

## Department materials description

Course Number	Course	Credit hours	Prerequisite
0301151	Logic&Set Theory	3	--

Logic and proofs: Propositions and Logical Connectives, statements containing quantifiers, Mathematical proofs, Principle of Mathematical Induction. Set Theory: definitions and algebraic operations on sets, Cross Product, Relations, Equivalence relations and partitions, Functions, Equipotent sets, Finite and Infinite Sets, Countable and uncountable Sets.

Course Number	Course	Credit hours	Prerequisite
0301201	Calculus 3	3	0300102

Vectors and analytic Geometry in the plane and in the 3D-space, Dot product and cross product, lines and planes in the 3D-space, Quadratic surfaces, Polar coordinates in the plane, cylindrical and spherical coordinates in the 3D-space, Functions of several variables, Level curves and level surfaces, limits and continuity, Partial differentiation, Chain Rule, Implicit differentiation, directional derivatives Tangent planes and normal lines, Extreme values and Lagrange multipliers, Multiple Integrals: double integral, Areas and volumes, double integrals using polar coordinates, Triple integrals.

Course Number	Course	Credit hours	Prerequisite
0301203	Ordinary Differential Equations 1	3	0300102

Solutions of Ordinary Differential equations: (first order, second order, and higher order) with applications to Mechanics and Physics, Laplace transforms and their applications to solve Ordinary differential equations, Series solution of simple ordinary differential equations of second order.

Course Number	Course	Credit hours	Prerequisite
0301204	Mathematical Methods	3	0301203

Introduction to Series solutions for ODE'S near regular and singular points, Legendre and associated legendre function, Boundary value problems in ordinary differential equations, Sturm – Liouville problem, Eigenvalues and Eigenfunctions, Expansion of a function as a series of Eigenfunctions (Fourier series as a special case), Laplace transform, Fourier transform.

Course Number	Course	Credit hours	Prerequisite
0301232	Statistical Methods	3	0300103

Simple and Multiple linear Regression, Correlation, Chi - Square Tests (Test of Independence, Homogeneity, goodness of fit), Analysis of Variance (one-Way, two- ways with and without Interaction), some designs, nonparametric inference (the Wilcoxon tests; rank - sum test, sign test, signed rank test), Spearman's rank Correlation coefficient, run test, Kruskal - Wallis test .

Course Number	Course	Credit hours	Prerequisite
0301241	Linear Algebra 1	3	-

System of linear Equations, Homogeneous and non homogeneous systems, Gauss elimination method and Gauss-Jordan method for solving systems of linear equations, Matrices: operations on matrices, using elementary matrices to find the inverse of a matrix, Determinants: definition and their properties, finding the determinants using cofactors, using adjoint of a matrix to write the inverse of a matrix, Cramer's Rule. Vector spaces, subspaces, linear independence and span, basis, dimension, Rank and nullity of a matrix, Gram-Schmidt method, Changing basis, Linear Transformation, kernel and range, Eigenvalues and eigenvectors, diagonalization.

Course Number	Course	Credit hours	Prerequisite
0301261	Euclidean Geometry	3	0301203

Axiomatic system and Euclidean axioms, Hilbert axioms of connectedness, betweenness and Congruence, distance, angles and the parallel axiom. Equivalences to the Euclidean fifth postulate, similarity of triangles, Pythagorean theorem and its inverse, parallelograms and circles

Course Number	Course	Credit hours	Prerequisite
0301301	Special Functions	3	0301203

Gamma and Beta functions, Power series solution of differential equations, Bessel functions, Legendre polynomials, Hermite polynomials, Laguerre polynomials, Chebyshev's functions

Course Number	Course	Credit hours	Prerequisite
0301302	Partial differential equation 1	3	0301203

Second order partial differential equations, Separation of variables, Fourier series and Fourier integral, Wave equations and diffusion equations. De Alembert Method.

Course Number	Course	Credit hours	Prerequisite
0301304	Advanced Calculus	3	0301201

Algebra of vectors, vector-valued functions, differentiation and integration, arc length and Curvature. Motion in polar coordinates, Scalar and vector field. Divergence, curl and Laplacian operators. Line, surface and volume integrals, Green's theorem, Divergent theorem, Stoke's theorem.

Course Number	Course	Credit hours	Prerequisite
0301305	Fractional Calculus	3	0301203

Special functions, Gamma function, Beta function, Riemann- Liouville fractional integral and derivative, Caputo fractional derivative, Conformable fractional integral and derivative, Laplace Transforms of Fractional Derivative, methods of solving fractional ordinary and partial differential equations, conformable laplace operator

Course Number	Course	Credit hours	Prerequisite
0301306	Mathematical Programming	3	0301241

Mathematical theory of linear programming, Simplex Methods, duality, Sensitivity Analysis, Nets

Course Number	Course	Credit hours	Prerequisite
0301311	Real analysis 1	3	0301151

Properties of real numbers, upper and lower bounds of a set, the completeness property of real numbers, density theorem, Nested sets, Open and closed Sets Dense Set, Sequence and subsequences, Bolzano - Weierstrass theorem, Cauchy sequences, limit and Continuity of real functions, Uniform Continuous, differentiability, Rolle's theorem, Mean value theorem, L' Hopital rule, Taylor theorem .

Course Number	Course	Credit hours	Prerequisite
0301334	Theory of Probability	3	0301201&0300103

Random Variable, Probability distribution of discrete and continuous random variable, Mathematical expectation the probability generating function, the moment generating function, some discrete distributions and their properties: mean variance, probability and moment generating functions (Uniform, Bernoulli, Binomial, Poisson), Continuous distribution (Uniform, Exponential. Gamma, Beta), joint probability distribution, conditional and Marginal distribution, Covariance and correlation functions of random variables, transformation and moment generating function techniques.

Course Number	Course	Credit hours	Prerequisite
0301336	Mathematical Statistics	3	0301334

Sampling distribution, the law of large numbers, the central limit theorem, Independency of the sample mean and variance sample the sampling distribution of mean, t-,  $\chi^2$  and F- distributions, order statistics point estimation, estimator properties, Rao-Blackwell theorem, Exponential family, the minimum variance unbiased estimator Cramer - Rao inequality, estimation methods (method of moments, maximum likelihood), interval estimation (Pivotal of moments, quality method, approximated methods, testing of hypotheses)

Course Number	Course	Credit hours	Prerequisite
0301341	Modern Algebra 1	3	0301151

Groups and subgroups, cyclic Groups, Abelian Groups, Cosets, Lagrange's theorem, normal subgroups and quotient Groups, First isomorphism theorem, Rings and sub rings, Integral domains, Ideals, Fields, Quotient rings.

Course Number	Course	Credit hours	Prerequisite
0301342	Theory of Numbers	3	0301151

Basic concepts: divisibility, Division Algorithm, Greatest common divisor and least common multiple; Diophantine equations, Prime numbers, the fundamental theorem of arithmetic, Introduction to theory of linear congruence, Chinese remainder theorem, decimal expansion of decimal numbers, Fermat little theorem, Wilson's theorem, Euler theorem, primitive roots, arithmetic functions .

Course Number	Course	Credit hours	Prerequisite
0301361	General Topology 1	3	0301151

Topological spaces, open and closed sets, boundary, interior and accumulation points, subspace topology, basis and sub-basis, finite product of topological spaces, continuous functions, open and closed functions, homeomorphisms, Separation and countability axioms, compact spaces, metric spaces.

Course Number	Course	Credit hours	Prerequisite
0301363	Graphs theory	3	0301341&0301361

Basic concepts of graph theory, isomorphism's of graphs, complement and self complement graphs, line graphs. (krausz theorem, van roji and wilf theorem, beineke theorem), graph decomposition, graph labeling (magic graphs, graceful trees, rosés theorem), Eulerian graphs, Hamiltonnian graphs, dirac therem, ore theorem, bondy-chevatal theorem, chevatal theorem), planar graphs (drawing in the plan, dual graphs, Eelers formula, kuratowskis theorem, grinbergs theorem), thickness and crossing number, chromatic numbers polynomials.

Course Number	Course	Credit hours	Prerequisite
0301371	mathematical modeling	3	0301203

Types of mathematical modeling, probabilistic model , computational model, applications of mathematical models, using the differential equations in the mathematical modeling, introduction of using the partial differential equations, introduction of using approximate theory and the transformation theories

Course Number	Course	Credit hours	Prerequisite
0301372	Numerical analysis 1	3	03001241

Some review of Calculus, Numerical analysis for solving nonlinear equations, interpolation of functions, numerical integration, numerical methods in linear algebra, O.D.E., P.D.E.

Course Number	Course	Credit hours	Prerequisite
0301474	Mathematical Softwares	3	0301304

Mathematica package is used in a computer Lab to illustrate selected mathematical concepts, explore some mathematical facts, build algorithms for problem solving cases, do numerical and analytical computations, do simulation studies and plot graphs. The selected topics can cover a wide range of mathematical topics such as geometry, calculus, linear algebra, linear programming, differential equations, probability, statistics, number theory, Fourier and Laplace transforms. The course starts with training on using the package and ends with writing Mathematica programs to solve some specific Mathematical problems.

Course Number	Course	Credit hours	Prerequisite
0401380	History of mathematics	3	–

Historical development of mathematics of various epochs of civilizations: Egyptian, Babylonian, Greek, Indian, and Islamic. Developments of the concepts in various mathematical fields: arithmetic, algebra, number theory, geometry, etc. and in modern mathematics like Calculus and analytic geometry. Islamic mathematics: athletes Arabs and Muslims, European mathematics until the sixteenth century.

Course Number	Course	Credit hours	Prerequisite
0301401	Integral Transforms	3	0301203

The Laplace and Fourier transforms and their applications to initial and boundary value problems and to integro-differential equations; Hankel-Hilbert and Mellin Transforms.

Course Number	Course	Credit hours	Prerequisite
0301402	Partial differential Equations 2	3	0301302

Introduction to first order P.D.E with two variables, semi linear equations, non-linear equations of first order, second order P.D.E. Existence and uniqueness theorems of boundary value problems.

Course Number	Course	Credit hours	Prerequisite
0301403	Ordinary differential Equations 2	3	0301203

Ordinary differential System, Method of solutions, Existence and Uniqueness theorems, Boundary value problems.

Course Number	Course	Credit hours	Prerequisite
0301405	Integral equations	3	0301302

Introduction, classification of I. E., Volterra I. E., Fredholm I. E., converting I. E. to BVP & IVP, methods of solutions of Volterra I. E., methods of solutions of Fredholm I. E., Integro-diff. Equations.

Course Number	Course	Credit hours	Prerequisite
0301411	Real Analysis 2	3	0301311

Riemann integral and its properties, the Fundamental Theorem of Calculus, Riemann - Stieltjes Integrals, Integration by parts for R-S Integrals, Functions of bounded variation, total variation functions, Jordan – decomposition theorem. Euclidean spaces, differential Calculus in  $\mathbb{R}^n$ : vector functions of several variables, continuity and partial derivatives, the Jacobian Matrix, Differentiability and Total derivative, Inverse function Theorem.

Course Number	Course	Credit hours	Prerequisite
0301412	Mathematical Analysis	3	0301311

Infinite numerical sequences and Series, tests of convergence, sequence of functions, convergence types: pointwise and uniform, differentiation and integration of sequences and series of functions, power series, Fourier series, improper integrals.

Course Number	Course	Credit hours	Prerequisite
0301413	Complex Analysis	3	0301311

Complex numbers, analytic functions, elementary functions, contour integration, Laurent series, residues and poles.

Course Number	Course	Credit hours	Prerequisite
0301414	Introduction to Functional Analysis	3	0301361 & 0301311

Metric spaces, Normed spaces, Banach spaces, Finite Dimensional Normed spaces and their properties, linear operators and linear functionals, Bounded & continuous linear operators, Dual spaces, Inner product spaces, Orthogonal complements and Direct sum, orthonormal sets, the projection theorem, the Riesz Representation theorem, self adjoint operators.

Course Number	Course	Credit hours	Prerequisite
0301436	Regression Analysis	3	0301336 & 0301241

least squares method , linear regression, fitting of regression models ,using the matrices in linear regression, multiple regression , selecting the best regression model.

Course Number	Course	Credit hours	Prerequisite
0301441	Linear Algebra 2	3	0301241

Review of matrices, Vector space, Basis and dimension, Linear transformation, change of basis, Diagonalization, eigenvalues and eigenvectors, Jordan canonical forms, minimal polynomials and Cayley - Hamilton theorem .

Course Number	Course	Credit hours	Prerequisite
0301442	Theory of Matrices	3	0301241

Review of elementary Linear algebra, spectral decomposition, Jordan canonical forms, quadratic forms, definiteness, norms, condition numbers, Linear square problem, generalized universe, orthogonal factorization.

Course Number	Course	Credit hours	Prerequisite
0301443	Modern Algebra 2	3	0301341

Rings and Homomorphisms, Polynomial rings, Factorization in Polynomial Rings, Integral domains and division rings, Field Extensions, introduction to Galois Theory.

Course Number	Course	Credit hours	Prerequisite
0301451	Foundations of Mathematics	3	0301311

Some review on properties of relations, equivalence relations and equivalence classes. Partial order relations, totally ordered and well ordered sets, Isomorphisms between two well ordered sets. Axiom of choice, Hausdroff Maximal principle, Zorn's lemma and well ordering theorem. Cardinal and ordinal numbers.

Course Number	Course	Credit hours	Prerequisite
0301461	General Topology 2	3	0301361

System of Neighborhoods, Separation axioms, connectedness and path connectedness, compactness, one-point compactification, Topologies induced by a metric (Metric spaces). Introduction to homotopy theory.

Course Number	Course	Credit hours	Prerequisite
0301465	Non-Euclidean Geometry	3	0301311

Using axiomatic system in modern mathematics by using affine projective, hyperbolic and elliptic geometry, parallel axiom, congruence triangles, Scary quadrilaterals, symmetric points and geometric solution.

Course Number	Course	Credit hours	Prerequisite
0301471	Methods in Applied Mathematics	3	0301203

Methods of (variation, asymptote, complex analysis, tensor analysis) and their applications.

Course Number	Course	Credit hours	Prerequisite
0301473	Numerical Methods 2	3	0301302 & 0301372

Review on numerical analysis, numerical methods in linear algebra, O.D.E.P.D.E.

Course Number	Course	Credit hours	Prerequisite
0301487	Advanced topics in mathematics 1	3	Department Approval

Course Number	Course	Credit hours	Prerequisite
0301488	Advanced topics in mathematic 2	3	Department Approval