Bangladesh University of Engineering and Technology, Dhaka

Department of Mathematics

Syllabus of Postgraduate degree

For the Department of Mathematics

Math 6101 (Special function and integral transforms-I)
3.00 Credit Hours

Gamma and Beta Functions: Properties of Gamma function, Continuity and convergence of gamma and beta functions, integral form of Γn . Asymptotic representation of Gamma function for Large $|n|$.

Elliptic Integral and Elliptic Functions: Reduction of elliptic integrals to standard form, properties of elliptic function addition formulae, periods of elliptic function.

The probability integral and related functions; application to the theory of heat conduction and to the theory of vibration. Generating function of the Hermite and Laguerre polynomials, recurrence relations, the differential equation and the integral equation satisfied by the polynomials. Integral representations, orthogonality and Laguerre polynomials Hypergoemetric functions its linear and quadratic transformations. The confluent hypergeometric function, its integral and asymptotic representation. Representation of various functions in terms of hypergeometric and the confluient hypergeometric functions. Hermite functions. Matheus functions and the Dirac Delta functions. The Minkowski Temple. Theory of generalized function. Schwartz's theory of distribution.

Math 6102 (Special function and integral transforms-II)
3.00 Credit Hours

Green's function and its applications. Fourier integral theorem and Fourier transforms. Multiple fourier transforms. Fourier transforms of radially symmetric functions. The solutions of integral equations of convolution type. Use of Fourier transforms in solving Laplace's equation, diffusion equations and wave equations. The double Laplace transform, the interated Laplace transform, the Stieltjes transform and the Hankel transform. The Perseval relation for Hankel transform and the relation between Fourier and Hankel transforms. Use of Hankel transforms in solving partial differential equations.

Math 6103: Advanced Modern Algebra

3.00 Credit Hours

Rings, fields, polynomials, homomorphisms, ideals, quotient rings. Ring extensions, field extensions, construction of finite fields. Integral domains, euclidean rings, polynomial rings, principal ideal domains and unique factorization domains. Chain conditions. Modules, submodules, finitely generated modules, direct sums, quotient modules and isomorphism theorems. Torsion, bases and free modules, free modules over polynomial rings. Invariant factors, structure of finitely generated modules.

Math 6104: Rings and Modules

3.00 Credit Hours

Artinian and Noetherian modules. Categories and functors, exactness of functors between module categories. Injective and projective modules. Semisimple modules and rings. Radical and socle. The tensor product, flat modules and regular rings. The ring of fractions, orders in a semisimple ring, modules of fractions. Application of rings and modules to abelian groups, to vector spaces with a linear transformation, to languages, grammars, machines, coding theory, etc.

Math 6105: Numerical Linear Algebra

3.00 Credit Hours

Summary of basic concepts from linear algebra and numerical implementation. Cholesky factorization. QR decomposition by Householder matrices and by given rotations. LU factorization and partial pivoting. Error analysis. Solving triangular systems and full systems. LU factorization for banded and sparse matrices. Storage schemes. SOR iterations. Krylov subspace methods and conjugate gradient method. Preconditioning. Basic theory using singular value decomposition (SVD). Perturbation theory. SVD and rank deficiency. Basic theory including perturbation results. Power method, inverse iteration. Similarity reduction. Solving nonlinear system of equations by finite-difference and modified Newton methods. Symmetric QR algorithm. Interpretation as a matrix factorization. Application to solving circulant systems. p-adic numbers, ring of p-adic integers, field of p-adic numbers, field of fractions of p-adic numbers, p-adic topology, cyclomatic field, Local field, Tate module. Solution of Diophantine equations. Mahler-Lech theorem. Valuation theory and Staudt-Clausen theorem. Local-global principle.

Math 6201 (Fluid Dynamics - I)
3.00 Credit Hours

Eulerian and Lagrangian method of description of fluid; Analytic approach of deformations; Derivation of equations of conservation of mass. Momentum and energy. Basic equations in different coordinate system, boundary conditions. Irrotational and rotational flows. Bernoulli's equation and some applications. Two dimensional irrotational incompressible flows with circulation;

sources and sinks; Vortex motion. Combination of basic flows, mapping of flows in complex coordinates. Aerofoil theory, Schwartz-Christorel theory, Navier-Stokes' equations. Gravity waves, One dimensional compressible flows sound waves, Shock waves; Two dimensional irrotational flows. Hypersonic flows; Viscous compressible fluid flows. Incompressible fluid flow between two parallel plates; flow through a circular pipe and annulus. Flow between a plane and a cone; Flow through convergent and divergent channel flow in the vicinity of a stagnation point; Unsteady flows.

Math 6202 (Fluid Dynamics - II)
3.00 Credit Hours

Small Raynold's number flows; flows over a sphere; flow over a cylinder through porous media Lubrication theory. Boundary layer theory; properties of Navier-Stokes equations; two dimensional boundary equations; displacement, momentum and energy thickness for two dimensional flows. Von Mises transformation. Similarity solutions of boundary layer equations. Boundary layer flow over a flat plate, boundary layer flow with pressure gradient; Approximate solutions of boundary layer equations, including Von-karman's method. Stability theory; Basic concepts of stability theory; Stability of Quett's flow; Stability of low between two parallel plates Rayleigh. Taylor instability; Kelvin-Helmholtz instability.

Turbulence: Reynolds stresses and basic equation for turbulent flows; Prandtl mixing length theory; some simple turbulent flows; homogeneous turbulence; spectral theory of homogeneous turbulence. Non Newtonian fluid flows; Riener-Rivlin fluids; power law fluids; flows in ells fluids; flow in Binghan plastics Visco-Elastic flows general visco elastic fluid flows.

Math 6203: Computational Fluid Dynamics and Heat Transfer-I

3.00 Credit Hours

Introduction to computational Fluid Dynamics (CFD) and Heat Transfer, Basics of the methods used in CFD and Heat Transfer, Conversion equations (mass, momentum, energy and chemical species), Finite difference and Finite Volume Methods, Grid Generation, space and time discretization schemes, Tri-diagonal Matrix Algorithm (TDMA), Data Analysis, Data Fusion and Post Processing, The Role of Experimental data in CFD and Heat Transfer.

Math 6204: Computational Fluid Dynamics and Heat Transfer-II

3.00 Credit Hours

Review on the physical properties of fluid flow and heat transfer, Coupling of flow and heat transfer; computational methods for coupled equations with appropriate boundary conditions. Conjugate heat transfer and combination of different modes of heat transfer, i.e., conduction, convection and radiation. Correlations for natural, forced and mixed convection governing equations, dimensionless parameters, optical thickness for radiative heat transfer, black- and gray-body radiation, different models for radiative heat transfer, Computation of coupled flow and heat transfer equations using Finite difference methods, Mesh generation. Triangular tetrahedral and brick meshing, Galerkin Weighted Residual method.

Math 6205: Finite Element Analysis on Heat and Mass Transfer

3.00 Credit Hours

Overview of finite element method, Discretization of a domain, the concept of element, various element shapes. Weak form formulation: Weighted Residuals, Galerkin method. Heat functions, Generalized matrix form of the Finite element equations, Shape functions, Integration, 2-D numerical integration, Different types of heat transfer, Overall heat transfer, Different types of mass transfer, Mass transfer theories. Overall mass transfer, Heat conduction and mass diffusion, Heat sources, Convective heat and mass transfer, Finite element formulation of the convection-diffusion equation, Computer implementation, Numerical solution of finite element equations, One dimensional and two-dimensional problems, Basic equations of fluid mechanics, Computational modelling, FEM for heat and mass transfer problems.

Math 6206: Mathematical Hydrology

3.00 Credit Hours

Hydrologic model system. Hydrologic model classification. Development of hydrology. Continuity equation. Discrete time continuity, Momentum equation. Open channel flow, Porous medium flow, Water balances. Precipitation. Evaporation and transpiration. Infiltration and soil moisture, Green-Ampt method. Hydrologic cycle, Groundwater in hydrologic cycle. Rainfall runoff relations: Sources of stream flow, Excess rainfall and Direct runoff. Abstraction using infiltration equation, SCS method for abstraction, Index method. Traveltime, Streamflow hydrographs, Unit hydrograph methods and their applications, Synthetic and instantaneous unit hydrographs and their applications. Flood routing: Basic equations, Reservoir flood routing, River flood routing, Lumped flow routing, Distributed flow routing. Frequency analysis: Rational method, Empirical formulae, Return period. Extreme value distributions, Frequency analysis using frequency factors. Linear channels. Conceptual and Mathematical Models: (i) Nash model, (ii) Time-area method (iii) Clark's model (iv) Dooge’s model, (v) Chow and Kulandaiswamy model, (vi) Muskingum model. Hydrodynamic Models: (i) Saint-Venant Equations from Navier-Stokes’ equation, (ii) Kinematic wave models, (iii) Diffusion wave models, (iv) Steady dynamic wave models, (v) Dynamic wave models. (vi) Gravity wave models. Flood Forecasting.

Math 6207: Thermodynamics and Statistical Mechanics

3.00 Credit Hours

Equations of State. Work, Coefficients of expansion and compressibility. The first law of thermodynamics and its application. Changes of phase. The Second law of Thermodynamics, Efficiencies of reversible engines. The Clausius-Clapeyron equations, Stefan's law entropy, Combined applications of the first and second law. Kinetic theory of an ideal gas. The distributions of molecular velocities, Mean free path, Coefficient of viscosity. Thermal conductivity, Coefficient of diffusion. The Maxwell-Boltzamann Statistics. Quantum theory of specific heats. Elements of Fermi-Dirac statistics and Bose-Einstein statistics.

Math 6208: Electrodynamics

3.00 Credit Hours

Equation of continuity. Displacement current, The Maxwell's equations and their differential forms, Maxwell's equation in free space, Energy in electromagnetic fields. Poynting’s theorem. Electromagnetic waves in free space; Energy flow due to plane electromagnetic waves; plane electromagnetic waves in matter, isotropic dielectric, anisotropic dielectric, anti in conducting media; polarization of electromagnetic waves. Boundary conditions for the electromagnetic field vectors, S.E.D and H at the interface between two media; Reflection and refraction at the boundary of two non-conducting madia; General treatment of reflection and refraction-Fresnel's equations; Scattering by free electrons, Scattering by a bound electron. Electromagnetic potentials, Non-uniqueness of electromagnetic potentials and gauge transformation; Coulomb gauge, solution of inhomogeneous wave equations, Retarded and advanced potentials; solution of inhomogeneous wave equation by Fourier analysis. Electromagnetic potentials in uniform electric and magnetic fields.

Domains of magneto-hydrodynamics and plasma physics; Electrica1 neutrality in a plasma, Debye screening; Magneto-hydrodynamic equations, plasma oscillations and Alfeen waves.

Math 6301: Similarity Analysis
3.00 Credit Hours

Principle and illustrations of dimensional analysis, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, different procedures, (Rayleigh; Buckingham pie-theorem, stepwise, echelon, propertionalities etc.) for the determination of dimensionless groups and its behaviour for some boundary value problems; Method of similude and introduction to fractional analysis of overall equations, a free parameter method for similarity solution applied to two dimensional boundary layer flows, method of separation of variables, similarity requirements for three dimensional. Axisymmetric velocity and thermal boundary layer laminar flows (both steady and unsteady), group theory method, absorption of parameters and natural co-ordinates in similarity variables, reduction of independent variables, similarity and natural co-ordinates on linearised compressible flow, supersonic and transonic similarity rules. Karman similarity criteria for turbulent shear layers.

Math 6302: Perturbation and Approximation Theory
3.00 Credit Hours

The nature of perturbation theory, some regular perturbation problems, the technique of perturbation theory, some singular perturbation in sirofoil theory, the method of matched asymptotic expansion, the method of strained co-ordinates in viscous flow at high Roynolds number, some inviscid single perturbation problems, aspect of perturbation theory. New classes of information by approximation theory, classification of problems and difficulties in approximation theory, analysis of the condition for approximation theory.

Math 6401: Optimization Techniques - I

3.00 Credit Hours

Introduction. Classical methods with single and multivariables. Linear programming, Graphical method with mathematical definitions and theorems; Solution of a system of linear simultaneous equations, Pivotal reduction of a general system of equations simples method with theoretical development. Transportation problem. Non linear programming: One dimensional problems by elimination and interpolation methods; Unconstrained techniques, direct search and descent methods; constrained techniques and indirect methods.

Math 6402: Optimization Techniques - II
3.00 Credit Hours

Geometrical programming, Dynamic programming; Stochastic programming; Game theory; CPM and PERT; Calculus of variations.

Math 6403: Integer Programming

3.00 Credit Hours

Basics of Mathematical Programming. Valid Inequalities and Faces of Polyhedra. Dimension. Extreme Points. Facets. Minkowski's Theorem. Most IPs are Linear Programs. Equivalent Definitions of Integrality. Matchings and Integral Polyhedra. Total Unimodularity. Conditions for Total Unimodularity. Applications of Unimodularity. Network Flows. Matchings and Integral Polyhedra. Total Dual Integrality. Submodularity and Matroids. Encoding Schemes. Problems and Instances. The Classes P and NP. The Complexity of Integer Programming. Optimality and Relaxation, Combinatorial Relaxations. Lagrangian Relaxation.

Knapsack Problem. Problems on Trees. Branch and Bound Algorithm. Cutting-Plane Algorithms. Gomory's Cutting-Plane Algorithm. Mixed Integer Cuts. Structured Inequalities. Convexity and Subgradient Optimization. Subgradient Optimization for the Lagrangian Dual.

Math 6404: Logistics Management

3.00 Credit Hours

Introduction to Logistics Management. Logistics Network Configuration. Transportation Rates. Warehousing Cost. Capacity and Location Demand Forecast. Inventory Management and Risk Pooling. Distribution Strategies. Strategies Alliances. Global Issues. Coordination Product and Supply Chain Design. Vendor and Buyer System. Vendor-Managed Inventory. Coordination Policies. Firms Location Strategies and Choice Model.

Math 6501: Quantum Mechanics
3.00 Credit Hours

Old quantum theory and its background. Wave particle duality. Wave packets in space and time. The Schrodinger wave equation. Solution of Schrodinger wave equation (Bound states). The hydrogen atom. Separation of the wave equation in different coordinate system. The orbital angular momentum. Solution of Schrodinger wave equation (Collision theory): Scattering amplitude and differential cross section. Matrix formulation of Quantum Mechanics: Angular momentum matrices. Combination of angular momentum states, Clebsch-Gordan coefficients. Approximation methods: Stationary and time dependent perturbation theory. The variation method, The WKB approximation. Adiabatic and sudden approximation. The scattering matrix and Green's function technique. Symmetry properties of S-matrix. Transition matrix and scattering cross-section. The Born approximation method. Identical particles: Bosons and Fermions. Collision of identical particles.

Math 6502: Relativistic Quantum Mechanics
3.00 Credit Hours

Basics of special theory of relativity. Formulation of a relativistic quantum theory. Klein-Gordon equation. The Dirac equation. The spin of a Dirac particle. Lorentz transformation and Dirac equation. The Dirac bilinear covariants. Solutions of the Dirac equation for a free particle. Projection operators for energy and spin. Physical interpretation of free particle solutions. Interactions in Dirac theory: Hydrogen atom and fine structure of its energy levels. Dirac's hole theory and theory of positrons. Charge conjugation. Propagators for electron and positron. Some applications: Coulomb scattering of electrons. Coulomb scattering of positrons, Electron scattering from a Dirac proton.

Math 6503: Quantum Field Theory-I
3.00 Credit Hours

Canonical formalism and Quantization for fields. Symmetries and Conservation laws. The Klein-Gordon Field. Second Quantization of the electromagnatic field. The Feynman Propagator. Interaction with an external field. Symmetry properties of interactions. Symmetries of strange particles. Vacuum expectation values. The S-matrix and Asymptotic Theory. General properties of the S-matrix. Unitarity and partial wave decomposition. Causality and Analylicity. Perturbation theory. Interaction representation and Feynman Rules. Dispersion Relations.

Math 6504: Quantum Field Theory-II
3.00 Credit Hours

Regularization and Power counting. Renormalization. Massless theories and Weinberg's theorem. Renormalization in case of Quantum Electrodynamics. Path Intergrals. Trajectores in the

Bargmann - Fock space. Relativistic formulation. S-matrix and Green Functions in terms of Path Integrals. Constrained systems: The Electromagnetic Field as an example. Large orders in perturbation theory. Symmetries: Quantum Implementation of Symmetries. Mass spectrum, Multiplets and Goldstone Bosons. Current Algebra and Commutators. Axial Current and Chiral Symmetry. The σ-model and renormalizations. Anomalies: Axial anomaly in the σ-model. Classical theory of non-abelian Gauge fields. Quantization of Gauge Fields. Feynman Rules. Massive Gauge fields. The Weinberg-Salam Model.

Math 6601: Advanced Matrix Theory

3.00 Credit Hours

Matrix Operations: Direct sum of matrices, Kronecker product, Jordan product, Lie product, Khatri-Rao product, Vec operation and their properties. Canonical Forms and Matrix Factorization : Jordan canonical form, Smith's canonical form, Full rank factorization, Shur's Triangularization, LU factorization, QR Factorization, Spectral decomposition. Norms and Measures of Matrices.

Matrix calculus: Matrix sequence, series and their convergence. Computation of matrix function by different methods; limit, continuity, differentiation of matrices. Solving ODE using matrix.

Generalized inverse of matrices: Classification and properties. Different methods of computing generalized inverse of matrices: using property, Decell's method, Fedeev-Leverrier's method, Penrose method, Graybill-Meyer-Painter method, Drazin pseudoinverse, Moore-Penrose-Cline inverse, Urquhart computation of various inverses from {1} inverse.

Math 6602: Nonlinear Dynamical Systems

3.00 Credit Hours

Carleman Embedding Technique of linearization of ODE, PDE, Difference equation, Algebraic equation. Linearization in a Hilbert space (ODE and PDE). Applications: Bifurcation and Chaos; Symmetries and First integrals of ODE and PDE. Other linearization Techniques: Lie-Koopman linearization, Invertible Point Transformation, Painleve test, the method of turning variables.

Math 6701: Partial Differential Equations (PDEs)

3.00 Credit Hours

Classification of PDE (parabolic, elliptic, hyperbolic), Existence, uniqueness and represention of solutions for the PDE (wave equation & heat equation). Cauchy, Dirichlet and Neumann boundary-value problems for the Laplace and Poisson equation. Potential theory in two and higher dimensional domains, initial and boundary value problems of heat equation and wave equation, Maximum principle of parabolic equation; Sturm-Liouville systems, boundary and eigenvalue problems, method of eigenfunction expansions.

Math 6702: Advanced Numerical Methods-I

3.00 Credit Hours

Richardson extrapolation of differentiation, Romberg integration, Predictor-corrector methods, Runge-Kutta Methods, Multistep methods (Adam Bashforth-Moulton method, Adams method for initial value problem, Milne-Simpson method); Stability, time stability, stiffness. Hybrid (Gragg and Stetter, Butcher, Nordsieck) and extrapolation (Bulirsch and Stoer) methods for two point boundary value problem, Linear shooting, shooting for nonlinear problems, finite difference methods for linear and nonlinear problems. Systems of ODE, stiffness, A-stability, Gear's method. Finite difference methods for Elliptic, Parabolic & Hyperbolic PDEs.

Math 6703: Advanced Numerical Methods-II

3.0 Credit Hour

Pade′ Approximants. Algebraic and Differential Approximants. Approximate Solution of Linear Differential Equations. Approximate Solution of Nonlinear Differential Equations. Asymptotic Expansion of Integrals. Perturbation Series. Summation of Series. WKB Theory. Multiple Scale Analysis. Keller Box methods. MAPLE and MATLAB.

Math 6704: Numerical Heat Transfer and Fluid Flows
3.0 Credit Hour

Overview of the Numerical Methods and General Mathematical Framework. The Heat Transfer Equation, Numerical Scheme and its implementation, Grid and Control Volumes. Interface-Related Quantities, General Discretization Equation, Treatment of Boundary Conditions, Calculation of the Boundary Flux, Solution of the Discretization Equations, Nonlinearity and Underrelaxation, Relative Dependent Variable, Treatment of Irregular Geometries, Flow and Heat Transfer in Ducts, Developing and Fully Developed Duct Flows, Mathematical Formulation of the Velocity Field, The Governing Equation, Presentation of the Overall Flow Characteristics, Fully Developed Heat Transfer, Mathematical Formulation of the Temperature Field, Prescribed Local Heat Flux, Axially Uniform Heat Flow and Peripherally Uniform Wall Temperature, Axially and Peripherally Uniform Wall Temperature, Uniform External Heat Transfer Coefficient, Complex Boundary Conditions, Duct Flow Adaptations.

Math 6801: Graph Theory - I
3.00 Credit Hours

Graphs and Subgraphs: Graphs and Simple graphs, The Incidence and Adjacency Matrices, Subgraphs, Vertex degrees, Paths and Connection, Cycles. Trees and Forests: Connectivity : Complementary graphs, Cut-vertices and Bridges, Blocks. Construction of Reliable Communication Networks. Euler Tours and Hamilton Cycles : Euler Tours, Hamilton Cycles, The Chinese Postman Problem, The Travelling Saleman problem. Vertex Colourings: Chromatic number, Chromatic Polynomials, Brooks Theorem, A Storage Problem, Edge Colourings:Edge chromatic number, Vizing's theorem, The time tabling problem.

Math 6802: Graph Theory - II
3.00 Credit Hours

Matchings, Factorization and coverings: The personal assignment problem. Planar and nonplanar Graphs: Euler's formula, Dual graphs, Characterization of planar graphs, The Five colour theorem and the Four colour conjecture. NonHamiltonian planar graphs. Independent sets and Cliques: Independent sets, Ramsey's theorem, Turan's theorem, Schur's theorem. Perfect Graphs: Directed Graphs: Directed graphs, Directed paths and cycles, A job sequencing problem. Networks : Flows, Cuts, The Max-flow Min-cut theorem, Manger's theorem. Tournaments: Elementary properties of tournaments, Hamiltonian tournaments, Score sequences.

Math 6803: General and Algebraic Topology

3.00 Credit Hours

Review of basic of general topology. Regular, completely regular and normal spaces. The Urysohn lemma and the Tietze Extension theorem. Convergence in general topology. Nets and filters. Compact and locally compact spaces. The Tychonoff theorem. Paracompactness. Uniform spaces. Function spaces. Compact open topology. Stone-Weierstrass theorem. Homotopy theory. Fundamental groups. Simplicial homology. Degree and Lefschetz number. Euler-Poincare formula. Borsuk-Ulam theorem. Brouwer's fixed point theorem.

Math 6804: Lattice Theory
3.00 Credit Hours

Two definitions of lattices. Representation of finite poset by covering relations. Hasse diagrams. Homomorphisms. Isotone maps, ideals, convex sublattice, congruence relations. Congruence lattices. The homomorphism theorem. Product of lattices, complete lattices, ideal lattices. Distributive-modular inequalities and identities. Complements and pseudocomplements. Boolean lattices. Boolean lattice of pseudo-complements in a meet semilattice. Atoms, irreducibility of elements. Characterization theorem for modular and distributive lattices. Dedekind's characterization of modular lattices. Birkhoff's characterization of distributive lattices. Representation of distributive lattices. Stone theorem, Natchbin theorem and Hashimoto's theorem. Distributive lattices with pseudocomplementation. Stone lattice and its characterizations. Stone algebra and its characterization. Distributive, standard and neutral elements. Distributive, standard and neutral ideals. Structure theorems.

Math 6805: Fuzzy Mathematical Structures
3.00 Credit Hours

Constructing fuzzy sets, Operations of fuzzy sets, t-and s-norms, α-cuts, Extension principle, Measurement of fuzziness, Fuzzy relations, Fuzzy similarity, Fuzzy ordering, Pattern classification based on fuzzy relations. Fuzzy relational equations. Representation theorems. Interval analysis, Arithmetic operations with applications. Multi-valued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges, Approximate reasoning. Fuzzy topologies, F-continuous functions, Fuzzy metric spaces, Fuzzy neighbourhood spaces, Fuzzy convergence, Compact fuzzy spaces, Fuzzy connectedness, Fuzzy components. Fuzzy substructures of algebraic structures, Fuzzy monoids and automata theory, Fuzzy subgroups and pattern recognition, Free fuzzy monoids and coding theory.

For the Department of MME

Math 6901: PDE, Statistics and Fourier Analysis
3.00 Credit Hours.

Partial Differential Equation: Derivation of one dimensional and two dimensional wave equation and heat equations and their solutions. Solution of boundary value problem by the method of separation of variables. Solution of elliptic, parabolic and hyperbolic equations. Solution of nonlinear PDE. Mong's method. Solution of PDE by finite difference method.

Statistics: Gaussian distribution. Time series analysis, Index numbers, Correlation theory. Multiple and Partial Correlation. Analysis of Variance.

Fourier Analysis: Fourier series, Determination of Fourier coefficient, Fourier sine and cosine series, Half range Fourier series, Change of intervals, Dirichlet's condition, Convergence of Fourier series, Complex form of Fourier series, Perseval's formula, Fourier integral, Fourier transforms and their uses in solving boundary value problems.

For the Department of NAME

Math 6903: Advanced Mathematics
3.00 Credit Hours.

Statistics: The Normal distribution. Correlation and Regression. Coefficient of Correlation. Correlation of time series. Characteristic Movements of time series. Moving averages. Measurement of seasonal variation, Forecasting. Chain Base Method and Cost of living index.

Numerical Analysis: Numerical solution of ordinary differential equation, Taylor series Method, Euler's method, Runge-Kutta method. Accuracy of one step method, multistep method. System of differential equation.

Boundary value and Engineering problems (linear and nonlinear). Shooting method (linear and nonlinear) finite difference method. Solution of applied problems. Solution of partial differential equation — Elliptic, Parabolic, Hyperbolic partial differential equation with special consideration to Heat Equation.

Fourier Analysis: Fourier series expansion for a single variable, Real and complex form, Convergent Fourier series, Calculus of Fourier series, Fourier integral formula and Fourier transforms. Fourier transform and its properties. Convergence of Fourier series, Fourier transforms for single and multivariable. The discrete Fourier transform and properties. Application in solving boundary value problems.

Advanced vector Analysis: Kinematics and Differential Geometry, Elementary theory of surfaces, Metric.

For the Department of WRE

Math 6905: Advanced Mathematics
3.00 Credit Hours.

Fourier Analysis: Fourier series expansion for a single variable, Real and complex form, Convergent Fourier series, Calculus of Fourier series, Fourier integral formula and Fourier transforms. Fourier transform and its properties. Convergence of Fourier series, Fourier transforms for single and multivariable. The discrete Fourier transform and properties. Application in solving boundary value problems.

Statistics: The Normal distribution. Correlation and Regression. Coefficient of Correlation. Correlation of time series. Characteristic Movements of time series. Moving averages. Measurement of seasonal variation, Forecasting. Chain Base Method and Cost of living index.

Numerical Analysis: Numerical solution of ordinary differential equation, Taylor series Method, Euler's method, Runge-Kutta method. Accuracy of one step method, multistep method. System of differential equation.
Boundary value and Engineering problems (linear and nonlinear). Shooting method (linear and nonlinear) finite difference method. Solution of applied problems. Solution of partial differential equation — Elliptic, Parabolic, Hyperbolic partial differential equation with special consideration to Heat Equation.

Advanced vector Analysis: Kinematics and Differential Geometry, Elementary theory of surfaces, Metric.

For the Department of Glass & Ceramic

Math 6907: Partial Differential Equations and Integral Transforms
3.00 Credit Hours.

Partial Differential Equation: Derivation of one dimensional and two dimensional wave equations and heat equations and their solutions. Solution of boundary value problem by the method of separation of variables. Solution of elliptic, parabolic and hyperbolic equations. Solution of nonlinear PDE. Mong's method. Solution of PDE by finite difference method.

Statistics: Gaussian distribution. Time series analysis, Index numbers, Correlation theory. Multiple and Partial Correlation. Analysis of Variance.

Integral Transforms: Fourier series, Fourier integral theorem and Fourier transform. Applications of Fourier integral and Fourier transform in solving Laplace's equation, Diffusion equation and wave equation. The Laplace transform and Hankel transform. Applications of Laplace and Hankel transform in solving boundary value problems.