parameter estimation and confidence interval.	
16			Final exam

Recommended Sources

TEXTBOOK(S)

1. Dennis G. Zill, Michael R. Cullen Differential Equations with Boundary-Value Problems, 2009
2. Erwin Kreyszig, Advanced Engineering Mathematics, 2011
3. Hiroyuki Shima. Tsuneyoshi Nakayama. Higher Mathematics for Physics and Engineering. Berlin 2010.
4. George B. Thomas', Calculus 13th edt. 2014, 536 p.
5. James R. Brannan, William E. Boyce. Differential equations. 2nd edt.
6. Complex Analysis through Examples and exercises by Endre Pap, Institute of Mathematics, University of Novi Sad. 1999.
7. A.D.Myshkis. Introductory Mathematics for Engineers.Moskow.1972.
8. Gabriel Nagy. Ordinary Differential equations. Nov.29.2017.
9. R . L . Herman A first course in differential equations for scientists and engineers. August 17.2018
10. Sheldon Ross, A First Course in Probability, 8th edition.

Additional information will be distributed either electronically or delivered in printed forms.

Assessment

Attendance	0%	Less than 75% class attendance results in NA grade
Presentation	20%	
Lab. works	0%	
Course work	0%	
Quiz	10%	
Midterm Exam	20%	Written Exam
Final Exam	50%	Written Exam
Total	100%	

Assessment Criteria

Final grades are determined according to the Academic Regulations of Azerbaijan State Oil and İndustry University for undergraduate studies

Course Policies

1. Attendance of the course is mandatory.
2. Material presented in the lecture as well as assigned readings will be included in testing.
3. Late assignments will not be accepted unless an agreement is reached with the lecturer.
4. Cheating and plagiarism will not be tolerated.
5. Cheating will be penalized according to the Azerbaijan State Oil and Industrial University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload (hour)
Course duration in class	14	4	56

Preparation for Midterm Exam	1	15	15
Individual or Group Work	9	4	36
Midterm Exam	1	3	3
Paper/Project (including preparation and presentation)	1	10	10
Homework	3	4	12
Preparation for the Final Exam	1	12	12
Final Exam	1	3	3
Total Workload			147
Total Workload/30(h)			4.9
ECTS Credit of the Course			5