



## Course Description

- 0301099      General Mathematics for Business      (3 Credit Hours)**  
**Administration and Social Sciences-Literary Stream**  
**Prerequisite:(None)**
- Algebraic expressions; factorization; exponents; logarithms; Cartesian coordinates; straight lines; parabolas; equations: linear, linear and quadratic, exponential, logarithmic; inequalities; functions; sequences; Binomial theorem.
- 0301101      Calculus-I      (3 Credit Hours)**  
**Prerequisite:      (None)**
- Functions: domain, operations on functions, graphs of functions; trigonometric functions; limits: meaning of a limit, computational techniques, limits at infinity, infinite limits ;continuity; limits and continuity of trigonometric functions; the derivative: techniques of differentiation, derivatives of trigonometric functions; the chain rule; implicit differentiation; differentials; Roll's Theorem; the mean value theorem; the extended mean value theorem; L'Hopital's rule; increasing and decreasing functions; concavity; maximum and minimum values of a function; graphs of functions including rational functions (asymptotes) and functions with vertical tangents (cusps); antiderivatives; the indefinite integral; the definite integral; the fundamental theorem of calculus ; the area under a curve; the area between two curves; transcendental functions: inverse functions, logarithmic and exponential functions; derivatives and integrals; limits (the indeterminate forms); hyperbolic functions and their inverses; inverse trigonometric functions; some techniques of integration.
- 0301102      Calculus-II      (3 Credit Hours)**  
**Prerequisite: ( 0301101)**
- Techniques of integration: integration by substitution; integration by parts, integrating powers of trigonometric functions, trigonometric substitutions, integrating rational functions, partial fractions, rationalization, miscellaneous substitution; improper integrals; application of definite integral: volumes, length of a plane curve, area of a surface of revolution polar coordinates and parametric equations: polar coordinates, graphs in polar coordinates , conics in polar coordinates, area in Polar coordinates; parametric equations; tangent lines and arc length in parametric curves and polar coordinates; infinite series: sequences, infinite series, convergence tests, absolute convergence, conditional convergence; alternating series; power series: Taylor and Maclurine series, differentiation and integration of power series: topics in analytic geometry : the parabola, the ellipse, the hyperbola; second degree equations: rotation of axes.



**0301103 Mathematics for Business Administration and Social Sciences (3 Credit Hours)**  
**Prerequisite: (None)**

Equations: linear, quadratic, cubic; functions: linear, polynomials, rational, exponential, logarithmic, multivariable functions; differentiation: derivative, rules of derivation, partial derivative, extrema of one variable functions, and two variable functions; integration: definite, rules of integration, by substitution, by parts, by partial fractions, improper integral, applications; matrices: algebra of matrices, elementary operations, Echelon form and solution of system of linear equations, determinants and Cramer's rule and solutions of system of linear equations, applications to economics.

**0301131 Principles of Statistics (3 Credit Hours)**  
**Prerequisite: (None)**

Describing statistical data by tables, graphs and numerical measures, Chebychev's inequality and the empirical rule, counting methods, combinations, permutations, elements of probability and random variables, the binomial, the Poisson, and the normal distributions, sampling distributions, elements of testing hypotheses, statistical inference about one and two populations parameters.

**0301201 Calculus-III (3 Credit Hours)**  
**Prerequisite: (0301102)**

Three dimensional space and vectors rectangular coordinates in 3-space; spheres, cylindrical surfaces; quadric surfaces; vectors: dot product, projections, cross product, parametric equations of lines. planes in 3-spaces; vector-valued functions: calculus of vector valued functions, change of parameters, arc length, unit tangent and normal vectors, curvature, functions of two or more variable: domain, limits, and continuity; partial derivatives; differentiability; total differentials; the chain rule; the gradient; directional derivatives; tangent planes; normal lines; maxima and minima of functions of two variables; Lagrange multipliers; multiple integrals: double integral, double integrals in polar coordinates; triple integrals; triple integrals in cylindrical and spherical coordinates; change of variables in multiple integrals; Jacobian.



- 0301202 Engineering Mathematics-I (3 Credit Hours)**  
**Prerequisite: (0301201)**  
Ordinary differential equations, linear differential equations of second and higher order, systems of differential equations, phase plane, stability, series solutions of differential equations, orthogonal functions, Laplace transforms, linear systems of equations, matrices and determinants.
- 0301211 Principles of Mathematics (3 Credit Hours)**  
**Prerequisite: (None)**  
Logic and proofs; quantifiers; rules of inference mathematical proofs, sets: set operations, extended set operations and indexed families of sets; relations; Cartesian products and relations; equivalence relations; partitions; functions; onto functions, one-to-one functions; induced set functions; cardinality; equipotence of sets; finite and infinite sets; countable sets, topology of  $\mathbb{R}$ .
- 0101212 Real Analysis (3 Credit Hours)**  
**Prerequisite: (0301211)**  
Real numbers: order, absolute value, bounded subsets, completeness property, Archimedean property; supremum and infimum; sequences: limit, Cauchy sequence, recurrence sequence, increasing, decreasing sequence,  $\limsup$ ,  $\liminf$  of a sequence; functions: limit, right, left limit, continuity at a point, continuity on an interval; uniform continuity (on an interval) relations between continuity and uniform continuity, differentiability: definition, right, left derivative, relation between differentiability and continuity, Rolle's theorem, mean value theorem, applications on mean value theorem.
- 0301221 Ordinary Differential Equations-I (3 Credit Hours)**  
**Prerequisite: (030102)**  
Solutions of differential equations (first order, second order, and higher orders) with applications to mechanics and physics, series solutions, Laplace transform method.



**0301241      Linear Algebra-I      (3 Credit Hours)**  
**Prerequisite: (None)**

Systems of linear equations; matrices and matrix operations; homogeneous and nonhomogeneous systems; Gaussian elimination; elementary matrices and a method for finding  $A^{-1}$ ; determinants; Euclidean vector spaces; linear transformations from  $R^n$  to  $R^m$  and their properties; general vector spaces; subspaces; basis; dimension; row space; column space; null space of a matrix; rank and nullity; inner product spaces; eigenvalues and diagonalization; linear transformations.

**0301261      Modern Euclidean Geometry      (3 Credit Hours)**  
**Prerequisite: (None)**

Axiomatic systems: consistency, independence and completeness, finite projective geometry, a brief critique of Euclid, the postulates of connection, the measurement of distance, ruler postulate, order relations, plane-separation postulate, space-separation theorem, angles and angle measurement, protractor postulate, further properties of angles, triangles and polygons, congruence postulate, parallel postulate, similarity, Pythagorean theorem, theorems of Ceva and Menelous, Morley's theorem, Erdős-Mordell theorem, circles, central and inscribed angles, cyclic quadrilaterals, Simson line, nine point circle, lines and planes in space.

**0301271      Financial Mathematics      (3 Credit Hours)**  
**Prerequisite: (0301102)**

Mathematical & Statistical techniques in compound interest, discounted cash flow, valuation of cash flows of insurance contracts, analysis and valuation of annuities, bonds, loans and other securities. Yield curves and immunization. Stochastic interest rate models. Actuarial applications.

**0301301      Advanced Calculus      (3 Credit Hours)**  
**Prerequisite: (0301201)**

Vector differential calculus: gradient, divergence, curl, curvilinear coordinates; vector integral calculus: line integral, surface integral volume integral, Green's theorem, Stoke's theorem, divergence theorem; implicit and inverse function theorems; Leibnitz theorem; calculus of variations (functionals of one variable).



**0301302      Engineering Mathematics-II      (3 Credit Hours)**  
**Prerequisite (0301202)**

Vector differential calculus, line and surface integrals, integral theorems, Fourier series, Fourier integrals, Fourier transforms, partial differential equations.

**0301304      Engineering Mathematics-III      (3 Credit Hours)**  
**Prerequisite (0301302)**

Complex numbers, complex analytical functions, complex integration, power series, Taylor series, Laurent series, residue integration method, conformal mapping, complex analysis applied to potential theory.

**0301311      Mathematical Analysis-I      (3 Credit Hours)**

**Prerequisite: (0301212)**

Function of bounded variation; total variation; the Riemann-Stieltjes integral; Riemann-Stieltjes sums and integral; integration by parts, integrability of continuous functions; metric spaces and Euclidean spaces; metric space topology; connectedness; completeness of  $R^n$ ; continuity in  $R^n$ ; differentiability in  $R^n$ ; partial derivatives and directional derivatives; differentials; chain rule; mixed partial derivatives; the implicit function theorem; total derivative, (Jacobian matrix); mean value theorem ; Taylor's theorem.

**0301321      Partial Differential Equations-I      (3 Credit Hours)**  
**Prerequisite: ( 0301221)**

Classification; some physical models (heat, wave, Laplace equations); separation of variables; Sturm-liouville BVP; Fourier series and Fourier transform; BVP involving rectangular and circular regions; special functions (Bessel and Legendre); BVP involving cylindrical and spherical regions.

**0301331      Biostatistics      (3 Credit Hours)**  
**Prerequisite: (None)**

Types of data; vital statistics; plots; measures of location and variation; correlation and association; probability; binomial; Poisson and multinomial distributions; probit analysis; chi-square test of independence; sign and rank tests; normal and t distributions; tests about means and proportions; ANOVA.



- 0301332 Statistical Techniques (3 Credit Hours)**  
**Prerequisite: (0301131)**
- Simple and multiple regression, correlation coefficient, the analysis of variance of one and two-factor experiments, the Latin squares, Chi square test for homogeneity, independent, and goodness of fit, non-parametric statistics that includes the sign test, Wilcoxon rank sum test, W. Icoxon signed rank test, and the Mann-Whiteny test, Spearman correlation coefficient.
- 0301333 Probability Theory (3 Credit Hours)**  
**Prerequisite: (0301201)**
- Distributions of random variables; conditional probability and stochastic independence; some special distributions (discrete and continuous distributions); univariate, bivariate and multivariate distributions; distributions of functions of random variables (distribution function method, moment generating function method, and the Jacobian transformation method); limiting distributions.
- 0301334 Stochastic Processes (3 Credit Hours)**  
**Prerequisite: (0301333)**
- Markov chains, transition probability, classification of states, branching and queueing chains, stationary distributions of Markov chain, Markov pure jump processes; second order processes, mean and covariance functions, Gaussian Process and Wiener process.
- 0301335 Reliability Theory (3 Credit Hours)**  
**Prerequisite (0301333)**
- Basic terminology: reliability function, failure rate function, mean life time, hazard rate. Old like new, old better than new, new better than old. Reliability systems: parallel, series, k-out-of-m. Life time distributions: Weibull distribution. Repairable systems, maintainability, availability.
- 0301336 Risk Theory (3 Credit Hours)**  
**Prerequisite (0301333)**
- Collective risk models, moment and mgf of aggregate claims, recursion formulae, effect of reinsurance, individual risk model, De Pril's recursion formula and Komya's method, premium principles: risk adjusted principle, applications of utility theory, reinsurance problems, ruin theory. Applications of contingency theory in life and health insurance. Loss distributions.



**0301338 Applied Probability (3 Credit Hours)**  
**Prerequisite: (0301333)**

Revision of probability distributions, queueing theory, reliability theory, quality control and acceptance sampling, information theory and coding.

**0301341 Modern Algebra-I (3 Credit Hours)**  
**Prerequisite: (0301211)**

Groups and subgroups; cyclic groups; permutation groups; isomorphisms of groups; direct product of groups; cosets, and Lagranges theorem; normal subgroups and factor groups; homomorphisms of groups; the first isomorphism theorems; rings; subrings; integral domains; factor rings; and ideals.

**0301342 Number Theory (3 Credit Hours)**  
**Prerequisite: (0301211)**

Division algorithm; divisibility; greatest common divisor and least common multiple; Diophantine equations; prime numbers and their distribution; fundamental theorem of arithmetic; congruence; linear congruence equations; Chinese remainder theorem; tests of divisibility. Fermat little theorem; Wilson's theorem; arithmetic functions; cryptography as an application of number theory.

**0301361 General Topology-I (3 Credit Hours)**  
**Prerequisite: (0301212)**

Topological spaces; open sets; boundary; interior; accumulation points; topologies induced by functions; subspace topology; bases and subbases; finite products; continuous functions; open and closed functions homeomorphisms; separation axioms; countability axioms; metric spaces, connectedness and compactness.

**0301371 Mathematical Programming (3 Credit Hours)**  
**Prerequisite: (0301241)**

Formulation of linear problems; the simplex method; the geometry of the simplex method; duality in linear programming; the dual simplex method; sensitivity analysis; introduction to graphs; network flows.



**0301381 Teaching Mathematics (3 Credit Hours)**  
**Prerequisite: (0301301)**

Nature of mathematics; mathematics curriculum; learning mathematics; teaching strategies; teaching mathematical concepts; principles and generalizations; algorithms and skills; teaching problem solving; proofs; planning for effective teaching evaluation.

**0301411 Mathematical Analysis-II (3 Credit Hours)**  
**Prerequisite: (0301311)**

Infinite series and infinite product; sequences of functions; pointwise and uniform convergence; interchange of limits theorem; series of functions; theorem of uniform convergence; power series; Fourier series; differentiation and integration of sequence of functions; multiple integrals; improper integrals.

**0301412 Complex Analysis (3 Credit Hours)**  
**Prerequisite: (0301212)**

Complex numbers: geometric interpretation, polar form, exponential form: powers and roots; regions in the complex plane; analytic functions; functions of complex variables: exponential and logarithmic functions ; trigonometric and hyperbolic functions; definite integrals; Cauchy theorem; Cauchy integral formula; Series; convergence of sequence and series, Taylor series; Laurent series; uniform convergence; integration and differentiation of power series, zeros of analytic functions; singularity ; principle part; residues; poles; residue theorem of a function; residues at poles; evaluation of improper integrals; integration through a branch cut.

**0301421 Ordinary Differential Equations-II (3 Credit Hours)**  
**Prerequisite: (0301221)**

Linear ordinary differential equations; existence and uniqueness theorems; infinite series solutions (Frobenius method); Bessel functions and Legendre Polynomials; Sturm-Liouville theory; Green's functions; linear systems with constant coefficients; non-linear differential equations and stability.

**0301422 Partial Differential Equations-II (3 Credit Hours)**  
**Prerequisite: (0301321)**

First order differential equation in two independent variables; semilinear and quasilinear equations; first order non-linear equations; second order linear equations; canonical forms; Green's function method; transforms method.



**0301423      Dynamical Systems      (3 Credit Hours)**  
**Prerequisite: (0301221)**

Discrete and continuous dynamical systems. Linear systems, diagonalizable and nondiagonalizable systems. Nonlinear systems, fixed points and stability. Periodic and chaotic behaviors of nonlinear systems. Fractal dimension.

**0301431      Mathematical Statistics      (3 Credit Hours)**  
**Prerequisite: (0301333)**

Estimation: point estimation, confidence interval; statistical test: UMP test; likelihood ratio tests, chi-square tests, SPRT; non-parametric methods; Sufficient statistics and its properties; complete statistics exponential family; Fisher Information and the Rao-Cramer inequality.

**0301432      Time Series      (3 Credit Hours)**  
**Prerequisite: (0301334)**

Descriptive techniques; types of variations: trend, cycle and seasonal fluctuations, autocorrelation; probability models for time series; stationary processes; autocorrelation function; estimation in time domain; fitting an autoregressive process; fitting a moving average process; forecasting; box and Jenkin's methods; stationary processes in the frequency domain; spectral analysis.

**0301433      Information Theory      (3 Credit Hours)**

**Prerequisite: (0301333)**

Methods and concepts of information; information measures: Hartley entropy; Wiener concept of information, Shannon entropy, Boltzmann entropy; A-entropy, Renyi entropy; Entropy generating function; required properties of an entropy measure; Coding theory: constructions of codes; capacity of a channel; properties of codes; Fisher information; Tukey information; Kullback-Leibler divergence; Akaiki information criterion; statistical applications:  $\beta$ -I-equivalent distributions, sample efficiency; normal approximations,  $\beta$ -sufficient partitions, characterizations of random variables, model selection, Bayesian information, improvement measure, normed information rate, information correlation, chi-square test, most influential part of data.



- 0301434 Credibility Theory and Bayes Methods (3 Credit Hours)**  
**Prerequisite: (0301333)**
- Loss functions, discrete frequency-severity insurance model under independence, limited fluctuation credibility approach, Buhlmann's approach, Buhlmann-Straub model, credibility and Bayesian inference, frequency-severity insurance model with continuous severity component, credibility and least squares, Morris-Van Slyke estimation, empirical Bayes parameter estimation, Decision Theory.
- 0301435 Pension Mathematics (3 Credit Hours)**  
**Prerequisite: (0301372)**
- Pension plan benefits, actuarial assumptions, basic actuarial functions, pension plan population Theory, pension liability measures, normal costs, supplement cost, ancillary benefits, multiple retirement ages, statutory funding requirements, pension accounting, alternative actuarial assumptions, alternative plan benefits, funding policy, investment policy, asset allocation, funding and accounting for retiree health benefits.
- 0301441 Linear Algebra-II (3 Credit Hours)**  
**Prerequisite: (0301241)**
- Vector spaces; subspaces; quotient spaces; linear independence and bases; dual spaces; inner product spaces; orthonormal bases; linear transformations; eigenvalues, eigenvectors and determinants of linear transformations; matrix representation; change of basis and similarity; invariant subspaces; canonical forms of linear transformations; diagonal form; triangular form; nilpotent transformations; Jordan form; companion matrices; commutators; the trace functional and Jacobson's lemma; normal transformations and the spectral theorem.
- 0301442 Modern Algebra-II (3 Credit Hours)**  
**Prerequisite: (0301341)**
- Ring homomorphisms; polynomial rings; factorization of polynomials; reducibility and irreducibility tests; divisibility in integral domains; principal ideal domains and unique factorization domains; algebraic extension of fields; introduction to Galois theory.



**0301443 Combinatorial Analysis (3 Credit Hours)**  
**Prerequisite: (0301241)**

Principles of enumeration; finite difference calculus; generating function; principles of inclusion and exclusion; introduction to the theory of combinatorial graphs; covering circuits and graph coloring; trees and searching; network algorithms.

**0301444 Matrix Theory (3 Credit Hours)**  
**Prerequisite: (0301241)**

Kronecker product of matrices; matrix functions; matrix equations, matrix differential equations; eigenvalues and eigenvectors; the characteristic polynomial; the minimal polynomial; Cayley-Hamilton theorem; canonical forms; Gershgorin's discs; strictly diagonally dominant matrices; Hermitian and unitary matrices; Schur's triangularization theorem; the spectral theorem for normal matrices; positive semidefinite matrices; quadratic forms; the polar decomposition and the singular value decomposition; the More-Penrose generalized inverse; matrix norms; QR factorization.

**0301451 Foundations of Mathematics (3 Credit Hours)**  
**Prerequisite: (0301211)**

Introduction and paradoxes; axioms of set theory; equivalence relations and functions; partially ordered classes; lattices; well-ordered classes; the axiom of choice and related principles; Dedekind cuts; cardinals and ordinals.

**0301461 Non-Euclidean Geometry (3 Credit Hours)**  
**Prerequisite: (0301261)**

Axiomatic systems of modern mathematics; special emphasis on affine geometry, projective geometry, hyperbolic geometry and elliptic geometry, plane hyperbolic geometry and parallelism axioms; asymptotic triangles and sacchiri quadrilaterals; ideal points and loci associated with it; area defect; representation of hyperbolic plane in the Euclidean plane.



**0301462      General Topology-II      (3 Credit Hours)**  
**Prerequisite: (0301361)**

Metric spaces: definitions and examples, metric topology, normed spaces and some important inequalities; Minkowski's inequality; connectedness: connected spaces, connected sets in the real line, components and local connectedness; compactness: compact spaces, compact sets in the real line; limit point compactness and local compactness.

**0301471      Methods in Applied Mathematics      (3 Credit Hours)**  
**Prerequisite: (0301413)**

Integral equations; integral transforms; asymptotic techniques: algebraic equations and integrals; complex analytic methods: conformal mapping and harmonic analysis.

**0301472      Numerical Methods      (3 Credit Hours)**  
**Prerequisite: (0301302)**

Numerical analysis; numerical methods in linear algebra; numerical methods for ordinary and partial differential equations.

**0301473      Mathematical Packages-I      (3 Credit Hours)**  
**Prerequisite: (0301301)**

Mathematica package may be 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 mathematics such as calculus, linear algebra, differential equations, statistics, vectors, set theory, number theory, variational methods, graph theory, special functions, Fourier and Laplace transforms. The course should start with training on using the package and end with writing some programs to solve some specific problems.



**0301474 Actuarial Mathematics-II (3 Credit Hours)**  
**Prerequisite: (0301372)**

Mathematical & Statistical techniques in: the survival function, construction of life tables, Laws of mortality, Life insurance. Continuous and discrete distributions for life annuities. Recursion equations. Benefit premium modes and their relationship to annuity. Apportion able premiums. Continuous and discrete probability distribution for benefit reserves. Distribution models for insurance expenses.

**0301475 Mathematical Packages-II (3 Credit Hours)**  
**Prerequisite: (0301301)**

Introducing the IMSL, Maple, Derive, MathCad, MatLab, Excel, Minitab, S-plus, NCSS, SPSS, and SAS packages including their components, syntax, features, functions, preparation of input, implementation of commands, interpretation of output, programming some algorithms to solve some pure and applied mathematical and statistical problems, comparison of the characteristics of these packages.

**0301476 Financial Mathematics-II (3 Credit Hours)**  
**Prerequisite: (0301371)**

Interest-rate based financial derivatives (fixed rate note, floating rate note, cap, floor, swap), interest-rate modeling. Equity derivatives: (Asian options, Barrier options, compound options, Look back options, Vanilla stock options (put and call options), American options. Equity binary trees. Option, call, put, forward, future, calling sequences. Hedging portfolios: Partially and fully hedged portfolio, minimizing portfolio sensitivities. No-arbitrage pricing, n-period binomial model, log-normal model of stock prices, risk-neutral pricing formula.

**0301477 Actuarial Modeling (3 Credit Hours)**  
**Prerequisite: (0301431)**

Principles of actuarial modeling, classification of stochastic processes, survival models and life table, estimating the lifetime distribution, the Cox regression model, the two-state Markov model, exposed to risk, evaluation of assurances and annuities, premiums and reserves. Binomial model of mortality, estimation of transition intensities depending on age, process of graduation.



**0301481 History of Mathematics (3 Credit Hours)**  
**Prerequisite: (0301301)**

Evolution of some mathematical concepts, facts and algorithms in arithmetic, algebra, trigonometry, Euclidean geometry, analytic geometry and calculus through early civilizations, Egyptians, Babylonians, Greeks, Indians, Chinese, Muslims and Europeans, evolution of solutions of some conjectures and open problems.

**0301499 Research Project (3 Credit Hours)**  
**Prerequisite: (0301474)**

Student is supposed to write a graduation project in actuarial sciences, after introducing him to different problems and issues in actuarial studies. The course also enables the student to write reports about actuarial problems, to draw conclusions, and to prepare recommendations concerning them.