DEPARTMENT OF MATHEMATICS

Description:

Mathematics is the language in which the laws of nature are written. In recent years, applications of mathematics have expanded far beyond the traditional boundaries of Basic Sciences and Engineering. Biologists, sociologists, economists, psychologists and even historians and lawyers have reached out of mathematicians in their quest for indisputable conclusions and novel methods of investigation. Department of Mathematics has created a broad-based program dedicated to excellence in teaching, quality research on the leading edge of technology and the professional development of students. Scientific view about mathematics is to our understandings of events that occur in real life. Mathematics is a varied subject, encompassing centuries-old disciplines with long-standing open problems along with recently discovered fields of application in physics, biology, economics and other areas. It is an exciting time to be studying mathematics, with new connections within the subjects and to fields outside continually being discovered. Mathematics develops ability to deal with abstract concepts and detailed calculations. This program is also facilitates the necessary knowledge and skills to the students who are planning their careers in government, semi-government and social organizations. The department maintains the highest level of education and research, expands interdisciplinary studies with science, engineering and business administration. Mathematicians are increasingly in demand. With a Mathematics degree one can turn hand to finance, statistics, engineering, computer teaching or accountancy with success. Graduates with bachelor's degree find various career paths. The program provides a balanced and well-developed program of study in research fields.

The main objective of this department is to provide practical exposure to the students along with theoretical knowledge so that they can have an opportunity for translating their theoretical knowledge to real life situation. The students will also be involved in project/thesis work as well as research work.

Program	:	B. Sc. (Hons.) in Mathematics
Name of Degree	:	Bachelor of Science (Honours) in Mathematics.
Duration	:	4 Years
Semester	:	8
Total Theory Courses	:	45 (143 credits)
Total Lab Courses	:	7 (11credits)
Viva-Voce	:	4 (5 Credits)
Project/Term Papers	:	1 (1Credit)
Total Credits	:	160

Course List and Code

Course Code	Course Title	Credits
Math-101	Higher Algebra and Plane Trigonometry	3
Math-102	Set Theory and Logic	3
Math-103	Differential Calculus	3
Math-104	Geometry of Two Dimensions	3
Phy-105	Physics-I	3
Eng-106	English Language Course	3
Math-108	Integral Calculus	3
Math-109	Geometry of Three Dimensions	3
Stat -110	Statistics-I	3
Eco-111	Economics	3
Comp-112	Computer Science-I	3
Comp-113	Computer Science Lab-I	1.5
Math-114	Math Lab-I	1.5
Math-115	Viva-Voce	1

Course Code	Course Title	Credits
Math-201	Advanced Calculus	3
Math-202	Linear Algebra	3
Math-203	Discrete Mathematics	3
Stat -204	Statistics-II	3
Phy-205	Physics-II	3
Comp-206	Computer Science-II	3
Comp-207	Computer Science Lab-II	1.5
Math-208	Math Lab-II	1.5

Course Code	Course Title	Credits
Math-209	Complex Analysis-I	3
Math-210	Ordinary Differential Equation	3
Math-211	Vector Analysis	3
Math-212	Tensor Analysis	3
Math-213	Real Analysis-I	3
Eng-214	Technical Writing and Presentation	2
Math-215	Math Lab-III	1.5
Math-216	Math Lab-IV	2
Math-217	Viva-Voce	1

Course Code	Course Title	Credits
Math-301	Complex Analysis-II	3
Math-302	Partial Differential Equation	3
Math-303	Real Analysis-II	3
Math-304	Abstract Algebra	3

Math-305	Numerical Analysis-I	3
Math-306	Statics	3
Math-307	Dynamics	3
Math-308	Linear Programming	3
Math-309	Classical Mechanics	3
Math-310	Topology	3
Math-311	Numerical Analysis-II	3
Math-312	Differential Geometry	3
Math-313	Applied Mathematics	3
Math-314	Math Lab-V	1.5
Math-315	Viva-Voce	1

* Choose any five courses from the courses Math-401 to Math-409 with the approval of the department.

Course Code	**Course Title**	**Credits**
Math-401	Number Theory	4
Math-402	Functional Analysis	4
Math-403	Fuzzy Mathematics	4
Math-404	Fluid Mechanics	4
Math-405	Mathematical Modeling in Finance and Business Management	4
Math-406	Theory of Relativity	4

Course Code	**Course Title**	**Credits**
Math-407	Graph Theory	4
Math-408	Difference Equation	4
Math-409	Mathematical Modeling in Economics	4
Math-410	Project/Term Paper	1
Math-411	Viva-voce	2

** Choose any four courses from the courses Math-412 to Math-420 with the approval of the department.

Course Code	**Course Title**	**Credits**
Math-412	Mathematical Astronomy	4
Math-413	Operation Research	4
Math-414	Integral Equations	4
Math-415	Rings and Modules	4
Math-416	Mathematical Cosmology	4
Math-417	Quantum Mechanics	4
Math-418	Computational Mathematics	4
Math-419	Mathematical Modeling in Biology	4
Math-420	Group Theory	4

COURSE DESCRIPTIONS:

Math-101: Higher Algebra and Plane Trigonometry (3 Credits)

Group A: Higher Algebra

This course will provide the primary knowledge on Algebra. This course is divided into two parts. In group: A, students will explore the nature of Order properties of Real Numbers, Average, Mean, Arithmetic Mean, Geometric Mean, Weierstras's Inequality, Cauchy-Schwarz Inequality and Holder's Inequality. Theory of Equations. Basic definitions of Series, Techniques of summing up Series, Test for Convergences and Divergence of Series. Elementary properties of Determinants and Matrices, Techniques of solving linear non-homogenous and homogenous Equations.

Group B: Plane Trigonometry

This section includes Complex Quantities, Demoiver's Theorem and its applications, Hyperbolic Functions, Trigonometric Series like Power Series, Logarithmic Series, Gregory's Series, Summation of Series, and Expansions in Series.

Math-102: Set Theory and Logic (3 Credits)

This course is designed to introduce the Axioms, Zermelo-Fraenkel set theory, Relations and Functions like Equivalence Relations, Distinction between Relations and Functions and Fundamental theorem of Equivalence Relations, Partition. Functions: Subjective, Injective, bijective functions, Inverse function, Characteristic function, Set function, Restriction function, Extension function, Real valued function, Natural numbers and the axioms of infinity. Cardinality and Logic.

Math-103: Differential Calculus (3 Credits)

This course will provide the primary knowledge on Basic ideas of the Real and Complex Number Systems. Functions of a Single Variable and its Domain and Ranges, Graphical representation of standard Functions. Existence of Limits, Definition and Elementary Properties of Continuous functions of a Single variable, Statement and Verifications of Standard Theorems by Suitable Examples. Techniques of Finding Derivatives of functions of a Single Variable, Geometrical Interpretation of Derivatives, Fundamental Theorems. Extrema of subsets of the Real Number System, Real valued Functions of Single Variable and Its extrema. Narrative extrema Problems and Related Rates Based on Elementary Theory. Tangent Lines Approximation, Differentials, Tangents, Normal, Curvature and Asymptotes, Points of Inflection, Increasing and Decreasing, Convexity and Concavity of functions, Curve Tracing, Polynomials and Rational Functions

Math-104: Geometry of Two Dimensions (3 Credits)

This course is designed to introduce the students with Co-ordinate Geometry: Cartesian Coordinates, Polar Coordinates, Parameter, Change of Axes, and Standard Equations in Different ordinate Systems and their Parametric Representations. General Equations of Second Degree: Standard Forms, Reduction of General Equations of Second Degree into Standard Forms. Pair of Straight Lines: General Equations of Second Degree Representing a Pair of Straight Lines, General Properties of Pair of Straight Lines. Circles and Ellipses: General Equations to a Circle in Rectangular and Polar Coordinates, Derivation of the

Equation of an Ellipse, General Properties of Circles and Ellipses. Parabola and Hyperbola: Derivation of the Equation of Parabola and Hyperbola and their General Properties.

Phy-105: Physics-I (3 Credits)

Group A: Mechanics and Properties of Matter

This course is designed to introduce the students with properties of Conservative and non-conservative forces and systems; conservation of energy and momentum; center of mass; collision problem. Rotational Motions: Rotational variable; rotation with constant angular acceleration; torque on a particle; angular moment of inertia; combined translational and rotational motion of rigid body; conservation of angular momentum. Oscillatory Motions: Hook's law and vibration; simple harmonic motion; motion combination of harmonic motions; damped harmonic motion; forced oscillation and resonance. Gravitation: Center of gravity of extended bodies; gravitational field and potential and their calculations; determination of gravitation constant and gravity; compound and Kater's pendulum; motion of planets and satellites; escape velocity. Surface Tension: Surface tension as a molecular phenomenon; surface tension and surface energy; capillary rise or fall of liquids; pressure on a curved membrane due to surface tension; determination of surface tension of water; mercury and soap solution: effect of temperature. Elasticity: Moduli of elasticity, Poisson's ratios; relations between elastic constants and their determination; cantilever; flat spiral spring. Fluid Dynamics: Viscosity and coefficient of viscosity Poiseale's equation, determination of the coefficient of viscosity of liquid by Stock's method, Bernoulli's theorem and its applications, Torricelli's theorem; venturimeter.

Group B: Wave and Sound

In group B students will provide knowledge about Wave in Elastic Media: Mechanical waves; types of waves, superposition principle, wave velocity; power and intensity in wave motion; interference of waves; complex waves; standing waves and resonance. Sound Waves: Audible, ultrasonic, and infrasonic, waves; propagation and speed of longitudinal waves; vibrating systems and source of sound; beats; Doppler Effect

Eng-106: English Language Course (3 Credits)

This is a basic course of English which enables students to progress from a broad awareness into a critically informed knowledge of English literature in its historical range and depth. Competence in textual analysis, ease in critical argument, the ability to recognize and fashion rhetorical and linguistic discourse and the manipulation of sound reasoning are among the skills, both in spoken and written form, conferred by the proper study of literature.

Math-108: Integral Calculus (3 Credits)

This course is designed to provide the student with the basic idea of Integration (Indefinite and Definite Integrals): Integration of a function of a Single Variable, Integrals as anti-derivatives, Techniques of Integrations Standard Forms. Integrals as Limits of Sums, Geometrical meaning of Definite Integrals, Gamma and Beta function, Elementary properties of Definite Integrals, Fundamental Theorem of Calculus,

Reduction Formula, Basic Ideas of Double and Triple Integration. Application of integration: Reduction formula, Lengths of Curves, Areas of Plane Regions, Areas of Surface of Solids of Revolution and volumes of Solids of revolution. Moments and Centroids of Plane regions and solid of Revolution.

Math-109: Geometry of Three Dimensions (3 Credits)

This course provide the further knowledge on Coordinate systems, Direction cosines and direction ratios, Planes. Straight lines, shortest distance. Sphere, Cylinder and Cone. The general equations of second degree and reduction to standard forms. Identification of Conicoids

Stat-110: Statistics-I (3 Credits)

This course is designed to introduce the students with Statistics: Its nature and scope; Nature of statistical data; Attributes and variables; Discrete and continuous variable; Method of data collection; Tabulation; Graphs and diagrams. Measures of Location: Arithmetic mean; Geometric mean; Harmonic mean; Median; Mode; Quartiles; Deciles; Percentiles. Measures of Dispersion: Characteristics of an ideal measure of dispersion; Absolute measure; Relative measure; Range; Standard Deviation; Mean deviation; Quartile deviation; Coefficient of dispersion; Coefficient of variation; Skewness and kurtosis. Regression and Correlation: Relationship between variables; Fitting of simple linear regression; Simple correlation; multiple correlation and multiple regression. Elements of Probability: Meaning and definition of probability; Apriori and a posteriori probability; Experiment; Sample space and event; Theorems of total, compound and conditional probability; Random variables; Probability functions; Expectation of sum and products; Concepts of Binomial, Poisson's and Normal distribution. Sampling Technique: Simple random sampling; Stratified random sampling and systematic sampling. Tests of Significance: Type -1, Type -11 level of significance, size of the test, power of the test; Tests of means; Variance; Correlation coefficient and regression coefficient; Contingency table analysis. Theory of Errors: Error; Causes of variation of measurements; Measurement of error; Distribution of error; Methods of estimation of error; Minimizing error, examples related to physics problems

Eco-111: Economics (3 Credits)

This course provides the basic concept of economics, which gives the overall idea in economics. Topics cover the introduction of economics, circular flow of income, demand and supply theory, elasticity, consumer behavior and market demand, production and cost theory, characteristics of perfectly competitive markets and imperfectly competitive markets, basic principles of factor pricing, resource allocation, international trade, non-renewable resources, macroeconomics phenomena, national output, income determination, aggregate demand and aggregate supply, trade-off between inflation and unemployment, balance of payments and the exchange rates are included in this course.

Comp-112: Computer Science-I (3 Credits)

This course serves as a foundation for understanding the early history of computing devices; Computers: Major components of a computer; Hardware: processor, memory, I/O devices, Hard Disk, storage media, CD ROM, DVD, Printer, Scanner; System Software: Functions of operating systems, Discussion on different

types of operating systems; Application software: Word Processing, Spreadsheet Analysis, Database etc.; Networking: Different types of networks, network topologies, communication media; Internet services. Language Concept: Different types of Computer Languages, Program development stages: flow charts; Basic programming concepts: Compiler and Interpreter, Executable and Object File; Programming constructs: Data types, operators, arithmetic expressions and assignment statements; Loops and Nested Loops; Functions; Argument and local variables; calling function, parameter passing conventions, scope rules and storage classes, recursion and recursive function.

Comp-113: Computer Science Lab-I (1.5 Credits)

Computers have permeated every aspect of our modern society. If the past is a predictor of the future, we can be assured that the trend toward increased computer usage will continue. This makes it important to learn all we can about computers- their components, operations, communications and usage as well as related security and other societal issues. This course provides a basic introduction to computers along with basic programming concepts that address how they work and how to use them as effective productivity tools. The class uses a combination of assigned readings, lectures, labs, and discussions on course content.

Math-114: Math Lab-I (1.5 Credits)

This course is so designed to provide the student with the basic idea on Introduction to the computer algebra package using MATHEMATICA. Problem solving in concurrent courses (e.g. Calculus, Algebra and Geometry) using MATHEMATICA

Math-115: Viva-Voce (1 Credit)

Viva Voce on courses taught in the First Year

Math-201: Advanced Calculus (3 Credits)

The purpose of this course is to provide with Functions of Several Variables: Functions of Two and Three Variables, Real Valued and Vector Valued Functions, Scalar Fields and Vector Fields. Limit and Continuity of Functions of Two and Three Variables. Differentiations of Functions of Several Variables: Partial Differentiation, Total Differentiation, Geometrical Meaning of Partial Derivative, Extrema of Functions of several variables: First Derivative Test, Second Derivative Test and Lagrange's Multiplier Method and Taylor's Theorem. Integration of Functions of Several Variables: Line integrals, Double and Triple Integration, Multiple Integration. Improper Integrals: Definition and Classification of Improper Integrals, Tests for Convergence and Divergence of improper Integrals, Gamma and Beta Functions.

Math-202: Linear Algebra (3 Credits)

Prerequisite: Math-102

This course develops the capability of the student with concept of Vector Spaces: Basic ideas of Groups and Fields (No Theorem)(Real Numbers, Complex Numbers and Rational Numbers). Definition of Vector Spaces, Subspaces and basic theorems. Basis and Dimensions: Linear Combination of Vectors, Spanning set, Linear dependence and Independence of Vectors, Basis and Dimensions of Vector Spaces, Finite dimensional Vector Spaces, Sums and direct sums of subspaces. Linear Transformations :Linear Transformation, The matrix of a Linear Transformations, The kernel and image of Linear Transformations, Rank and Nullity of a Linear Transformations, Non-singular Linear Transformations, Linear functional, Dual spaces and dual bases. Diagonalization of Matrices: Introduction, Eigen Values and Eigen Vectors, Diagonalization of Matrices, The minimal polynomial of a matrix and Cayley-Hamilton theorem, The diagonalization of symmetric Matrices. Inner Product Spaces, Norms and Forms: Inner Product Spaces, Norms, Orthogonality and Gram-Schmidt orthogonalization Process, Bilinear Forms, Symmetric, Antisymmetric and Quadratic Forms related theorems.

Math-203: Discrete Mathematics (3 Credits)

This course is designed to introduce the students with propositional logic including predicate calculus and set, complexity of algorithms, growth of function and big O notation, sequences, summations, recurrence relations, special numbers, generating functions, counting, properties of the integers and modular arithmetic, applications of number theory, algebraic structures including finite field, cryptology and coding theory, basic ideas of public key cryptology, relations, partial ordering, lattices, graphs and graph models, graph terminology and special types of graphs, representing graphs and graph isomorphism, connectivity, Euler and Hamilton paths, shortest-path problems, planar graphs, graph coloring, introduction to trees, applications of trees, minimum spanning trees, and Boolean algebra.

Stat-204: Statistics-II (3 Credits)

Prerequisite: Stat-110

The purpose of this course is to provide with Sampling Distributions: Fisher's Lemma. Study of χ square - distribution.t-distribution and F- distribution. Properties, uses and application. Distribution of sample regression coefficient and correlation coefficient in null case. Point Estimations: Basic concepts. Sufficiency, Consistency, Unbiasedness, Efficiency, Minimum variance bound estimate, Cramer-Rao Lower bound. Principle of maximum likelihood. Method of moments, Illustration from Binomial, Poisson and Normal distribution. Hypothesis Testing: Basic concepts. Simple hypothesis, Composite hypothesis, Critical region, Best Critical region, Most Powerful test, uniformly most powerful test, Likelihood Ratio test and Examples. Large Sample Test: Equality of K Proportions. Means and Variances. Test for regression and Correlation Coefficients. Test for r×c Contingency tables. Exact Test for 2×2 Contingency tables Examples. Non -parametric Test: Sign test, Run test and Rank Sum test. Examples.

Phy-205: Physics-II (3 Credits)

This course develops the capability of the student with Thermodynamics: First law of Thermodynamics-Internal energy; work done by expanding fluid'; specific heats of perfect gas ratio of to, isothermal and adiabatic expansions. Second law of Thermodynamics and Entropy: Reversible and irreversible processes;

cantor cycle; efficiency of heat engines; absolute scale of temperature; Clausius and Clapeyron's Equation; entropy; change of entropy in reversible and irreversible processes. Thermodynamics Function: Thermodynamics potentials at constant volume and pressure; Maxwell's thermodynamics relations; specific heat equation; Joule- Thomson effect; production of low temperature. Modern Physics: Atomic Physics-Motion of electrons under electric and magnetic fields; measurement of e/m and 'e', positive sign: Thermodynamics emission; photoelectric emission; Bohr's atom model; atomic spectra; x-rays; Matter waves. Nuclear Physics: Basic concept and properties of the nucleus; nuclear size, binding energy; radioactivity; elementary knowledge of fission, fusion, and reactors cosmic rays. Electronics: Vacuum diodes and triodes; p-type and n-types, semiconductors; p-n junctions; transistor biasing; transistor amplifiers; transmitters and receivers.

Comp-206: Computer Science-II (3 Credits)

Prerequisite: Comp-112

The purpose of this course is to provide with Structured programming language: Variables, data types, operators, expressions, statements, control statements, functions. Header files; Preprocessor; array, multidimensional array; Strings; User defined data types: structures, unions, enumerations; Input and Output: standard input and output, formatted input and output; Files: file function for sequential and random I/O; Pointers: Pointers and structures; Pointer and function; Operation and Pointer; Pointer and function; Pointer and array Pointer and memory address; Operations on Bits; Variable length argument list; Command line parameters; Error Handling; Graphics; Linking; Library functions.

Computational Analysis: Arrays: single and multi-dimensional, Matrix representation, operations and algorithms. Searching: binary and linear. Sorting: Selection sort, Insertion sort, Bubble sort, Quick Sort. Linked list: singly, doubly, circular, applications and operations. Stacks and queues: linked list and array representation, computer implementations. Trees: Binary trees, binary search tress, operations on trees. Heaps, Heap sort. Graphs: Graph representations, Graph search techniques, spanning tree, shortest paths and algorithms, Hashing: Hash Tables, Hash Functions, Hash Map, Chaining and open addressing collision handlers.

Techniques for analysis of algorithms, methods for design of efficient algorithms: divide and conquer, greedy method, dynamic programming, backtracking, branch and bound. Search and traversal techniques for different data structures. Algebraic simplification and transformations; Lower bound theory; NP-completeness, NP-hard and NP-complete problems.

Comp-207: Computer Science Lab-II (1.5 Credits)

Laboratory works based on Comp-206

Math-208: Math Lab-II (1.5 Credits)

This lab develops the capability of the student with FORTRAN: Introduction to Fortran, Program Structure, Fortran language constants, Variables, Arithmetic Statements, I/O operations, Basic ideas of algorithm, Flow Chart, Control statement, Looping, Arrays, Function and Subroutines.

Math-209: Complex Analysis-I (3 Credits)

This course will provide basic knowledge of the complex number system. This course will also include Complex Differentiation: Limits, continuity and differentiability of complex functions, Necessary and sufficient conditions for analytic functions, Mobius transformation, power series. Harmonic function; Complex Integration: Power series representation of analytic functions, zeros of analytic functions. Cauchy's theorem. Morera's theorem. Cauchy integral formula, classification of singularities.

Math-210: Ordinary Differential Equation (3 Credits)

Prerequisite: Math-103 & Math-108

This course is designed to introduce the students with definitions and classifications of differential equations, Formation of differential equation. This course will also includes solution of 1st order 1st degree ordinary differential equation: Variable separable, Homogenous equation, Linear equation, Bernoulli equation, Exact equation, Integrating factor, Equations made exact by integrating factor, linear differential equation with constant co-efficients, First order higher degree equations-solvable for x, y and p, trajectories, Higher order linear homogeneous equation with constant coefficients, Linear equation with variable coefficients: Cauchy-Euler equation, Legendre equation, Operational factoring, Exact equation, Series solutions of linear differential equations: Taylor series method, Frobenius method, Systems of linear differential equations: Method of elimination, Euler's method, Matrix method.

Math-211: Vector Analysis (3 Credits)

In this course student will learn basic knowledge of Vectors and scalars, definitions and fundamental laws, Product of vectors, Reciprocal vectors, Vector Geometry. This course will also includes Vector Differentiation: Vector differential operators, gradient, divergence and curl and its physical significance, Vector integration: Line, Surface and Volume integrals over Vectors Fields, Green's theorem, Gauss's theorem and Stoke's theorem and their applications. Curvilinear co-ordinates.

Math-212: Tensor Analysis (3 Credits)

This course provides the basic concept of Tensors, which gives the overall idea in Tensor analysis: Covariant and contravariant vectors and tensors, mixed and invariant tensors. Addition, subtraction and multiplication of tensor, contraction, symmetric and skew-symmetric tensors, Quotient law, Line element and metric tensor, Conjugate and associated tensors, Christoffel's symbols, and their transformation laws, Geodesics and Parallelism, Covariant derivative of a vector and a tensor, Intrinsic, derivative, Tensor form of gradient, divergence, and curl, Riemann Christoffel tensor, Curvature tensor, Ricci tensor, Bianchi identity, Flat space, and Einstein space.

Math-213: Real Analysis-I (3 Credits)

This course helps students to study Real Number System: Rational number, field, ordered set, ordered field, least upper bound and greatest lower, bound, the least upper bound property and its applications. The existence theorem and its proof. Dedekind theorem and its equivalence to the least upper bound

property and its applications. Finite and infinite sets, equivalence of sets, denumerable and countable sets, uncountable sets. Metric spaces, open and closed sets, compact sets. Perfect set. Cantor set. Convergence sequence, bounded sequence, subsequence, Cauchy sequence and completeness of R, Convergent series, Cauchy's criteria for convergent series, comparison test, Cauchy's, condensation test, Root and Ratio test, Integral test, Raabi's test, Leibnitz's test, Absolutely convergence. Continuous function, continuity and compactness, uniform continuity, Differentiability of functions.

Eng-214: Technical Writing and Presentation (2 Credits)

This course is designed to help students to develop writing and oral skills needed by Computer Science & Engineering professionals. The scope of this course includes not only general guidelines for technical writing, including word choice, sentence structure, and paragraph development, but also discipline-specific technical writing that conforms to IEEE or ACM standards. The course includes oral presentation skills and the effective use of graphic and design elements.

Math-215: Math Lab-III (1.5 Credits)

This course is designed to introduce the students with Problem solving in concurrent courses (e.g. Calculus, Linear Algebra and Differential Equations and Numerical Analysis) using MATHEMATICA & FORTRAN.

Math-216: Math Lab-IV (2 Credits)

This course provides the basic concept of MATLAB: Introduction; Matrix Analysis; Basic Graphics: Two and three dimensional plots, Basic Data Analysis; Functions; M-Files: Scripts and Functions, Flow Control, Comparing, Strings; Arrays; Mat Lab Programming: For Loops, Logical Expressions, While Loops, Conditional Programming, Function M-Scripts, Return Statement, Recursive Programming, Structures; 3D Modelling; Debugging.

Math-217: Viva-Voce (1 Credit)

Viva Voce on courses taught in the Second Year.

Math-301: Complex Analysis-II (3 Credits)

Prerequisite: Math-209

This course is designed to provide the student with Maximum modulus theorem, the homotopic version of cauchy's theorem and simple connectivity, the open mapping theorem, Taylor's and Laurent series, Fundamental theorem of algebra, Rouches theorem, Liovilli's theorem. The argument principle, The Residue theorem contour integration. Conformal mapping, bilinear mapping. The application of the conformal mapping Riemann Mapping theorem, Riemann zeta function, Analytic continuation, Riemann surface. Mittag Leffier's expansion, Number of Poles and Zeros of a Meromorphic Functions, Principle of argument, Rouche's theorem.

Math-302: Partial Differential Equation (3 Credits)

Prerequisite: Math-210

In this course student will learn Integrability condition, Solution method for $Pdx + Qdy + Rdz = 0$ and $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, Formation of PDEs, First order linear PDEs, First Order quasilinear and nonlinear PDEs, Second Order homogeneous and nonhomogeneous PDEs, Second order nonlinear PDEs, Classification of general second order PDEs and canonical forms, Solutions of Laplace's equations in Cartesian, cylindrical and Spherical coordinates, Solutions of diffusion (or heat flow) equation and wave equation.

Math-303: Real Analysis-II (3 Credits)

Prerequisite: Math-213

This course is designed to Definition and properties, K-cell, Heine-Borel theorem, Wierstrass theorem. Cantor set, Limit and continuity of function of two variables, Definition of partial differentiation, Schwarz's theorem & Young's theorem, the contraction principle, the inverse function theorem, the implicit function theorem, the rank theorem. The Riemann and the Riemann stieltjes integral: Definition and existence of the integrals, properties, integration and differentiation, Sequences and series of functions: Discussion of main problem, uniform convergence, uniform convergence and continuity, Uniform convergence and integration, uniform convergence and differentiation, the Stone-Weierstrass theorem, The Lebesgue theory: Set functions, construction of the Lebesgue measure, Measure spaces, Measurable functions. Simple function, Integration, comparison with the Riemann integral, integration of complex functions.

Math-304: Abstract Algebra (3 Credits)

Prerequisite: Math-202

This course is designed to introduce the students with Concept of Groupoid, Semi-group, General properties of Groups, Sub-Groups, Cyclic Groups, Concepts of Lagrange's Theorem. Normal Sub-Groups and Quotient Groups, Normalizer, Centre of Group and Centralizer. Permutation, Symmetric Group of Permutation, Cyclic Permutation, Transposition, Even and odd Permutation and Alternating groups. Concept of Homomorphism, Isomorphism, Monomorphism, Epimorphism, Auto morphism, Kernel and image of a Homomorphism, Homomorphism and Isomorphism Theorems. Cayley's theorem, Direct product of Groups. Definition of Rings and examples, Various types of Rings, Properties of Rings, Characteristic of Ring, Sub-rings, Ideals and Residue class ring, Principal, Prime and Maximal Ideals. Definition, Examples and Related Topics.

Math-305: Numerical Analysis-I (3 Credits)

This course provides the operators and their algebraic Properties. Difference tables, Forward, Backward and General Differences fundamental theorem of Difference Calculus. Bisection algorithm, Method of false position. Fixed point iteration, Newton-Raphson method, Error analysis for iterative method, Accelerating limit of convergence. Taylor polynomials, Interpolation and Lagrange polynomial, Iterated Interpolation, Extrapolation. Numerical Differentiation, Richardson's Extrapolation, Elements of

Numerical Integration, Adaptive quadrature method, Romberg's Integration, Gaussian quadrature. Gaussian elimination and backward substitution, pivoting strategies, LU decomposition method.

Math-306: Statics (3 Credits)

In this course student will learn Forces; Couples; Co-planar forces; Astatic equilibrium; Friction; Equilibrium of a particle on a rough curve; Virtual work; Catenary; Forces in three dimensions; Reduction of a system of forces in space; Invariance of the system; General conditions of equilibrium; Centre of gravity for different bodies; Stable and unstable equilibrium.

Math-307: Dynamics (3 Credits)

This course provides Motion of a particle in two dimensions. Velocities and accelerations in Cartesian, polar, and intrinsic coordinates. Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Motion of a particle in a plane under different laws of resistance. Central forces. Stability of nearly circular orbits. Motion under the, inverse square law Kepler's laws. Time of describing an arc and area of any orbit. Slightly disturbed orbits. Motion of artificial satellites. Problems of motion of varying mass such as falling raindrops and rockets. Tangential and normal accelerations. Motion of a particle on a smooth or rough curve. Principle of conservation of energy. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.

Math-308: Linear Programming (3 Credits)

This course is designed to introduce the students with Convex Sets and their properties, Hyper plane, Convex Hull, Convex Cone and Polarity, Convex combination, Separation and Support of sets, Weierstrass Theorem. Introduction, Formulations and Graphical LP solution, Basic solution, The simplex method, revised simplex method. Formulation of the Dual problem, Primal-Dual relationship, the Dual simplex method sensitivity analysis and parametric analysis. Basic feasible solution of LP, Optimum feasible solution of LP, Unbalanced transportation problem. Integer linear programming, dynamic programming. Introduction, Assignment algorithm, unbalanced assignment problem.

Math-309: Classical Mechanics (3 Credits)

This course provides Holonomic and non-holonomic systems. Lang ranges equation for holonomic systems, Mechanics of a particle and system of particles constraints, D-Alembert's principle and Lagrange's equation. simple applications of Lagrange's equation. Introduction to calculus of variation, Euler-Lagrange differential equation, applications. Motion in rotating frames, motion relative to earth. Foucault's pendulum. Impulsive motion, ignoration of coordinates, small oscillation, constant of motion. Phase space, Hamilton's equation, Hamilton's principle, principle of least action, Hamilton's principle function and Hamilton-Jacoby equation. Lagrange & Poisson brackets, contact transformation, commutator. Introduction to the Lagrangian and Hamiltonian formulations for continuous systems and fields.

Math-310: Topology (3 Credits)

This course is designed to introduce the students with Topology, Topological Space, Neighborhoods, Limit points, Closed Sets, Interior points, Open Sets, Bases & Subbases of a topology, Separated sets, Connected Sets in Metric Spaces and Topological Spaces. Continuous Functions, Restriction and Extension of Mapping, Invariant under Continuous mapping and homeomorphism. Disconnected Sets, Connected Sets, Components, Connected Components Functions on Connected Spaces. Compact Sets, Compact Metric Spaces, uniform Continuity and Separation Properties. Product of Two Topological Spaces, Open Sets and Closed Sets in product Spaces; General Product Spaces. Complete Metric Spaces, Metrication and Embedding Theorems

Math-311: Numerical Analysis-II (3 Credits)

Prerequisite: Math-305

This course is designed to linear system of equations, error estimation and iterative refinement. Eigenvalues and eigenvectors, the power method, Householders method, Q-R method. Fixed point for functions of several variables, Newton's method, Quasi- Newton's method, Steepest Descent techniques. Euler's and modified Euler's method, Higher order Taylor's method, Single-step methods (Runge-Kutta methods, extrapolation methods-higher order differential equations and system of differential equations), Multi step methods (Adam's-Bash forth, Adams- Moulton, Predictor- Corrector and Hybrid methods), variable step-size multi-step methods, error and stability analysis. Shooting method for linear and nonlinear problems, Finite difference methods for linear and nonlinear problems.

Math-312: Differential Geometry (3 Credits)

This course helps students to study Introductory Concepts of Differential Geometry, Vector Algebra and Calculus of Vectors, Functions of class Cm; Regular and Implicit Representation of curves inR3; Tangents plane, normal Plane and Osculating Plane, Curvature and Torsion. Theory of Curves and Surfaces; The Fundamental Existence and Uniqueness Theorems, Involutes and Evaluates, Theory of Contact , Osculating Curves and surfaces , Coordinate patches , Simple surfaces and Topological Properties of Simple Surfaces. First and Second Fundamental Forms; Normal Curvature, Principal Curvature , Gaussian and Mean Curvature ; Rodriguez Formula and Conjugate Families of Curves. Gauss Weingarten Equations, Gauss Theorem and the Fundamental theorem of Surfaces ; Elementary manifolds , application of tensors in surface theory ; mapping of surfaces , Intrinsic Geometry , Geodesies and Gauss-Bonet Theorem.

Math-313: Applied Mathematics (3 Credits)

This course is designed to introduce the students with The Laplace Transform: Definition, existence and basic properties, Differentiation and integration, Inverse Laplace transform and convolution, Solution of linear differential equations with constant coefficients and linear systems. Bessel's Equations: Solution, Generating function, Recurrence relation, values of Bessel's function, Orthogonality, Neuman and Hankel function, Modified Bessel's function. Legendre's Equation: Solution, Generating function, Recurrence relation, Rodrigue's formula and Orthogonality of Legendre polynomials. Hermite's Equation: Solution, Integral and Recurrence formula, Orthogonality, Differential formula. Leguerre's Equation: Solution,

Integral and Recurrence formula, Differential forms, Orthogonality. Hypergeometric Equation: Solution, Hypergeometric function and its properties, Integral formula and transformations of hypergeometric functions. Fourier series: Fourier coefficients, sine and cosine series, Dirichlet's theorem, Properties and applications. Sturm-Lioville problem: Self adjoint differential equation, Characteristic values and characteristic function. Orthogonality; Green's function. Fourier transforms: Fourier sine and cosine transforms, Complex Fourier transform. convolution theorem, Applications to boundary value problem.

Math-314: Math Lab-V (1.5 Credits)

The course is designed for Problem solving in concurrent courses (Complex Analysis, Numerical Analysis, and Applied Mathematics, Linear Programming) using MATLAB, C and C++

Math-315: Viva-Voce (1 Credit)

Viva Voce on courses taught in the Third Year.

Math-401: Number Theory (4 Credits)

The purpose of this course is to provide with the number system, Euclidian algorithm, Diophantine equation, Congruence's and their solutions, Euler's function, The theorems of Fermat, Euler and Wilson. Primitive roots and indices, an application to Fermat's conjecture. Quadratic residues, Gaussian integers, Continued fractions, nonlinear congruence's, Elementary theory of the distribution of primes, The proof of the prime number theorem, Quadratic fields: Simple fields; Euclidian fields.

Math-402: Functional Analysis (4 Credits)

This course is designed to introduce the students with Normed Spaces (NS): Bounded and Continuous Linear Operators and Functional on Finite Dimensional Spaces, Normed Spaces of operators and Functional on Finite Dimensional Spaces, normed Spaces of Operators and Dual Spaces. Inner Product Spaces (IPS): Inner Product, Properties of IP, Hilbert Spaces, Orthonormal Sets and sequences, Representation of Functional on Hilbert Spaces, Self – Adjoint, Unitary and Normal Operators. Fundamental Theorem of NS and Banach Spaces, Axiom of Choice, Zorn's Lemma, Hahn – Banach Theorem, Application to Bounded Linear Functionals. Banach Fixed Point Theorem (BFPT) Application of BFPT to Linear Equations, Des and IEs.

Math-403: Fuzzy Mathematics (4 Credits)

This course is designed to introduce the students with Crisp sets and fuzzy sets, Operation of fuzzy sets, Fuzzy arithmetic, Fuzzy relation, Fuzzy Topology: Fuzzy point, Examples, Image and Pre-image of a Fuzzy set under a mapping, Fuzzy topological space, Base and sub-base of a Fuzzy topological space. Quasi-coincident, Q-neighborhood, Neighborhood of a Fuzzy point, Neighborhood germ, S-neighborhood. Accumulation point, Derived sets and their properties, Subspaces of a Fuzzy topological space, Relative Fuzzy topology, Fuzzy product spaces, Related Propositions and Examples.

Math-404: Fluid Mechanics (4 Credits)

The purpose of this course is to provide with Hydrostatics: Pressure heavy fluids, Equilibrium of fluids in given fields of forces, Centre of Pressure, Equilibrium and Stability of floating bodies.

Hydrodynamics: Introductory Notions; Velocity, Streamlines and path of the particles, Stream tubes and filaments, fluid body, Bernoulli's theorems, Flow in a converging pipe. Equation of motion, Differentiation with respect to time, the equation of Continuity (or the Conservation of mass), Equation of motion of inviscid fluid, boundary conditions (Kinematical and Physical), Conservative forces, energy equation, irrotational motion at Kelvin's circulation theorem. Two-dimensional motion; Motion in two-dimensions, Stream function, Pressure equation in terms of Stream function, Stagnation points and velocity potential. Streaming motion-complex potential, the circle theorem, Streaming motion past circular and elliptic cylinders, theorem of Blasius. Source and Sinks: Two-dimentioal Source and Sink, and their complex potentials, Combination of Sources and Streams, Source in uniform stream, doublet, Source and equal Sink in a stream, the method of images. Vorticity and Stoke's stream function and Bulter's Sphere Theorem with applications. Derivation of Navier-Stokes equations and their exact solutions.

Math-405: Mathematical Modeling in Finance and Business Management (4 Credits)

This course is designed to introduce the students with Mathematics for data processing: Binary number system, computations in binary system, Consumer Mathematics: Consumer loans, other Consumer computations. Marketing Mathematics, Mathematics for accounting. Mathematics for Finance: Simple and compound interest and discounts, Investments in stocks and bonds, Mathematics of real estates, Mathematics of insurance, elements of actuarial science. Mathematics of management: Analysis of statements, other business computations.

Math-406: Theory of Relativity (4 Credits)

Prerequisite: Math-212

This course develops the capability of the student with attempt to locate absolute frame, the speed of light relative to Eaeth, Aberation of star-light. Fresnel's co-efficient of ether-drag. Figeau's experiment. Inertial and non-inertial frame, validity of theory of relativity. Mechelson-Morleys experiment, Einsteins definition of simultaneity, the two postulates of Relativity, Lorentz's Transformation, Fitzgereldcontaction, Dilation of time, proper time interval, Minkowski's four dimensional world, transformulation of velocity and acceleration, force, variation of mass and energy, Four dimensional representation of velocity, momentum etc. Electromagnetic vectors as the component of tensor, Electromagnetic field tensor, Maxwell's equations for Electromagnetic field, in relativistic form, in four potential form, Lorentz's Transformation of the component of Electromagnetic field tensor, four vector current, Invariant of fields, Lorentz force, Energy momentum tensor, pointing vector and its physical interpretations. Principle of Covariance, principle of Equivalence, principle of Mech-Einsteins law of gravitational potentials, properties of Metric tensor. Derivation Einstein's equations, Curvature tensor, Discussion of Schwarzschild, spherically symmetric, cylindrical symmetric and Robertson-Walker line element, Lie dervatives and killing vectors.

Math-407: Graph Theory (4 Credits)

This course is designed to introduce the students with Graphs: simple graphs, digraphs, subgraphs, vertex-degrees, walks, paths and cycles; Trees, spanning trees in graphs, Bipartite Graph, Visibility Graph, distance in graphs; Complementary graphs, cut-vertices, bridges and blocks, k-connected graphs; Euler tours, Hamiltonian cycles, Chinese Postman Problem, Traveling Salesman Problem; Chromatic number, chromatic polynomials, chromatic index, Vizing's theorem, planar graphs, planar drawing, drawing aesthetics, orthogonal drawing, perfect graphs.

Math-408: Difference Equation (4 Credits)

The purpose of this course is to provide with review of calculus of differences. Difference equations: Basic terminology, definition and simple examples, formation of difference equation, discrete analogy to differential equations, order and degree of a difference equation. Homogeneous linear difference equations (constant co-efficient equations and their solutions, linear dependence and independence, initial value and boundary value problems, reduction and order Euler equations, generating functions, Eigen value problem). Inhomogeneous linear difference equations (operator methods, variation of parameters, reduction of order, method of undetermined coefficient). Linear difference equations with variable coefficients and their solutions. Simple nonlinear difference equations; pseudo nonlinear equations, Z- transform and its use in solving difference equations. Differential difference equations. Extension of difference equation to function of a continuous variable partial difference equations. Modeling with difference equations. Simple applications, (application to vibrating systems, electrical networks, beams, collisions, probability, the Fibonacci numbers, integration, geometry, determinant, power series isolations, investigation of special functions, biology). Commercial applications (simple interest, compound interest, annuities). Application to chaos, Julia sets and the Mandelbrot set.

Math-409: Mathematical Modeling in Economics (4 Credits)

This course develops the capability of the student with Introduction: Role of Mathematics in Economics, Mathematical versus Nonmathematical Economics, Mathematical Economics versus Economics, Importance and Ingredients of Economic Models, Diagrammatic representations of function of one and two variables, Production functions, Isoquants, Utility functions, Utility surface, Iso-utility curve. Equilibrium analysis in Economics: Partial Market Equilibrium- A linear and nonlinear model, General market equilibrium, Equilibrium in national income analysis. Application of Differential Calculus, Application of Integral Calculus, Application of Matrix Algebra, Optimal Control Theory.

Math-410: Project/Term Paper (1 Credit)

Each student is required to work on a project and present a project report for evaluation. Such project should be extension for applications of materials included indifferent honours courses and may involve field work and use of technology. There may be group projects as well as individual projects.

Math-411: Viva-Voce (2 Credits)

Viva Voce on courses taught in the Four Years.

Math-412: Mathematical Astronomy (4 Credits)

This course is designed to introduce the students with elements of spherical trigonometry: cosine, sine and cotangent formulas, Celestial sphere and celestial coordinates Transformation of celestial coordinates, Refraction, planetary motion, Time, seasons, Parallax, aberration, Precession and nutation, Eclipses, The solar system.

Math-413: Operation Research (4 Credits)

Prerequisite: Math-308

The purpose of this course is to provide with Simplex: Big-M method. Game Theory(Basic Concept): Theory of two-person zero-sum game and their methods of solution, Two person non-zero sum games, Graphical solution of game problems, Solution Concepts in non-zero sum games, Dominance and its use to solve game problems. Connections between game theory and linear programming problems. Degeneracy in linear programming. Minimal cost network flows: The Minimal cost network flow problem, some basic definitions and terminology from graph theory, Properties of a matrix, Representation of a Non basic Vector in terms of the basic Vectors, The Simplex method for network flow problems, An example of the network Simplex method, Finding an initial BFS. Network flows with lower and upper bounds, The Simplex tableau associated with a network flow problem, Degeneracy, cycling and stalling, generalized network problems. Nonlinear programming: Lagrange multipliers method: necessary and sufficient conditions Quadratic programming problem: Beale's QPP Algorithm, Wolfe's modified Simplex method. K-T condition, Queuing Models.

Math-414: Integral Equations (4 Credits)

This course is designed to introduce the students with introduction of integral equations, Abel's problem, types of IEs, differentiation under an integralsign, relation between differential and integral equations. Solution of VIEs of the first and second kinds.Solution of FIEs of the first and second kinds. Fredholm's first, second and third fundamental theorems. Fundamental function, IEs with degenerate kernels, eigenvalues and eigen functions. Symmetric kernel, orthogonal and normalized systems, Schmidts solution of nonhomogeneous IEs, Hilbert Schmidt theorem. Green's function, construction of Green's function, Influence function, IE and Green's function for BVPs. Singular integral equations, Abel IE, cauchyprinciplal integral, Poincare Bertrand formula, Hilbert kernel and Hilbert formula. Solution of Hilbert type IEs of the first and second kinds.

Math-415: Rings and Modules (4 Credits)

Prerequisite: Math-304

The purpose of this course is to provide with Rings: Rings, integral domains, ideal and quotient rings, field and imbedding theorem. Homomorphism and isomorphism theorems of rings, polynomial rings. Euclidean rings, Principal ideal rings. Noetherian rings: Hilbert basis theorems. Wedder-bum's commutativity theorem. Artinian rings: Radicals, semi simple rings, Simple rings, wedderbum's structure theorem.

Modules: Modules, submodules, factor modules, module homomorphism's. Exact and short exact sequences. Cartesian products, direct sums free modules. Projective and injective modules. Hom (A, B) and its properties. Tensor product, adjoint associativity Diagram lemmas. Torsion product of abelian groups.

Math-416: Mathematical Cosmology (4 Credits)

Prerequisite: Math-212

This course is designed to introduce the students with Large Scale Structure of the Universe: Astronomy and Cosmology, Hubble's Law, The Background Radiation, Relativistic Cosmology, Structural hierarchy. General Relativity: Covariant Differentiation, Riemannian Geometry, Space-Time Curvature, Geodesics, The Principle of equivalence, Action Principle and the Energy tensor, Gravitational equations, The Schwarzschild solution. From Relativity to Cosmology: Historical background, The Einstein Universe, The Expanding Universe, Modifying assumptions of Cosmology, The Redshifts, The Luminosity of Distance, Angular size. The Friedmann models: The Robertson-walker Metric and Einstein's equation. Derivation of the Robertson-walker Metric.Energy terms. The solution of Friedmann equations. Cosmological constant. The Space-time Singularity. Hubble Constant and Deceleration Parameter: Measurement of , Measurement of , Exact solution for zero pressure, Solution of pure radiation, Behavior near zero. The Steady State Theory: Motivation for a Non big-bang Cosmology. The perfect Cosmological Principle, The Creation field, Observational parameters of Steady State Theory, Physical and Astrophysical consideration. History of the Universe: Matter Vs. Radiation Dominant Universe, The Hot Universe, The very Early Universe, Early Universe inflation and Higgs Field.

Math-417: Quantum Mechanics (4 Credits)

The purpose of this course is to provide with Black body radiation: Plank's radiation law, Einstein photon theory, Compton Effect. De Broglie wave: Phase and group velocities. Wave packets. Uncertainty Principle. Rutherford atom model: Alpha particle scattering, Bohr's theory; Correspondence principle. Wave mechanical concepts: Schrodinger wave equation, interpretation of wave function, Normalization of, Probability of Current density, expectation value and Ehrenfest's Theorem. Eigen functions, Potential steps, linear harmonic oscillator, spherically symmetric potentials, interpretative postulates and energy Eigen functions. Momentum eigen functions, Box normalization, Dirac delta function, motion of a free wave packet; minimum uncertainty product and form of minimum packet. Linear harmonic oscillator, Spherically potentials in three dimensions, angular momentum. Hydrogen atom, Perturbation Theory, Theory of Scattering.

Math-418: Computational Mathematics (4 Credits)

This course is designed to introduce the students with solving mathematical problems by computer simulation as opposed to analytic methods of applied mathematics. Numerical methods used in scientific computation, for example-Numerical linear algebra and numerical solution of partial differential equation. Error analysis: Errors and propagation of errors, process graph. Computational complexity of algorithms; algorithms and their efficiency; searching algorithms, sorting algorithms, and their computational complexities. Algorithms on integer operations. Recursive algorithms. Summation and recursion; different techniques of summation. Simulation: Monte Carlo simulation, evaluation of multi-dimensional integrals. Percolation theory: Introduction to percolation theory.

Math-419: Mathematical Modeling in Biology (4 Credits)

This course develops the capability of the student with continuous population models for single species: Simple models, Continuous growth models, Mahhusian models, logistic models, delay models, harvesting models, Continuous Models for Interacting population: Two species population models, Prey-predator models, Lotka-Volterra models, multi-spaces population models, war models, competition models mutualism, Discrete population models: Simple discrete models, Malthuzian discrete models, logistic discrete models, Stability, discrete delay models, discrete growth models for interacting populations, Fishery management models. Epidemic Models and Dynamics of Inflectious Diseases: Simple epidemic models and some practical applications (HIV/AIDS models, etc.), control of epidemic model.

Math-420: Group Theory (4 Credits)

Prerequisite: Math-304

This course is designed to introduce the students with definition and properties of groupiods, quasi-groups, semi groups, monoids; and groups. The symmetric and alternating groups, permutation groups, cyclic groups, Lagrange's theorem. Normal subgroups, homomorphism, isomorphism and their theorems. Direct product of groups, the centralizer and the normalizer of subset of a group, the Centre of a group . The commutator subgroups, solvable groups, normal, subnormal and composition series, Jordan-Holder theorem, Schreier's theorem, nilpotent groups. Conjugacy classes, p-group's theorem. Sylow subgroups and sylow theorems, free groups. Structure theory of finite abelian groups. Group representations. Group extensions.