Course Title	Higher mathematics (ECTS 10)
Course/Module Code	OM11210
Semester(s) Offered	Semester 1, 2
Instructor	Abilov Boburjon Baxriddin o‘g‘li, Associate Professor
Language of Instruction	Uzbek
Course Type	Compulsory
Total Academic Hours (including Independent Study)	Total hours: 300 Classroom hours - 120 Lecture Hours: - 60 Practical Hours: - 60 Self Study Hours: -180
ECTS Credits	10
Course Objectives, Tasks, and Learning Outcomes	Objectives of teaching the subject: - to develop students' mathematical thinking and to equip them with the mathematical knowledge, skills, and competencies necessary to address theoretical and practical challenges within production processes—specifically those related to the light industry—and to effectively apply this knowledge. The tasks of the course include: - teaching students concepts in algebra, geometry, complex numbers, and vector algebra, along with their application to engineering problems in the light industry; ensuring mastery of matrix algebra and methods for solving systems of linear equations; covering the theory of sequences, series, limits, and the continuity of functions; teaching differential calculus for single-variable functions, its practical methods, and optimization (extremum) problems; introducing methods of integral calculus and their application to geometric, physical, and engineering problems; and developing skills in data processing, probability theory, and the application of distribution laws to problems in transport and engineering statistics. Learning outcomes: - Students will acquire in-depth practical and theoretical knowledge as outlined in the course curriculum; they will be able to visualize the mathematical concepts and propositions they have mastered from a geometric perspective. They must thoroughly master knowledge in their field of specialization, possess a clear grasp of the mathematical concepts encountered within the subject matter, and be able to translate basic technical processes into the mathematical “language.” Furthermore, they must be capable of selecting the appropriate mathematical methods to analyze models of fundamental practical processes and drawing practical conclusions based on that analysis.
Course Content (Topics)	**I. Main Theoretical Part (Lectures)** **Topic 1:** Second and third-order determinants. Methods for calculating determinants. Basic properties of determinants. Minors and algebraic cofactors. Concept of the nnn-th order determinant.

	Topic 2: Concept of a matrix. Basic types of matrices. Operations on matrices. Inverse matrix and its construction. Rank of a matrix. Eigenvalues and eigenvectors of a matrix with real variables. Applications of matrices to practical problems. **Topic 3:** System of linear equations and methods for solving them. Kronecker-Capelli theorem. Homogeneous systems of linear algebraic equations. **Topic 4:** Vectors and linear operations on them. Projection of a vector onto an axis. Length of a vector. Direction cosines. Linear independence of vectors. Expansion of a vector in terms of basis vectors. **Topic 5:** Scalar, vector, and triple scalar products of vectors. Their properties. Angle between vectors. Conditions for collinearity and coplanarity of two vectors. Applications of linear and vector algebra theory to technical problems. **Topic 6:** Straight line in the plane. Various forms of equations of a straight line in the plane. Distance from a point to a straight line in the plane. Relative positions of straight lines. Angle between two straight lines. Applications of straight lines to practical problems. **Topic 7:** Second-order curves. Circle, ellipse, hyperbola, parabola. **Topic 8:** Vector, general, and normal equations of planes in space. Relative positions of planes. Angle between two planes. Conditions for parallelism and perpendicularity of planes. Pencil of planes. **Topic 9:** Vector, canonical, parametric, and general equations of straight lines in space. Relative positions of straight lines. Angle, conditions for parallelism and perpendicularity between two straight lines. Relative position of a straight line and a plane. **Topic 10:** Variable and constant quantities. Sets and operations on them. Numerical sequence and its limit. **Topic 11:** Concept of a function. Limit of a function. First and second remarkable limits. Continuity of a function. Points of discontinuity of a function and their types. **Topic 12:** Definition of the derivative, its geometric and mechanical meaning. Table of derivatives. Differentiability of a function. Basic rules of differentiation. **Topic 13:** Derivatives of elementary functions. Derivatives of implicitly and parametrically defined functions. Derivative of a composite function. Higher-order derivatives. **Topic 14:** Differential of a function. Higher-order differentials. Equations of the tangent line and normal to a curve. L'Hopital's rule. **Topic 15:** Monotonicity, critical and extremum points of a function. Complete investigation of a function. Application of differential calculus to practical problems.

	Topic 16: Complex numbers. Operations on complex numbers. Trigonometric and exponential forms of complex numbers. **Topic 17:** Definition and properties of the antiderivative and indefinite integral. Table of indefinite integrals. Basic methods of integration: substitution and integration by parts. **Topic 18:** Integration of simplest rational fractions. Decomposition of rational fractions into simple rational fractions. Algorithm for integrating rational functions. Integration of certain integrals containing trigonometric functions. **Topic 19:** Problems reducible to a definite integral. Definition of a definite integral and its basic properties. Newton-Leibniz formula. Substitution in a definite integral. Integration by parts. **Topic 20:** Improper integrals. Improper integrals with infinite limits. Improper integrals of unbounded functions. Convergence tests for improper integrals. Applications of definite integrals to geometry and mechanics. Application of the definite integral to solving engineering problems. **Topic 21:** Definition, domain of definition, range, limit, continuity, and partial derivatives of a function of several variables. Total differential. Partial and total differentials of a composite function of several variables. **Topic 22:** Higher-order partial derivatives. Higher-order differentials. Differentiation of an implicit function. Equations of the tangent plane and normal to a surface. Extrema of a function of several variables. Conditional extremum. Application of functions of several variables to solving engineering problems. **Topic 23:** Problems reducible to a differential equation. Basic concepts of the theory of differential equations. Theorem on the existence and uniqueness of the solution to the Cauchy problem for a first-order differential equation. Differential equations with separable and separated variables. **Topic 24:** Homogeneous differential equations. First-order linear differential equations. Bernoulli equation. Exact differential equation. Existence and uniqueness of the solution to the Cauchy problem for higher-order differential equations. Differential equations whose order can be reduced. Linear homogeneous differential equations. **Topic 25:** Second-order linear homogeneous differential equations with constant coefficients. Method of undetermined coefficients. Higher-order non-homogeneous differential equations with constant coefficients having a special right-hand side. Applications of differential equations to engineering problems. **Topic 26:** Basic concepts of numerical series. Necessary conditions for the convergence of a series. Convergent series and their properties. Harmonic series. Sufficient conditions for the convergence of positive-term series: D'Alembert's ratio test, Cauchy's radical and integral tests.

Topic 27: Alternating and sign-variable numerical series. Leibniz theorem. Absolutely and conditionally convergent series.

Topic 28: Basic concepts of probability theory. Elements of combinatorics. Algebra of events. Classical definition of probability. Geometric probability. Conditional probability. Total probability. Bayes' formula. Independence of events.

Topic 29: Concept of a random variable. Discrete random variable and its distribution law. Continuous random variable. Distribution function of a continuous random variable.

Topic 30: Numerical characteristics of random variables: mathematical expectation, variance, and standard deviation. Examples of discrete random variables. Hypergeometric, binomial, Poisson, and geometric distributions. Normally distributed random variables. System of random variables.

II. Guidelines and Recommendations for Practical Classes

1. Second and third-order determinants. Methods for calculating determinants. Basic properties of determinants. Minors and algebraic cofactors. Concept of the nnn-th order determinant.
2. Concept of a matrix. Basic types of matrices. Operations on matrices. Inverse matrix and its construction. Rank of a matrix. Eigenvalues and eigenvectors of a matrix with real variables. Applications of matrices to practical problems.
3. System of linear equations and methods for solving them. Kronecker-Capelli theorem. Homogeneous systems of linear algebraic equations.
4. Vectors and linear operations on them. Projection of a vector onto an axis. Length of a vector. Direction cosines. Linear independence of vectors. Expansion of a vector in terms of basis vectors.
5. Scalar, vector, and triple scalar products of vectors. Their properties. Angle between vectors. Conditions for collinearity and coplanarity of two vectors. Applications of linear and vector algebra theory to technical problems.
6. Straight line in the plane. Various forms of equations of a straight line in the plane. Distance from a point to a straight line in the plane. Relative positions of straight lines. Angle between two straight lines. Applications of straight lines to practical problems.
7. Second-order curves. Circle, ellipse, hyperbola, parabola.
8. Vector, general, and normal equations of planes in space. Relative positions of planes. Angle between two planes. Conditions for parallelism and perpendicularity of planes. Pencil of planes.
9. Vector, canonical, parametric, and general equations of straight lines in space. Relative positions of straight lines. Angle, conditions for parallelism and perpendicularity between two straight lines. Relative position of a straight line and a plane.
10. Variable and constant quantities. Sets and operations on them. Numerical sequence and its limit.
11. Concept of a function. Limit of a function. First and second remarkable limits. Continuity of a function. Points of discontinuity of a function and their types.

	12. Definition of the derivative, its geometric and mechanical meaning. Table of derivatives. Differentiability of a function. Basic rules of differentiation. 13. Derivatives of elementary functions. Derivatives of implicitly and parametrically defined functions. Derivative of a composite function. Higher-order derivatives. 14. Differential of a function. Higher-order differentials. Equations of the tangent line and normal to a curve. L'Hopital's rule. 15. Monotonicity, critical and extremum points of a function. Complete investigation of a function. Application of differential calculus to practical problems. 16. Complex numbers. Operations on complex numbers. Trigonometric and exponential forms of complex numbers. 17. Definition and properties of the antiderivative and indefinite integral. Table of indefinite integrals. Basic methods of integration: substitution and integration by parts. 18. Integration of simplest rational fractions. Decomposition of rational fractions into simple rational fractions. Algorithm for integrating rational functions. Integration of certain integrals containing trigonometric functions. 19. Problems reducible to a definite integral. Definition of a definite integral and its basic properties. Newton-Leibniz formula. Substitution in a definite integral. Integration by parts. 20. Improper integrals. Improper integrals with infinite limits. Improper integrals of unbounded functions. Convergence tests for improper integrals. Applications of definite integrals to geometry and mechanics. Application of the definite integral to solving engineering problems. 21. Definition, domain of definition, range, limit, continuity, and partial derivatives of a function of several variables. Total differential. Partial and total differentials of a composite function of several variables. 22. Higher-order partial derivatives. Higher-order differentials. Differentiation of an implicit function. Equations of the tangent plane and normal to a surface. Extrema of a function of several variables. Conditional extremum. Application of functions of several variables to solving engineering problems. 23. Problems reducible to a differential equation. Basic concepts of the theory of differential equations. Theorem on the existence and uniqueness of the solution to the Cauchy problem for a first-order differential equation. Differential equations with separable and separated variables. 24. Homogeneous differential equations. First-order linear differential equations. Bernoulli equation. Exact differential equation. Existence and uniqueness of the solution to the Cauchy problem for higher-order differential equations. Differential equations whose order can be reduced. Linear homogeneous differential equations. 25. Second-order linear homogeneous differential equations with constant coefficients. Method of undetermined coefficients. Higher-order non-homogeneous differential equations with constant coefficients having a special right-hand side. Applications of differential equations to engineering problems. 26. Basic concepts of numerical series. Necessary conditions for the convergence of a series. Convergent series and their properties. Harmonic series. Sufficient conditions for the convergence of

positive-term series: D'Alembert's ratio test, Cauchy's radical and integral tests.

27. Alternating and sign-variable numerical series. Leibniz theorem. Absolutely and conditionally convergent series.
28. Basic concepts of probability theory. Elements of combinatorics. Algebra of events. Classical definition of probability. Geometric probability. Conditional probability. Total probability. Bayes' formula. Independence of events.
29. Concept of a random variable. Discrete random variable and its distribution law. Continuous random variable. Distribution function of a continuous random variable.
30. Numerical characteristics of random variables: mathematical expectation, variance, and standard deviation. Examples of discrete random variables. Hypergeometric, binomial, Poisson, and geometric distributions. Normally distributed random variables. System of random variables.

III. Independent Study and Self-Directed Learning

Self-directed learning competency serves to foster students' independent self-development and enhance the efficiency of their professional activities. Students complete independent assignments on their mobile devices under the guidance of the instructor, either in traditional or electronic formats.

Recommended topics for independent study:

1. Matrices and some of their types. Operations on matrices. Determinant of a square matrix. Determinants and their properties.
2. Higher-order determinants. Inverse matrix. Rank of a matrix. System of linear equations and methods for solving them.
3. Coordinate systems in the plane and in space. Vectors. Linear operations on vectors. Scalar, vector, and triple products of vectors and their applications.
4. Definition and classification of a function. Numerical sequences. Limit of a sequence and some of its properties. Limit of a bounded monotonic sequence. The number eee. Limit of a function. One-sided limits. Limit of a function at infinity.
5. Infinitesimal and infinite functions. Basic theorems on limits. Remarkable limits. Continuity and discontinuity of a function. Points of discontinuity of a function and their types. Properties of a function continuous on a closed interval.
6. Derivative of a function at a point. Geometric and mechanical meaning of the derivative. Equations of the tangent line and normal. Differentiability of a function. Geometric and mechanical meanings of the differential of a function. Derivatives of a sum, difference, product, and quotient.
7. Derivatives of composite and inverse functions. Derivatives of basic elementary functions. Differentiation of implicitly and parametrically defined functions. Higher-order derivatives and differentials. Applications of the differential of a function to approximate calculations.

	8. Basic theorems of differential calculus: Fermat's, Rolle's, Cauchy's, and Lagrange's theorems. L'Hopital's rule for resolving indeterminate forms. 9. Monotonicity of a function, extremum of a function, necessary and sufficient conditions for an extremum, finding the greatest and least values of a function continuous on a closed interval. 10. Convexity, concavity, and inflection points of a function's graph. Asymptotes of a function's graph. General scheme for investigating a function and sketching its graph. 11. Antiderivative and indefinite integral. Properties of the indefinite integral. Methods of integration for the indefinite integral. Table of integrals. 12. Integration of rational functions. Integration of trigonometric functions. Integration of irrational expressions. Euler's formula. 13. Definite integral. Geometric and physical applications of the definite integral. 14. Differential calculus of functions of several variables. Extrema of functions of several variables. 15. Functions of several variables. Total differential. Higher-order total differentials. Conditional extrema of functions of several variables. 16. Ordinary differential equations. Higher-order differential equations. Non-homogeneous second and higher-order linear differential equations. 17. Numerical series. Necessary and sufficient conditions for the convergence of a series. 18. Elements of probability theory. Addition and multiplication theorems of probabilities. Random variable and its properties. 19. Discrete random variables. Bernoulli distribution. Poisson distribution. Continuous random variables. Probability density function. 20. Numerical characteristics of random variables. Mathematical expectation, variance, and standard deviation.
Student Assessment	The assessment of student knowledge is based on their mastery of course materials, as demonstrated through tests, assignments, and written or oral work conducted during the semester and final examinations. In the course on Analytical, Physico-colloid, and Bioorganic Chemistry, students are evaluated using a 100-point grading system. Of these 100 points, 50 are allocated to ongoing and intermediate assessments (comprising 60% for current assessments and independent study, and 40% for intermediate assessments), while the remaining 50 points are assigned to the final examination. Students who score a combined total of less than 30 points from the ongoing and intermediate assessments are not permitted to take the final examination. A student who achieves 30 or more points in the final examination is considered to have successfully mastered the subject.
Examination Requirements	The student must have fully mastered the theoretical and practical concepts related to the subject and be able to accurately present the results of their analysis. The student is required to have completed all assignments given as part of independent study, as well as those for ongoing and interim assessments. Furthermore, the student must have earned the necessary points from ongoing assessments, interim assessments, independent study tasks, and final evaluations within the designated timeframe. A student who has failed to submit assignments for ongoing assessments, interim assessments, or independent study—or who has

	accumulated fewer than 30 points across these components—will not be permitted to take the final examination. Additionally, any student who misses 25% or more of the scheduled in-class hours for a subject without a valid excuse will be removed from the course, barred from the final examination, and considered to have failed to earn the credits associated with that subject. A student who fails the final examination, or who scores between 0 and 29.9 points on such an examination, is considered to have an "academic debt" (i.e., an outstanding academic requirement).
Recommended Literature	**Main Literature** 1. Khurramov Sh.R. Oliy matematika. Textbook — Tashkent: “Tafakkur”, Volume 1, Volume 2, 2018. 2. Claudio Canuto, Anita Tabacco. Mathematical Analysis I, II. Springer-Verlag Italia, Milan, 2008, 2010. 3. D.T. Pismenny. Konspekt lekciy po vysshey matematike. Polnyy kurs. Moscow: Iris Press, 2009. 4. A.S. Rasulov, G.M. Raimova, X.K. Sarimsakova. “Ehtimollar nazariyasi va matematik statistika”, Textbook — Tashkent: “O‘zbekiston faylasuflari milliy jamiyati nashriyoti”, 2006. 5. V.P. Minorsky. Sbornik zadach po vysshey matematike. FIZMATLIT, 2010. 6. Khurramov Sh.R. Oliy matematika. Misol va masalalar. Nazorat topshiriqlari. Parts 1, 2, 3. Tashkent: “Fan va texnologiyalar”, 2015. **Additional Literature** 7. Soatov Yo.U. Oliy matematika. Volumes 1, 2, 3. Textbook — Tashkent: “O‘qituvchi”, 1996. 8. S. Otaqulov. Chiziqli algebra asoslari va uning tadbiqlari. Study Guide. Tashkent, 2021. 9. Usanov M.M., Ne’matov A.R., Rahimov B.Sh. Analitik geometriya. Study Guide. Tashkent, 2023. 10. Xusanov D., Shamsiddinov N.A., Berdiyorov A.Sh. Aniq va aniqmas integrallar. Study Guide. Tashkent: “Turon iqbol”, 2021. 11. J. Stewart. Calculus. Brooks/Cole, Cengage Learning, 2012. 12. S.S. Sharipov, K.S. Akhadova, Sh.S. Kuziev. Vysshaya matematika. Tashkent: “Lisson Press”, 2021. 13. S. Otaqulov, A. Musayev. “Iqtisodiyotdagi matematik usullar”. Study Guide. Tashkent: “Innovatsion rivojlanish nashriyot-matbaa uyi”, 2020. **Internet (Information) Resources** • www.gov.uz • www.ziyonet.uz • www.bilim.uz • www.catback.ru