Course Outline

MTH 101: ELEMENTARY MATHEMATICS I

Number systems: indices, surds and logarithms, polynomials, remainder and factor theorems, inequalities, mathematical induction, permutations and combinations, Binomial theorem, Sequences and series: Quadratic equation and functions: relation between the roots and the coefficients. Complex numbers: addition, subtraction, multiplication and division, Argand diagrams, De-Moivre's theorem, n-th roots of complex numbers. Elementary set theory: Venn diagrams and applications of De-Morgan's laws. Trigonometry: Elementary properties of basic trigonometric functions, Addiction formulae and basic identities, sine and cosine formulae, Half angle formulae, Area of a triangle, solution of trigonometric equations, Inverse trigonometric functions. Functions: concepts and notations, examples, composition, exponential and logarithmic functions. graphs and properties, Limits and continuity, techniques for finding limits. The derivative: calculations from first principles, techniques of differentiation, chain rule, higher order derivatives, extreme problems, mean value theorem, applications, indeterminate forms and L'Hopital's rule, Taylors and Maclaurin's series, Curve sketching. Integration**:** as the inverse of differentiation, types of integration, as area, as limit of finite sums, applications**.**

MTH 102 ELEMENTARY MATHEMATICS II

Transcendental functions. Hyperbolic functions inverse function, logarithmic differentiation integration by substitution, integration by parts. Improper integrals applications. Areas and volumes. Centre of mass, ordinary differential equations. First order linear equations. Second order homogenous equations with constant coefficients. Applications. Plane analytic geometry rectangular Cartesian coordinates. Distance between two points straight line. Loci. The circle, parabola, ellipse and hyperbola. Second degree curves plane polar co-ordinates. Vectors: Vector addition and multiplications, products of three or more vectors, vector functions and their derivatives. Velocity and acceleration. Matrix algebra: Addition and multiplications. transpose, determinants, inverse of non-singular matrices, Cramer's rule and application to the solution of linear equations. (Example should be limited to mxn matrices where m =3, n=3). Transformations of the plane: translation, refection, rotation, enlargement, shear, composition of transformations. Invariant points and lines.

MTH 201 MATHEMATICAL METHODS 1

Functions of two or more variables. Limits and Continuity, Partial Derivatives, Directional Derivatives, Tangent plane and Normal line. Gradient, Chain rule, Total differential, Implicit functions, Jacobians, Inverse functions, Maxima and Minima,

Lagrange multipliers, Higher order derivatives, the Laplacian, Second derivative test for maxima and minima, Exact differentials. Derivatives of integrals, Taylor's theorem, Multiple integrals, Calculations of areas, volumes, centres of mass, moments of inertia etc. Infinite sequences and series, Absolute and conditional convergence, Power series .

MTH 202: MATHEMATICAL METHODS II

Vectors, Products of vectors, Equations of lines and planes, Vector spaces, Linear dependence and independence, Basis and dimension, Linear transformation, Matrices: Inverse of a matrix, determinants, Operations on matrices, Rank of a matrix, Cramer's rule, Eigenvalues and eigenvectors, Similarities to diagonal matrices.

MTH 203: ELEMENTARY DIFFERENTIAL EQUATIONS I

Derivation of equations from Physics, Chemistry, Biology, Geometry etc. First order equations. Second order equations, Applications of first order equations. Second order linear equations, Fundamental solutions, Linear dependence and independence, Wronskian, properties, solutions of linear equations, Method of undetermined coefficients and Variation of parameters, Applications of second order linear equations, General theory of n-th order linear equations, Laplace transform, Convolution, Solution of initial-value problems by Laplace transform method, Difference equations.

MTH 204: ELEMENTARY DIFFERENTIAL EQUATIONS II

Series solutions about ordinary and regular singular points, Bessel, Legendre and hypergeomeric equations and functions, Gamma and Beta functions, Sturm- Liouville problems, Orthogonal polynomials and functions, expansion in series of orthogonal functions, Fourier, Fourier-Bessel and Fourier- Legendre series, Fourier transformation, Solution of Laplace, Wave and heat equations by Fourier method.

MTH 222: NUMERICAL METHODS

Solution of algebraic and transcendental equations, Curve fitting, Lagrange and Aithens interpolating polynomials, Errors, difference calculus, Newton forward and backward difference formulae, Approximation of functions, Numerical differentiation and Integration, Numerical solution of systems of linear equations, numerical methods for differential equations.

MTH 301: ABSTRACT ALGEBRA I

Sets, Operations on set, Relations and equivalence relations, Mappings, Finite and infinite sets, The axiom of choice, Natural numbers and integers, Divisibility and primes, Congruencies, The Theorems of Euler/ Fermat, Linear congruencies, the Chinese Remainder Theorem, Solutions of simultaneous linear congruencies, Groups, subgroups, cyclic groups, Cosets and Lagrange's theorem, Normal subgroups and

factor groups, Homeomorphisms and the Isomorphism theorems, Direct products of groups.

MTH 302: ABSTRACT ALGEBRA II

Rings: integral domains, Fields, Characteristic of a ring, Subrings, Ideals and Quotient rings Homomorphism of rings, Polynomial rings , Factorization of polynomials over a field, Polynomial rings, Modulo, Prime and maximal ideals, Extension fields, Automophisms of fields, Splitting fields, Linear transformations, Bilinear and quadratic forms.

MTH 303: REAL ANALYSIS I

Sets, Functions, Mathematical induction, Properties of real numbers, Cauchy convergence criterion, Tests for convergence, Limits and continuity of functions, Uniform continuity of functions, Uniform continuity and approximations, The derivatives, Mean Value Theorem (MVT), L' Hopital's rule, Taylor's theorem, Convex functions, Applications.

MTH304: REAL ANALYSIS II

The Riemann integral, Fundamental theorem of calculus, Improper Integrals, Riemann-Satieties integral, Sequences and series of functions, Point wise and uniform convergence, Functions of several variables, Limits and continuity, The derivative in R^n, Chain rule, Higher order derivatives, Extremism problems. Integrations of functions of several variables.

MTH 305: FUNCTIONS OF COMPLEX VARIABLES WITH APPLICATIONS I

Complex numbers, Powers and roots, Functions of a complex variable, Limits, continuity, Derivatives, The Cauchy-Riemann equations, Elementary functions, Mappings by elementary functions, Integrals, Cauchy Theorems, Taylor and Laurent series, Poles, Residues and Residue Theorem, Applications, Inversion of Laplace transformation.

MTH 306: FUNCTIONS OF COMPLEX VARIABLES WITH APPLICATIONS II

Review of Residue Theorem and applications to integrals and series, Entire and meromorphic functions, Zeros and poles, Argument principles, Rouche's theorem, Infinite products, Maximum modules theorem, Analytic continuation, Riemann surfaces, Conformal transformations, The Riemann mapping theorem, Schwarz-Christoffel transformations, Applications to electrostatics, Heat conduction and Fluid mechanics.

MTH 307: METRIC SPACE TOPOLOGY

Sets, Metrics and examples, Open spheres or balls, Open sets and neighborhoods, Closed sets, Interior, Exterior, Frontier, Limit points and closure of a set, Dense subsets and separable space, Convergence in metric space, Homeomorphism, Completeness, Continuity, Compactness and connectedness in Metric Spaces, Contraction Mapping Principle.

MTH 309: DIFFERENTIAL GEOMETRY

Vector functions of real variable, Curves, Fresnet formulae, Natural equation, Isoperimetric, Vector functions of vector variables, Local surfaces, Fundamental form, Levi-Civita parallelism, Normal curvature, Gaussian curvature, Minimal surfaces, Geodesics, Isometrics, Global surfaces, Gauss-Bonnet Theorem, Shortest connecting curves, Convex surfaces.

MTH 322: VECTOR AND TENSOR ANALYSIS

Scalar fields and vector fields, Derivatives of a vector, Tangent vector, Curvature, Torsion, The divergence and curl of vector fields, Combined operations, Line integrals, Green's theorem, Surface integrals, Gauss' and Stoke's theorems, Integrals independent of path, Applications, Vector spaces, Basis and reciprocal basis, Co-variant and contra-variant components of vector, Tensor algebra, Contraction of indices, Symmetry, Principal axes and invariants, Covariant differentiation, Christoffel symbols, Ricci theorem. Riemann-Christoffell tensor. Ricci tensor. Differential operators in generalized co-ordinates, Integral theorems related to Gauss's and Stoke's theorems.

MTH 401: MEASURE THEORY AND INTEGRATION

Measurable sets, Measurable functions, Measures, Measure spaces, The integral, Monotone convergence theorem. Fatou's lemma. Integrable functions, Lebesgue Dominated Convergence Theorem. Lebesque space, L^p, Completeness, Modes of convergence, Decomposition of measures, Generation of measures, Product measures.

MTH 403: TOPOLOGY I

Set theory, metric spaces. Topologies. Derived topological spaces, Continuity, Homeomorphisms, Separation axioms, Convergence, Covering properties, Compactness, Connectedness, Metrizability, Complete metric spaces, Baire's category theorem.

MTH 405: ABSTRACT ALGEBRA III

Introduction to Galois Theory, Finitely generated Abelian groups, Series of groups, Sylow's Theorems and applications, Free groups, Group presentations, Simplified complexes, Homology groups, Homological algebra, Splitting fields, Elements of Galois theory.

MTH 421: NUMERICAL ANALYSIS I

Numerical Differentiation, Numerical Integration; Trapeziodal and Simpson's rules, Newton-cotes integration formulae, Gaussian quadrature, Romberg integration, Weekly singular integrals, Numerical solution of differential Equations, The multi-step mid-point and trapezoidal methods, higher Single-step methods, Convergences and stability, Systems of Linear Equations, Gauss's elimination method, Matrix inversion, Gauss's-Seidel iteration method.

MTH 423: PARTIAL DIFFERENTIAL EQUATIONS

Theory and applications of firs-order equations, Series solutions, Cauchy-Kovalevsky theorem, Second order linear equations, Classifications, Characteristics, Canonical forms, Cauchy problem, Laplace's equation, Greens function, Boundary-value problems, Poisson's Formula Properties of harmonic functions, The wave equation, D'Alembert solution, Domain of dependence and range of influence. Vibrating string and membrane, Heat equation, Initial-value and boundary-value problems.

MTH 431: OPERATIONS RESEARCH AND OPTMIZATION I

Classical methods of optimization. Linear programming. Convex set and functions, simplex and Revised simplex methods, Duality theory and applications. Game theory. Two persons' zero-sum games. Saddle point. Dominance strategies. Applications

Decision Theory: Decision under risk and decision under uncertainty Elementary inventory models, case studies.

MTH 441: CONTINUUM MECHANICS

Review of tensor algebra and analysis. Notion of a continuum. forces in a continuum. Stress, Strain and deformation. Material derivative. Rate of deformation tensor. Finite strain and deformation. Eulerian and Lagragain formulations, General Principles. Constitutive equations. Material frame inference, ideals fluids, Riener-Revlin fluids, Elasticity, Visco-elasticity and Plasticity.

MTH 501: FUNCTIONAL ANALYSIS I

Linear spaces, Normed Linear spaces, Banach spaces, Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Linear operators and functionals, Inner product spaces, Hilbert spaces, Orthonormal sets, Riesz Representation Theorem, Self-adjoint, Unitary and Normal operators, Projections, Applications.

MTHE 502: MATHEMATICAL MODELING

Transformation of real life situations into mathematics statements, Simplifications, Analysis, Interpretation and Evaluation of mathematical models, Optimization, Applications in Chemistry Biology, Commerce, Industry and etc. Case studies.

MTH 504: APPLIED MODERN ALGEBRA

Binary relations and Graphs. Finite State Machines, Programming languages. Lattices and Boolean Algebras. Applications to switching circuits and computer design. Directed and undirected graphs, cycles, connectivity. Flow charts and state transition graphs., Optimal paths in graphs binary group codes. Polynomial rings and group codes. Elementary group representation theory by matrices and permutation groups, Recurrent sequences, Radar communications systems, Difference codes autocorrelation, Computability.

MTH 510: FUNCTIONAL ANALYSIS II

Topological linear spaces, locally convex spaces, Metrizale Topological Linear spaces, Functional and weak Topologies, Krein-Milman Theorem, Spactral Analysis, Linear Operators, Spectral Analysis in Hilbert space, Banach Algebras.

MTH 521: ORDINARY DIFFERENTIAL EQUATIONS

Existence uniqueness of solution, Continuation of solutions, Dependence on initial data and parameters, linear homogenous and non-homogenous systems, Oscillation instability theorems, Absolute stability, Routh-Hurwitz conditions for stability.

MTH 522: NUMERICAL ANALYSIS II

Finite difference methods for the solution of two dimensional problems, Partial differential operators, double interpolation and integration, Integration of elliptic, parabolic and hyperbolic equations, The finite element methods, Variational principles, Method of approximation, Basic functions, Convergence of approximation, Time – dependent problems, Applications.

MTH 524: PARTIAL DIFFERNTIA EQUATIONS II

Systems of first –order equation, Riemann method for linear hyperbolic equations, Wave equation in n-dimensional space, Methods of spherical means and descent, Duhamel's principle and general Cauchy problem, Initial–boundary–value problems, Higher order hyperbolic equations with constant coefficients, Solution by Fourier transformation, Elliptic equations, Fundamental solutions, Maximum principle, The Dirichlet problem, Higher order elliptic equations, Parabolic equations, Maximum principle uniqueness and regularity, Initial value problems for general second order linear parabolic equations.

MTH 525: METHOD OF APPLIED MATHEMATICS

Integral equations with separable kernel, Method of successive approximations, Fredholm alternative symmetric kernels, Neumann series, Basic existence theorems, Integral equations with L_2 kernels, Applications, Problems of calculus of variations, Direct methods of solution, Euler's equations, Boundary conditions, The second variation and the Legendre condition, Variation problems with subsidiary conditions,

Transformation of variation problems to canonical and involuntary forms, Variation calculus and equations of Mathematical Physics, Applications.

MTH 526: CONTROL THEORY

System dynamics and differential equations, Transfer functions and block diagrams, State space formulation, Transient and steady state response analysis, Stability, Controllability and Observability, Multivariable's feedback and Pole location, Introduction to optimal control, variational calculus, Optimal control with unbounded continuous controls, Bang-bang control, Application of optimal controls.

MTH 531: OPERATION RESEARCH AND OPTIMIZATION

The Theory of the Simplex method, Duality Theory and Sensitivity Analysis, Other Algorithms for Linear Programming, The Transportation and Assignment Problems, Network Analysis including PART – CPM, Dynamic Programming, Game Theory, Inter Programming: Markov Chains, Non Linear Programming, Queuing Theory, Inventory Theory, Forecasting, Markov Decision Processes, Decision Analysis, Simulation.

MTH 532: MATHEMATICAL METHODS IN ECONOMICS AND FINANCE

Optimal control, Convex analysis functions, Stabilization of economics, Location theory, Optimal steady state of an economy with stochastic production and resources, Net present value, Internal rate of return on investment, Capital market theory, Measure of risk and uncertainty applied to investments, Decision making.

MTH 542: FLUID MECHANICS

Kinematics of fluids in motion; Equation of continuity, Reynolds' Transport Theorem mechanics of fluids motion, Boundary conditions, Euler's equation of motion of an ideal fluid, Bernoulli's Equation, Kelvins circulation theorem, Vorticity equation, potential flow, sources, sinks and Doublets images, Two –dimensional flow, stream functions, complex potential Miline-Thomson circle theorem, Blasius' Theorem, Conformal Transformation and Applications Waves.