Course Contents

MATH 140 : Introduction to Mathematics (E) 2 (2+0+0) credit hours
Linear equations and applications, linear inequalities, absolute value in equations and inequalities, complex numbers, quadratic equations and applications, functions , odd and even functions, operations on functions, inverse functions, exponential and logarithmic functions, trigonometric functions, conic sections, systems of equations and inequalities, matrices, matrix operations.**(Preparatory Year)**

MATH 150 : Differential Calculus (E) 3 (3+0+0) credit hours
The concept of limit, computation of limits, continuity and its consequences, limits involving infinity, formal definition of limit, the concept of derivative, computation of derivatives (power rule, higher order derivatives, acceleration), the product and quotient rules, the chain rule, derivatives of exponential and logarithmic functions, implicit differentiation and inverse trigonometric functions, the mean value theorem, indeterminate forms and L'Hopital's rule, maximum and minimum values, increasing and decreasing functions, concavity and the second derivative test, optimization, related rates.
Prerequisite : MATH 140 **(Preparatory Year)**

MATH 111 : Integral Calculus (E) 4 (3+1+0) credit hours
Definition of Definite Integral and its Properties, The Anti-derivative, Indefinite Integral and the Fundamental Theorem of Calculus. Change of Variables, Integrals of natural and general exponential functions, Integrals of natural and general Logarithmic functions, Derivatives and Integrals of Hyperbolic and Inverse-Hyperbolic functions, Techniques of Integration: by parts, Trigonometric substitutions, Completing the square, Integrals of rational functions, Miscellaneous Substitutions, Indeterminate forms, Improper Integrals, Applications of Integration: Area, Solids of Revolutions, Arc length and Surface of Revolution, Linear Motion, Work, Momentum and Center of Mass, Numerical Integration, Polar coordinates, relation between polar and Cartesian coordinates, Graphs of polar curves, Area in Polar coordinates, Parametric Equations.
Prerequisite : MATH 150

MATH 131: Foundations of Mathematics 4 (3+1+0) credit hours
Introduction to logic, methods of proof, mathematical induction. Sets, operations, on sets, cartesian product, binary relation, partition of a set, equivalence relation, equivalence classes, mappings, equivalence of sets, finite sets, countable sets, cardinal numbers, Binary operations, morphisms, Definition and examples of groups, definition and examples of rings and fields.
Prerequisite : MATH 150

MATH 201 : Differential and Integral Calculus (E) 4 (3+1+0) credit hours
Cartesian, cylindrical and spherical coordinate systems, Functions of two and three variables, limits and continuity, partial derivatives, the chain rule, extrema of functions of two variables, Lagrange multipliers, Double integrals, moments and center of mass, double integrals in polar coordinates, triple integrals, application of triple integrals, triple integrals in cylindrical and spherical coordinates, surface area, Sequences, infinite series, convergence tests, representation of functions by power series, Taylor and Maclaurin series, the binomial series.
Prerequisite : MATH 111

MATH 202 : Vector Calculus (E) 4 (3+1+0) credit hours
Vectors in two and three dimensions, scalar and vector products, equations of lines and planes in 3-dimensional space, Surfaces of revolution and their equations in cylindrical and spherical coordinates, Vector valued functions of a real variable, curves in space, curvature, Rates of change in tangent and normal directions, directional derivatives, Gradient of a function, equations of normal and tangent space to a surface at a point, Vector fields, divergence, curl of a vector, line and surface integrals. Green's theorem, Gauss' divergence theorem, Stockes' theorem.
Corequisite : MATH 201

MATH 225 : Introduction to Differential Equations (E) 4 (3+1+0) credit hours
Classification of Differential equations and their origins, Methods of solution of first order differential equations, orthogonal trajectories, Linear equations with constant coefficients and variable coefficients, Linear system of equations, power series solutions of linear differential equation of the second order with polynomial coefficients, Laplace transform and the convolution, Fourier's series.
Prerequisite : MATH 201

MATH 243 : Number Theory 4 (3+1+0) credit hours
First and second principles of Mathematical Induction, Well-ordering principle. Divisibility, Euclidean Algorithm, Prime numbers and their properties, Linear Diophantine equations, Congruences and their properties, linear Congruences, The Chinese remainder theorem, Fermat's little theorem, Euler's theorem, Wilson's theorem, Arithmetic functions, Pythagorean triples, Some cases of Fermat's last theorem.
Prerequisite : MATH 131

MATH 246: Linear Algebra 4 (3+1+0) credit hours
Matrices and their operations, types of matrices, Elementary transformations, Determinants, elementary properties, Inverse of a matrix, Vector spaces, linear independence, finite dimensional spaces, linear subspaces, Inner product spaces, Linear transformation, kernel and image of a linear transformation, Eigen values and eigen vectors of a matrix and of a linear operator.
Prerequisite : MATH 131

MATH 316 : Mathematical Methods (E) 4 (3+1+0) credit hours
Inner product space, sequences of functions and their modes of convergence, Strum-Liouville problem (ordinary and singular), self-adjoint differential operator, Fourier series, convergence in L^2, pointwise convergence, Orthogonal polynomials (Legendre, Hermite, Laguerre) and their properties, expansions of functions, Bessel functions, properties, orthogonality , Fourier transform, Fourier integral, applications.
Prerequisite : MATH 202 and MATH 225

MATH 343 : Group Theory 4 (3+1+0) credit hours
Definitions and examples, subgroups, Lagrange's theorem, normal subgroups, Factor groups, homomorphisms, isomorphism theorems, automorphisms, Cayley's theorem and its generalization. Simple groups, permutation groups, Class equation. Group action on a set, p-groups, Cauchy's theorem, Sylow theorems, External and internal direct products of groups, Burnside's theorem. Dihedral groups, Quaternions, Groups of automorphisms of cyclic groups.
Prerequisite: MATH 246 and MATH 243

MATH 352 : Numerical Analysis (1) 4 (3+1+0) credit hours
Numerical methods for nonlinear equations, Error and convergence, analysis, Direct & iterative methods for linear systems, Error analysis & iterative methods convergence, Interpolation & approximation Error analysis, Numerical differentiation & numerical integration & their error analysis .
Prerequisite: MATH 160 and MATH 246

MATH 373 : Introduction to Topology (E) 4 (3+1+0) credit hours
Topological spaces, examples, closure of a set, derived set, subspace topology, Bases, finite product topology, subbases, Metric spaces, examples, metrizability, $\mathbb{R}^n$ as a metrizable space, Continuous functions, characterization of continuous functions on topological and metric spaces, homeomorphisms, examples, topological property,Compact spaces, compactness in $\mathbb{R}^n$ limit point and sequentially compact spaces.
Prerequisite: MATH 382

MATH 379 : Foundations of Euclidean and Non-Euclidean Geometry 4 (3+1+0) credit hours
Axiomatic methods and Axiomatic systems, Euclidean geometry: Euclid's postulates, Transformations in E^2 and E^3; translations, rotations, reflections, dialations and isometrics, The parallel postulates and non-Euclidean geometry, the hyperbolic plane, Affine geometry: Linear and affine transformations, isometrics, Finite affine planes, A brief introduction to projective geometry.
Prerequisite : MATH 202 and MATH 246

MATH 382 : Real Analysis I (E) 4 (3+1+0) credit hours
Basic properties of the field of real numbers, completeness axiom, countable sets, Sequences and their convergence, monotone sequence, Bolzano-Weierstrass theorem, Cauchy criterion, Basic topological properties of the real numbers, Limit of a function, continuous functions and properties of continuity, uniform continuity, compact sets, The derivative of a function, mean value theorem, L'Hospital rule, Taylor theorem.
Prerequisite: MATH 201

MATH 391 : History of mathematics (A &E) 2 (2+0+0) credit hours
Mathematics in Babylonia and Egypt, The Greek mathematics, History of mathematics in India and China, Mathematics in the Islamic age, Development of mathematics in Europe from the seventeenth century up to now. Prerequisite: MATH 243

Course Contents

MATH 425 : Partial Differential Equations (E) 4 (3+1+0) credit hours
Classification and formation of PDE, First order equation, solution of the quasil-linear equation by Lagrange Method, Cauchy problem, Second order linear equation, classification, solution factorization of operator and by separation of variables, Cauchy problem, Laplace's equation, harmonic functions; Dirichlet, Neumann, and Mixed conditions; examples in Cartesian, polar, cylindrical, and spherical coordinates, Wave equation in one and two dimensions, solution by Fourier series , Heat equation in bounded and unbounded one-dimensional domain, solution by Fourier series and transform.
Prerequisite: MATH 316

MATH 426 : Modeling in Mathematical Biology (E) 3 (3+0+0) credit hours
Introduction to compartments models: What is a Model, What is the goal of a Model, Examples: Foxe and Rabbits model, Brief introduction to Glucose Insulin model; Phase-Plane Analysis: Linear System, Population dynamics: Verhulst Model, A Predator-Prey Model, reaction kinetic; A basic epidemic model (SIR); Nonlinear Systems and Linearization, Qualitative Analysis of the General Population Interaction Model, Qualitative Analysis of the Epidemic Model, The Spruce Budworm Model, SI Model with treatment and Hopf Bifurcation, A cell population model, Parameter estimation, Project.
Prerequisite: MATH 160, MATH 225

MATH 431 : Combinatorics and Graph Theory (1) 4 (3+1+0) credit hours
Basic counting principles, The inclusion-exclusion principle, The pigeonhole principle, Ordinary generating functions, Exponential generating functions, Homogeneous recurrence relations, Non-homogeneous recurrence relations, Basic concepts in graph theory, Eulerian graphs, Hamiltonian graphs, Trees, Planar graphs, Coloring, Chromatic polynomials.
Prerequisite: MATH 246

MATH 433 : Combinatorics and Graph Theory (2) 4 (3+1+0) credit hours
Partitions of sets. Stirling numbers. Partitions of integers. Ferrers diagrams. Euler's identity. Ordered sets. Dilworth's theorem. Linear extensions. Combinatorial designs. Block designs. Latin squares. Connectivity of graphs. Blocks. Edge connectivity. Matching. Hall's theorem. Directed graphs. Tournaments. Networks. Connectivity and networks.
Prerequisite: MATH 431

MATH 436 : Mathematical Logic (E) 4 (3+1+0) credit hours
Propositional calculus. The deduction theorem for propositional calculus. Completeness and consistency of propositional calculus. Predicate calculus. First-order theorems. Consistency of first-order predicate calculus. Completeness theorem for predicate logic.
Prerequisite: MATH 131

MATH 441 : Rings and Fields 4 (3+1+0) credit hours
Rings, group of units and groups of automorphisms of a ring. Ideals and factor rings Principal ring. Prime and maximal ideals. Field of quotients of integral domain. Characteristic of a ring. Direct sum of rings. Modules. Euclidean rings. Ring of polynomials. Roots of polynomials over a field. Field extensions. Finite and simple extensions of fields. Algebraic closure of a field. Splitting fields. Finite fields.
Prerequisite: MATH 343

MATH 442 : Applications of Algebra 4 (3+1+0) credit hours
Classical cipher systems, Steam ciphers, Introduction to cryptanalysis, Exponential ciphers and public keys, Introduction to codes, Linear codes, Perfect codes, Cyclic codes. Prerequisite: MATH 441

MATH 453 : Numerical Analysis (2) (E) 4 (3+1+0) credit hours
Numerical methods for solving nonlinear systems: fixed point iteration, Newton and quasi Newton methods, Numerical methods for solving initial value problems in ODE: finite difference, multistep and predictor corrector methods; derivation of some methods, error analysis, stability and convergence, Rung-Kutta methods, Numerical methods for solving boundary value problems in ODE: finite difference methods for linear and nonlinear problems, error analysis and convergence, Collocation method, Applications (applicable problems solved by the computer). Prerequisite: MATH 352

MATH 456 : Introduction to Mathematical Programming 3 (2+1+0) credit hours
Modeling of real life optimization problems, Convex sets & polyhedra approach and geometrical approach, Exchange method & the structure of matrices, Simplex method & variants (2 phase; revised, degeneracy Blands rule etc), Duality theory and application, Transportation Problem, Networks & Flow problems. Prerequisite: MATH 246

MATH 466 : Dynamical Systems and Chaos (E) 4 (3+1+0) credit hours
Dynamical systems, regular and irregular behavior of nonlinear dynamical systems, existence and uniqueness theorems; linear ODEs with constant and periodic coefficients, Floquet theory; linearization and stability analysis; Nonlinear oscillations and the method of averaging; perturbation methods; bifurcation theory and normal forms; phase plane analysis for autonomous systems, Hamiltonian dynamics, chaotic systems, Chaotic motion, Lyapunov exponents functions, Poincare maps, including horseshoe maps and the Melnikov method.
Prerequisite: MATH 316

MATH 473 : Introduction to Differential Geometry (E) 4 (3+1+0) credit hours
Theory of curves in space, Regular curves, Arc Length and reparametrization, natural parametrization, Serret-Fernet apparatus, existence and uniqueness theorem for space curves, Bertrand curves, Involutes and evolutes, Local theory of surfaces: Simple surfaces, coordinate transformations, tangent vectors and tangent spaces, First and second fundamental forms, Normal and geodesic curvatures, Weingarten map, principal, Gaussian and mean curvatures, Geodesics, equations of Gauss and Codazzi-Mainardi.
Prerequisite : MATH 202 and MATH 246

MATH 481 : Real Analysis II (E) 4 (3+1+0) credit hours
Riemann Integrations: the definition, Darboux theorem, Riemann sums, the fundamental theorem. Sequences and series of functions: uniform convergence for the sequences and series of functions, power series. Lebesgue measure: Borel $\sigma-$ algebra, outer measure, Lebesgue measurable sets, Properties of Lebesgue measure. Lebesgue integral: simple functions, measurable functions, definition of Lebesgue integral, Monotone convergence theorem, bounded convergence theorem, the relation between Lebesgue and Riemann integrals.
Prerequisite : MATH 382

MATH 482 : Multivariable Calculus (E) 4 (3+1+0) credit hours
Define norms, inner product on general vector spaces, linear transformations and their properties, basic concepts of topology in the Euclidian space, Continuous functions on the Euclidian space and their properties, differentiability in $\mathbf{R}^n$ and its properties, chain rule and other rules, higher order derivatives and Taylor's, Theorem, maxima and minima, quadratic forms, Lagrange multiplier method, Inverse and implicit function theorems in higher dimension, Integration of function of n variables, Fubini Theorem and change of variable formula.
Prerequisite: MATH 246 and MATH 481

MATH 487 : Complex Analysis (E) 4 (3+1+0) credit hours
Complex numbers, Cartesian and polar representation of complex numbers, powers and roots of complex numbers, Limits and continuity of a complex fun, Analytic functions, Cauchy-Riemann equations, harmonic functions. Exponential, trigonometric, hyperbolic functions and logarithmic functions, Complex integration, contour integrals, Cauchy's theorem, Cauchy's formula, Bounds on analytic functions, Series representation of analytic functions, Taylor and Laurent series, power series, Zeros and singularities, Residue theory, Applications to real and improper integrals.
Prerequisite: MATH 382

MATH 499 : Research Project 3 (0+0+0+3) credit hours
The student should prepare a research project under the supervision of a faculty member. This procedure involves three main steps:

- Choosing the subject matter of the project.
- Locating relevant references and studying them.
- Writing up the research project and presenting it.

Prerequisite: Completion of 100 credit hours