DEPARTMENT OF APPLIED MATHEMATICS
Four year B.S. Honours Programme
Sessions : 2015-2016 (1st year) to 2018-2019 (4th year)

Degree Requirements: Successful completion of 139 credits

Major Courses		**129 credits**
Minor Courses		**10 credits**
Theory Courses	106 credits	
Lab Courses	12 credits	
Honours Project	3 credits	
Viva Voce	8 credits	
Total		**139 credits**

(Minor Subjects : Statistics, Physics)

Year-wise Class-Load

First Year		**32 credits**
Major Courses	19 credits	
Minor Courses	8 credits	
Math Lab	3 credits	
Viva Voce	2 credits	

Second Year		**33 credits**
Major Courses	26 credits	
Minor Courses	2 credits	
Math Lab	3 credits	
Viva Voce	2 credits	

Third Year		**35 credits**
Major Courses	30 credits	
Math Lab	3 credits	
Viva Voce	2 credits	

Fourth Year		**39 credits**
Major Courses	31 credits	
Math Lab	3 credits	
Honours Project	3 credits	
Viva Voce	2 credits	

List of Major Courses

First Year

AMTH 101	Fundamentals of Mathematics	3 credits
AMTH 102	Applied Calculus	4 credits
AMTH 103	Coordinate and Vector Geometry	3 credits
AMTH 104	Applied Linear Algebra	3 credits
AMTH 105	Computer Fundamentals and C++ Programming	3 credits
AMTH 106	FORTRAN Programming	3 credits
AMTH 150	Math Lab I (Mathematica)	3 credits
AMTH 199	Viva Voce	2 credits

Second Year

AMTH 201	Mathematical Analysis	3 credits
AMTH 202	Multivariate and Vector Calculus	4 credits
AMTH 203	Ordinary Differential Equations with Modeling	3 credits
AMTH 204	Advanced Linear Algebra	3 credits
AMTH 205	Numerical Methods I	3 credits
AMTH 206	Discrete Mathematics	3 credits
AMTH 207:	Principles of Economics	3 credits
AMTH 208	Mathematical Statistics	4 credits
AMTH 250	Math Lab I (Fortran)	3 credits
AMTH 299	Viva Voce	2 credits

Third Year

AMTH 301	Complex Variables and Fourier Analysis	3 credits
AMTH 302	Theory of Numbers	3 credits
AMTH 303	Partial Differential and Integral Equations	4 credits
AMTH 304	Mathematical Methods	4 credits
AMTH 305	Numerical Methods II	3 credits
AMTH 306	Mechanics	3 credits
AMTH 307	Hydrodynamics	3 credits
AMTH 308	Introduction to Financial Mathematics	3 credits
AMTH 309	Optimization Techniques	4 credits
AMTH 350	Math Lab III	3 credits
AMTH 399	Viva Voce	2 credits

Fourth Year

AMTH 401	Applied Analysis	3 credits
AMTH 402	Fluid Dynamics	3 credits
AMTH 403	Physical Meteorology	3 credits
AMTH 404	Elementary Hydrology	3 credits
AMTH 405	Differential Geometry and Tensor Analysis	4 credits
AMTH 406	Asymptotic Analysis and Perturbation Methods	3 credits
AMTH 407	Stochastic Calculus	3 credits

Several Courses from AMTH 408 to AMTH 430 will be offered as per the decision of the academic committee. Among those three courses will be chosen by the students.

AMTH 408	Econometrics	3 credits
AMTH 409	Actuarial Mathematics	3 credits
AMTH 410	Heat Transfer	3 credits
AMTH 411	Modern Astronomy	3 credits

AMTH 412	Quantum Theory and Special Relativity	3 credits
AMTH 413	Mathematical Modelling in Biology and Physiology	3 credits
AMTH 414	Mathematical Neuroscience	3 credits
AMTH 415	Industrial Mathematics	3 credits
AMTH 416	Computational Science and Engineering	3 credits
AMTH 430	Special Topics	3 credits
AMTH 450	MATH LAB IV	3 credits
AMTH 460	Honours Project	3 credits
AMTH 499	Viva Voce	2 credits

Detailed Syllabi

AMTH 101: Fundamentals of Mathematics — 3 credits

1. Elements of Logic: Mathematical statements. Logical connectives. Conditional and biconditional statements. Truth tables and tautologies. Quantifications. Logical implication and equivalence. Deductive reasoning. Methods of proof (direct, indirect); method of induction.
2. Sets, Relations and Functions: Set operations. Family of Sets. De Morgan's laws. Cartesian product of sets. Relations. Order relation. Equivalence relations. Functions. Images and inverse images of sets. Injective, surjective, and bijective functions. Inverse functions.
3. The Real number system: Field and order properties. Natural numbers, integers and rational numbers. Absolute value. Basic inequalities. (Including inequalities involving means, powers; inequalities of Cauchy, Chebyshev, Weierstrass).
4. The Complex number system: Geometrical representation Polar form. De Moivre's theorem and its applications.
5. Summation of finite series: Arithmetico-geometric series. Method of difference. Successive differences.
6. Theory of equations: Synthetic division. Number of roots of polynomial equations. Relations between roots and coefficients. Multiplicity of roots. Symmetric functions of roots. Transformation of equations.
7. Elementary number theory: Divisibility. Fundamental theorem of arithmetic. Congruence's (basic properties only).

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set in which any **five** questions are to be answered.

References

1. S. Lipschutz, Set Theory, Schaum's Outline Series.
2. S. Barnard & J. M. Child, Higher Algebra.
3. W.L. Ferrar, Algebra.
4. P.R. Halmos, Naive Set Theory.
5. Kenneth H Rosen, Discrete Mathematics.

AMTH 102: Applied Calculus — 4 credits

A. Differential Calculus

1. Functions and their graphs: polynomial and rational functions, logarithmic and exponential functions, trigonometric functions and their inverses, hyperbolic functions and their inverses, combination of such functions.
2. Limit and Continuity of Functions: Definition. Basic limit theorems, limit at infinity and infinite limits. Continuous functions. Properties of continuous functions on closed and bounded intervals.
3. Differentiability and related theorems: Tangent lines and rates of change. Definition of derivative. One-sided derivatives. Rules of differentiation. Successive differentiation. Leibnitz theorem. Related rates. Linear approximations and differentials. Rolle's theorem, Lagrange's and Cauchy's mean value theorems. Extrema of functions, problems involving maxima and minima. Concavity and points of inflection. L'Hospital's rules.
4. Power series expansion: Taylor's theorem with general form of the remainder; Lagrange's and Cauchy's forms of the remainder. Taylor's series. Maclaurin series. Differentiation and integration of series. Validity of Taylor expansions and computations with series. Indeterminate forms.
5. Applications: Physical, Biological, Social Sciences, Business and Industry.

B. Integral Calculus

1. Integrals: Antiderivatives and indefinite integrals. Techniques of integration. Definite integration using antiderivatives. Definite integration using Riemann sums.
2. Fundamental theorems of calculus. Basic properties of integration. Integration by reduction.
3. Improper integrals. Improper integrals of different kinds. Gamma and Beta functions.
4. Graphing in polar coordinates: Tangents to polar curves. Area and arc length in polar coordinates.
5. Applications of integration: Plane areas. Solids of revolution. Volumes by cylindrical shells. Volumes by cross-sections. Arc length and surface of revolution.

Evaluation: Incourse Assessment 30 marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, four from each group, of which **five** are to be answered, taking at least **two** questions from each group.

References

1. H. Anton et al, Calculus with Analytic Geometry.
2. E.W. Swokowski, Calculus with Analytic Geometry.
3. Michael Sulivan, Pre-Calculus
4. Deborah Hughes-Hallett, Applied Calculus.
5. Stefan Waner and Steven Costenoble, Applied Calculus
6. G. Strang, Calculus

AMTH 103: Coordinate and Vector Geometry — 3 credits

1. Coordinates, Equations and Graphs: The rectangular coordinate system: The coordinate plane, Test for symmetry and their applications, Equations of lines and Circles and their graphs, Applications, extensions and changes of both rectangular and polar coordinates.
2. Transformations: Translations of axes, Equation of a curve in a translated system, Graphing a translated conic, Rotation of axes, analyzing an equation using a rotation (identify and sketch), Identifying conics without rotation (use discriminant).
3. Conic sections: Standard equations of parabolas, ellipses and hyperbolas and their properties. Solve applied problems involving parabolas, ellipses and hyperbolas. Polar Equations of conics, Finding a polar equation of an orbit, Application to describe a closed orbit of a satellite around the sun (Earth or Moon).
4. Pair of straight lines: Ideas of pair of lines, Equation of a pair of lines, lines passing through origin, angle between the lines, general equation of second degree, Equation of the angle of bisectors, Homogenous equation of second degree.
5. Three dimensional coordinate system: Rectangular coordinate system in 3-space, Octants, Direction cosines and direction angles, direction ratios, angle between two lines, projection on a line, Applications to Human biomechanics, Genome expression profiles, Antogenic cartography, species, vaccine design and vaccination.
6. Parametric equations of lines: Vector equation of a line, parametric form of equation of a line, symmetric equations, intersection of two line (parametric form), Different types of lines (perpendicular, parallel and skew), shortest distance and equations.
7. Plane in three space: Equation of a plane (vector and rectangle equations), line of intersection of two planes, distance between two skew lines, point of intersection, intersection of a line with other curves, planes and surfaces, Finding distance between two parallel lines, Angle between two intersecting planes, Distance between a point and a plane.
8. Vectors in space: Geometric vectors, vectors in a coordinate plane, position vector, sum and difference of vectors, magnitude, unit vectors, graphs of the sum and difference. Dot product and Cross product: physical interpretation of the dot product (applications and extensions), orthogonal vectors, component and projection of a vector on another, cross product of basis vectors, right hand rule, physical interpretation of the cross product (applications and extensions) Areas, scalar triple product, volume of a parallelepiped, coplanar vectors.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set in which any **five** questions are to be answered.

References

1. Khosh Mohammad, Analytic Geometry and Vector Analysis.
2. H. Anton et al, Calculus with Analytic Geometry.
3. D. G. Zill and J. M. Dewar, Pre-calculus with calculus previews.
4. Michael Sullivan, Pre-calculus.
5. Calculus Early Transcendentals by D. G. Zill and W. S. Wright.
6. Howard Anton, Iri Bivens and S. Davis ,Calculus Early Transcendentals.

AMTH 104: Applied Linear Algebra 3 credits

1. Matrices and Determinants: Review of matrix and determinants. Different types of matrices, elementary row and column operations and row-reduced echelon matrices, rank. Block matrices, Invertible matrices, matrix exponentials.
2. System of Linear Equations: Linear equations. System of linear equations (homogeneous and non-homogeneous)and their solutions. Application of Matrices and determinants for solving system of linear equations. Gaussian and Gauss-Jordan eliminations. LU decomposition. Applications.
3. Vector Spaces: Review of geometric vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$ space. Norms vectors in $\mathbb{R}^n$ and $\mathbb{C}^n$. Vector space and subspace. Sum and direct sum of subspaces. Linear independence of vectors, basis and dimension of vector spaces. Row spaces, column spaces and null spaces, rank and nullity of a matrix. Solution spaces of systems of linear equations.
4. Linear Transformations: Linear transformations. Kernel and image of a linear transformation and their properties. Matrix representation of linear transformations. Change of bases, Transition matrix.
5. Eigenvalues and Eigenvectors: Definition of Eigenvalues and eigenvectors, diagonalization. Cayley-Hamilton theorem.
6. Applications: Solving problems in physical, social and applied sciences.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. H. Anton, and C.Rorres, Linear Algebra with Applications.
2. S. Lipshutz, Linear Algebra, Schaum's Outline Series.
3. Brestscher, Linear Algebra with Applications.
4. D. Lay, Linear Algebra with Applications.
5. G. Strang, Linear Algebra with Applications.
6. Peter J. Olver and Cheri Shakiban, Applied Linear Algebra

AMTH 105: Computer Fundamentals and C++ Programming 3 credits

1. Introduction to Computers: Computer basics, Components of a computer system, Importance and limitations of computers, Classification of computer (based on purpose, signals, capacity).
2. Microcomputer System: Microcomputer basics, PC and PC clones, Motherboard and its components.
3. Input and Output Devices: I/O operations and interfaces, Keyboard, Pointing devices, Scanning devices, Monitor, Printer. Microprocessors: Functions of microprocessors, Organization of a microprocessor, Arithmetic logic unit, Control unit.

4. Memory Organization: Classification of memory, General properties of memory devices, Memory hierarchies, Read only memory, Random access memory, Cache memory, Secondary memory: Floppy disk, Hard disk, Optical disk, Comparisons of primary memory and secondary memory.
5. Computer Software: Software, Classification of software, Advantages of package programs, System Software and Operating System, Types of operating systems: Linux, UNIX, MS DOS, Windows. Database Concepts: Basic Concepts, Database management system, Benefits and limitations of database management.
6. Computer Networks and the Internet: Introduction to computer network, Network terminologies of WAN, Bandwidth, Evolution of the internet, Internet services, Internet address, Electronic mail, The world wide web.
7. Basic Knowledge of C++Language: Rules of Identifiers, Variables and Keywords, C++ Console I/O, C++ Comments, Conditional Statement, Looping, Arrays & Functions.
8. Objects Oriented Programming Concepts: Features of OOP, Classes, Objects, Access Specifiers, Member Function, Constructor, Destructor, Friend Function, Inline Function and Automatic Inline Function; Pointer and References: Using Pointer to Object, This Pointer, Using new and Delete, References, Passing References to Objects, Returning References.
9. Polymorphism (Function &Operator Overloading): Overloading Constructor functions, Creating Copy Constructor, Overloading and Ambiguity, Operator Overloading (Binary, Relational, Logical and Unary operators); Inheritance and Virtual Function: Constructor, Destructor and Inheritance, Multiple Inheritance, Pointer to Derive Classes, Applying Polymorphism.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. P. K. Sinha, Computer Fundamentals.
2. Anita Goel, Computer Fundamentals.
3. V. Rajaraman, Fundamentals of Computers.
4. M. Lutfar Rahman and M. Alamgir Hossain, Computer Fundamentals.
5. E Balagurusamy, Object Oriented Programming with C.
6. John R Hubbard, Schaum's outline series: Programming with C++.
7. P. J. Deitel, H. M. Deitel, C++ How to Program.
8. Herbert Schildt, Teach yourself C++.
9. Joyce Farrell, Object Oriented Programming using C++.

AMTH 106: FORTRAN Programming 3 credits

1. Introduction to Computing: Introduction to Digital Computers, Operating Systems, Programming and Problem Solving .
2. Number System: Binary to Decimal and Decimal to Binary, other systems – octal, hexadecimal, etc.
3. Fundamentals of Computer Programming: Programming basics, High-level programming languages, Introduction to FORTRAN, Fortran Evolution, how to write, process and run program, Programming and Problem Solving.
4. Problem-solving techniques using computers: Flowcharts, Algorithms, Pseudo code.
5. Programming in FORTRAN: Syntax and semantics, Data Types, Constants, and Variables, Operation and Intrinsic Functions, Expressions and Assignment Statements, Numeric, Relational and Logical operations, Operator Precedence, single and mixed mode arithmetic, Fortran I/O and External files.
6. Control Constructs: IF Constructs, Nested and Named IF Constructs, SELECT CASE Construct, Do Loops, Named and Nested Loops, Implied do loops.

7. Arrays and Array Operations: Declarations, Array Constructors, Array Sections, Array operations, Allocatable Arrays.
8. Programming Units: Types of Programming Units, Main Program, External Procedures, Internal Procedures, Modules, Subroutines, Functions, Recursion.
9. Computing using FORTRAN: Construction and implementation of FORTRAN programs for solving problems in mathematics and sciences.

Classes: Theory (2 hours/week), Lab (At least 10 assignments).

Evaluation: Incourse Assessment (Theory and Laboratory work) 30 Marks, Final examination (Theory, 3 hours) 70 Marks.

Eight questions of equal value will be set of which any **five** are to be answered.

References

1. Stephen J Chapman, Introduction to FORTRAN 90/95.
2. Programming in Fortran, Schaum's Outline Series.
3. Gordon B. Davis & Thomas R. Hoffmann, FORTRAN 77: A Structured, Disciplined Style.

AMTH 150: MATH LAB I — 3 credits

Introduction to the computer algebra package MATHEMATICA.
Problem solving in concurrent courses (e.g., Calculus, Linear Algebra and Geometry) using MATHEMATICA.
Lab Assignments: There are at least 15 lab assignments

Evaluation: Internal Assessment (Laboratory works) 40 Marks.
Final examination (Lab, 3 hours) 60 Marks.

AMTH 199: Viva Voce — 2 credits

Viva Voce on courses taught in First Year.

AMTH 201: Mathematical Analysis 3 credits

1. Real number system: Supremum and infimum of a set. cluster (limit) points; the completeness axiom, Dedekind's theorem and Bolzano-Weierstrass theorem (No proof). Open and closed sets, interior, exterior and boundary of a set, cluster point and derived set.
2. Infinite sequences: Sequences of real number, Convergence, Monotone sequences, subsequences, Cauchy's general principle of convergence, some important sequences.
3. Infinite series of real numbers: convergence and absolute convergence. Tests for convergence; Power series. Uniform convergence, differentiation and integration of power series.
4. Limit, continuity and differentiability of functions, properties. Intermediate value theorem (no proof). Uniform continuity, Differentiation in R^n, Implicit and inverse function theorems (Statements and verifications, and applications only, no proof).
5. Metric Spaces. Definition and examples. ε-neighborhood, open and closed sets in metric spaces. Interior, exterior and boundary of a set. Cluster points of sets in metric spaces. Derived set, closure of a set. Bounded sets. Equivalent metrics.
6. Infinite sequences in metric spaces and their convergence. Cauchy sequences. Complete metric spaces. Continuity and uniform continuity of functions on metric spaces. Sequences and series of functions and their convergence.
7. The Riemann integral; definitions via Riemann's sums and Darboux's sums. Darboux's theorem. (equivalence of the two definitions) Necessary and sufficient conditions for integrability. Classes of integrable functions. Convergence of Improper integrals.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Fatema Chowdhury and Munibur Rahman Chowdhury, Essentials of Real Analysis.
2. W F Trench, Introduction to Real Analysis.
3. R. G. Bartle, Introduction to Real Analysis.

AMTH 202: Multivariate and Vector Calculus 4 credits

A. Differential Calculus

1. Vector-valued functions: Introduction to Vector-Valued Functions, Calculus of Vector-Valued Functions, Tangent lines to graphs of vector-valued functions. Arc length from vector view point. Arc length parameterization.
2. Curvature: Unit Tangent, Normal, and Binormal Vectors, Curvature of plane and space curves: Curvature from intrinsic, Cartesian, Parametric and Polar equations. Radius of curvature. Centre of curvature.
3. Partial Differentiation: Functions of several variables, Graphs of functions of two variables, Limits and continuity, Partial derivatives, Differentiability, linearization and differentials. The Chain rule. Partial derivatives with constrained variables, Directional Derivatives and Gradients, Tangent Planes and Normal Vectors.
4. Extrema of functions of several variables, Lagrange multipliers. Taylor's formula for functions of two variables.

B. Integral Calculus

1. Double Integrals: Double Integrals over Nonrectangular Regions, Double Integrals in Polar Coordinates, Surface Area; Parametric Surfaces and Applications of Double Integrals.

2. Triple integrals: Volume as a triple integral, Triple Integrals in Cylindrical and Spherical Coordinates, Centers of Gravity Using Multiple Integrals and Applications of Triple Integrals.
3. Change of Variables in Multiple Integrals; Jacobians.
4. Topics in vector calculus: Vector Fields, Gradiaent, Divergence, curl and their physical meanings Line Integrals, Green's Theorem, Surface Integrals, The Divergence Theorem, Stokes' Theorem, Applications of Surface Integrals; Flux.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. H. Anton, Irl Bivens, Stephen Davis, Calculus: Early Transcendentals, 10th Edition.
2. J. Stewart, Calculus: Early Transcendentals, 6th Edition.
3. E. Swokowski, Calculus with Analytic Geometry.
4. R. T. Smith and R. B. Minton, Calculus: Early Transcendental Functions 4th Edition.

AMTH-203: Ordinary Differential Equations with Modeling — 3 credits

1. Modeling and Differential Equations: The Modeling Approach, A Modeling Adventure, Models and Initial Value Problems, Solution Curves without a solution: Direction fields, Autonomous first order DEs. The Modeling Process: Differential Systems
2. First-Order Differential Equations: Introduction: Motion of a falling body, Existence and uniqueness theorem (without proof), Solution of First-order DE's: Separable, Homogenous, Linear, Exact, Solutions by substitutions, Linear models, Nonlinear models. Modeling with systems of first order DEs: Population models, Models of growth and decay, Acceleration velocity models, Compartmental analysis, heating and cooling of buildings, Newtonian mechanics, Electrical circuits.
3. Higher-Order Differential Equations: Introduction: The mass spring oscillator, Homogenous and Nonhomogenous equations, Reduction of order, Homogenous linear equations with constant coefficients, Undetermined coefficients, Variation of parameters, Cauchy Euler equations, Coupled Spring/Mass systems: Free damped motion, free Undamped motion, Driven motion, Series circuit Analogue. Electrical Networks and Mechanical Systems, Linear models: BVP, Nonlinear models.
4. Systems of Linear Differential Equations: Matrix form of a linear system, Homogenous and Non-homogeneous linear systems, Second order systems and Mechanical applications. Metapopulations, Natural killer cells and Immunity, Transport of Environmental pollutants, Solution by Diagonalization
5. Systems of Nonlinear Differential Equations: Chemical Kinetics: The Fundamental Theorem, Autonomous systems, Stability of linear systems, Ecological models: Predators and competitors, linearization and local stability.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Robert L. Borrelli and Courtney S. Coleman, Differential equations: A Modeling Perspective.
2. D.G. Zill and Warren S Wright, Differential Equations with Boundary-Value Problems.
3. C. Henry Edwards and Dvid E. Penney, Differential Equations and Boundary-Value Problems: Computing and Modeling.
4. Nagel, Saff and Sinder, Fundamentals of Differential Equations and Boundary value problems.

AMTH 204: Advanced Linear Algebra 3 credits

1. Similar Matrices: Canonical forms of matrices, Similar matrices, Symmetric, orthogonal and Hermitian matrices.
2. Linear Functional and Dual Space: Linear functional and the dual space, Dual basis, Second dual space, Annihilators, Transpose of a linear transformation.
3. Inner Product Space: Inner products, Norms and inner product of vectors in R^n and C^n, Inner product spaces, Orthogonality and Gram-Schmidt process, orthonormal sets, Orthogonal complement, Linear functional and adjoints, Positive operators, Unitary operators and normal operators.
4. Bilinear, Quadratric and Hermitian Forms: Matrix form of transformations, Symmetric and skew symmetric bilinear forms, Canonical forms, Reduction form, Index and signature of real quadratic form, Definite and semi-definite forms, Hermitian forms, Principal minors and factorable forms.
5. Notions of Group: Definition and examples of groups and subgroups, symmetric and cyclic groups, normal subgroups and quotient groups, groups of small orders.
6. Applications of linear algebra in solving problems in Mathematics Physical, Social and Applied sciences.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks .
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Howard Anton and Chris Rorres, Elementary Linear Algebra Applications Version .
2. W. Greub, Linear Algebra.
3. Bernard Kolman, Linear Algebra.
4. WK Nicholson, Introduction to Abstract Algebra.

AMTH 205: Numerical Methods I 3 credits

1. Preliminaries of Computing: Basic concepts, Floating point arithmetic, Types of errors and their computation, Convergence
2. Numerical solution of non-linear and transcendental equations: Bisection method, Method of false position. Fixed point iteration, Newton-Raphson method, Iterative method and Error Analysis.
3. Interpolation and polynomial approximation: Polynomial interpolation theory, Finite differences and their table, Taylor polynomials, Newton's Interpolation, Lagrange polynomial, Divided differences, Extrapolation.
4. Numerical Differentiation and Integration: Numerical differentiation, Richardson’s extrapolation, Elements of Numerical Integration, Trapezoidal, Simpson's, Weddle's etc., Adaptive quadrature method, Romberg’s integration.
5. Numerical Solutions of linear systems: Direct methods for solving linear systems, Gaussian elimination and backward substitution, pivoting strategies, numerical factorizations, Iterative methods: Jacobi method, Gauss Seidel method, SOR method and their convergence analysis.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.L. Burden and J.D. Faires, Numerical Analysis.
2. K. Atkinson , Introduction to Numerical Analysis
3. M.A.Celia and W.G. Gray, Numerical Methods for Differential Equations.
4. L.W. Johson & R.D. Riess, Numerical Analysis.

AMTH 206: Discrete Mathematics **3 credits**

1. Logic and Proofs: Propositional logic and equivalences, Rules of inferences and quantifiers, Methods of proof.
2. Induction and Recursion: Mathematical induction, Well ordering, Recursive definitions and structural Induction.
3. Combinatorics: Counting principles. The principle of Inclusion and Exclusion. Pigeonhole principle. Generating functions. Recurrence relations. Applications to computer operations.
4. Graph theory and applications: Graphs and subgraphs, structure and symmetry of graphs, Graph isomorphism.Trees and connectivity, Eulerian and Hamiltonian graphs and diagraphs, Directed graphs, planar graphs.
5. Algorithms on graphs: Introduction to graphs, paths and trees. Shortest path problems: Dijkstra'a algorithm, Floyd-Warshall algorithm and their comparisons. Spanning tree problems. Kruskal's greedy algorithm, Prim's greedy algorithm and their comparison.
6. Boolean algebra: Boolean functions, Logic Gates, minimization of circuits, Karnaugh maps.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. K. H. Rosen, Discrete Mathematics and Its Applications.
2. RP Grimaldi and BV Ramana, Discrete and Combinatorial Mathematics.

AMTH 207: Principles of Economics **3 credits**

1. Basic Concepts: Definition and scope of economics, basic economic problems and their sources, choice, tradeoff and opportunity cost, economic systems - command economy, market economy and mixed economy; microeconomics and macroeconomics.
2. Demand and supply: definition, factors influencing them, demand and supply schedules & curves, law of downward-sloping demand, market demand and market supply, movements along and shifts in demand curve, shifts in supply curve, market equilibrium: price theory in the market, its implications, effects of a shift in demand or supply on equilibrium position, special cases.
3. Elasticity: Elasticity of demand and supply - concepts, definitions and problems associated with calculations, price elasticity, income elasticity and cross elasticity of demand, consumer's expenditure pattern and total revenue in relation to elasticity of demand, computation of elasticity from demand function and family budget data.
4. Consumer Behaviour and Utility: basic concepts, ordinal and cardinal measurements of utility, consumers preference ordering. Total utility and marginal utility, relationship between them, law of diminishing marginal utility, equal marginal utilities: equimarginal principle. Substitution and income effects and the law of demand. Slutsky equation, computation of elasticity from Slutsky equation. consumer's surplus and its applications.
5. The indifference Curve Analysis: Indifference curve analysis as an improvement over Marshallian analysis, consumer's indifference curve: properties, rate of commodity substitution. The equilibriums position of tangency: consumer's equilibrium, effects of income and price change on equilibrium.
6. Production and Cost: Firm's behavior: main aim, optimal policy, price-taking behaviour, factors of production-fixed and variable. Costs of production-fixed and variable, total and marginal costs.
7. Pricing of the Factors of Production: Theory of distribution-meaning, factor pricing by marginal productivity, factor demand, marginal revenue product. Demand for & supply of factors of production and their curves, least-cost rule. Theories of Wage, Rent, Interest and Profit.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. P.A. Samuelson, Economics.
2. P.A. Samuelson and W.D. Nordhaus, Economics.
3. H.R. Varian, Intermediate Microeconomics: A Modern Approach.

AMTH 208: Mathematical Statistics 4 credits

Part A:

1. Concept of population, sample, parameter, statistic, random sample, probability distribution, Standard errors of statistics and their large sample approximations. Transformation of variables including square root, log, sin-inverse etc.
2. Basic concept of random variable and its types, Distribution of sum, difference, product and quotient of random variables, functions of random vectors of continuous and discrete type.
3. Central limit theorem, other limit laws and their applications.
4. Conditional expectations, Chebyshev's inequality, probability generating function, characteristic function, inversion theorem.
5. Sampling distributions: Definition, Different sampling distributions: Chi-square (χ^2), Snedecor-Fisher's F and Student's t distribution, Different methods of finding sampling distribution: Analytical method, inductive method, geometrical method, method of using characteristic function, etc. Sampling from the normal distributions, Distribution of sample mean and variance and their independence for normal population, Sampling distribution of correlation and regression coefficients, frequency χ^2, and their uses.

Part B:

1. Methods of estimation and criteria of estimations.
2. Preliminaries of tests: Hypothesis, Types of hypotheses, concept of test of significance, procedures of a test, errors in testing of hypothesis, level of significance, one tailed and two-tailed tests, p-value. Tests based on different statistic.
3. Testing the significance of a single mean, single variance, single proportion, difference of two means and proportions, ratio of two variances and their confidence intervals. Tests and confidence intervals concerning simple correlation coefficient and regression coefficient for single and double sample. Paired t-test.
4. Association of attributes, Association & disassociation, Measure of association, Attribute, contingency tables, General test of independence in an r x c contingency table. Fisher's exact test for a 2×2 contingency table.
5. Test of goodness of fit. Analysis of Variance (ANOVA): One-way, two-way classification, etc.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Hoog, R.V.& Craig, A.T., An introduction to mathematical statistics.
2. Gupta, S.C. and Kapoor, V.K., Fundamental of Mathematical Statistics.
3. M.G. Bulmer, Principles of Statistics.
4. Richard A. Johnson and Gouri K. Bhattacharyya, Statistics: Principles and Methods.
5. John E. Freund, Miller and Miller, Mathematical Statistics with Applications.
6. Steel &Torie, Principles and Procedures of Statistics

AMTH 250: MATH LAB II **3 credits**

Problem solving in concurrent courses (e.g., Calculus, Linear Algebra, Differential Equations, Numerical Analysis and Discrete Mathematics) using FORTRAN Programming.

Lab Assignments: There are at least 15 assignments.

Evaluation: Internal assessment (Laboratory works) 40 Marks.
Final examination (Lab, 3 hours) 60 Marks.

AMTH 299: Viva Voce. **2 credits**

Viva Voce on courses taught in the Second Year.

AMTH 301: Complex Variables and Fourier Analysis 3 credits

1. Complex Numbers: The Complex Number System, Fundamental Operations with Complex Numbers, Graphical Representation of Complex Numbers, Polar Form of Complex Numbers, De Moivre's Theorem, Roots of Complex Numbers, Equations, The nth Roots of Unity, Vector Interpretation of Complex Numbers.
2. Complex Function and its Derivative: Functions, Limits and Continuity, The Complex Derivative, The Derivative and Analyticity, Cauchy–Riemann Equation, Harmonic Functions, Some Physical Applications of Hannonic Functions.
3. Complex integration: Definite Integrals, Contour Integrals, Antiderivatives, CauchyGoursat Theorem, Cauchy Integral Formula, Liouville's Theorem, Fundamental Theorem of Algebra, Maximum Modulus Principle.
4. Series: Taylor's and Laurent's expansion, singularity, Poles and Residues, Cauchy's Residue Theorem, Residue at Infinity, Zeros of Analytic Functions.
5. Conformal mappings: Elementary conformal mappings and their geometric properties. The bilinear transformations.
6. Beta and Gamma function: Introduction, different form of beta function, relationship between beta and gamma function, reduction of definite integrals to beta and gamma functions.
7. Fourier Series: Fourier series and its convergence. Fourier sine and cosine series. Properties of Fourier series. Operations on Fourier series. Complex from. Applications of Fourier series.
8. Fourier transforms: Fourier transforms. Inversion theorem. Sine and cosine transforms. Transform of derivatives. Transforms of rational function. Convolution theorem. Parseval's theorem. Applications to boundary value problems and integral equation.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.V. Churchill & J.W. Brown, Complex Variables and Applications.
2. M. R. Spiegel, Complex Variables, Schaum's Outline Series.
3. R.V. Churchill & J. W. Brown, Fourier Series and Boundary value problems.
4. E. Kreuszig, Advanced Engineering Mathematics.
5. M. R. Spiegel, Laplace Transforms, Schaum's Outline Series.

AMTH 302: Theory of Numbers 3 credits

1. Arithmetic in $\mathbb{Z}$. Euclidean algorithm. Continued fractions.
2. The ring $\mathbb{Z}_n$ and its group of units. Chinese remainder theorem. Linear Diophantine equations.
3. Application of congruence: Divisibility test, Round Robin tournament schedule, ISBN Check Digits etc.
4. Arithmetical functions. Dirichlet convolution. Multiplicative function.
5. Representation by sum of two and four squares.
6. Arithmetic of quadratic fields. Euclidean quadratic Fields.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Kenneth H. Rosen, Elementary Number Theory.
2. G.H. Hardy & E.M. Wright, An Introduction to Theory of Number.
3. I.S. Niven and H.S. Zuckermann, An Introduction to Theory of Number.
4. W.J. LeVeque, Fundamentals of Number Theory.

AMTH: 303 Partial Differential and Integral Equations 4 credits

1. Mathematical formulation and modeling of physical systems in PDE, well-posed problems, usual operators and classes of equations, boundary conditions, IVP, BVP, EVP, IBVP.
2. First order equations: Methods for finding general solutions, constant-coefficient advection equation, liner and quasi-linear equations, methods of characteristics, variable-coefficient equation, IVP for conservation laws and applications. Solution by ODE method and separation variables. System of first order equations.
3. Second order PDE: General equations and classifications, constant coefficient equations. Methods of solutions: separation of variables and eigenfunction expansion methods for one dimensional heat (heat flow in a rod) and wave equations, nonhomogeneous problems. Initial BVPs. Two dimensional heat and wave equations.
4. The potential equation: Method of separation variables for Laplace and Poisson equations, Dirichlet and Neumann problems in rectangular, circular (disk), partially bounded and unbounded domains, Properties of Harmonic functions. Maximum-Minimum principles, Mixed BVPs, Eigenvalue problem, Helmholtz equation, Nonhomogeneous boundary conditions.
5. Integral equations: Classification of integral equations: Volterra and Fredholm integral equations, Singular and Integro-differential equations. Converting Volterra equation to ODE and IVP to Volterra integral. Converting IVP and BVP to Fredholm integral equations. Volterra equation of the first and second kind, various types of Fredholm integral equations.
6. Methods of solutions of integral equations: Successive approximations and substitutions, Adomian decomposition methods for Volterra and Fredholm integral equations. Nonlinear integral equations: Picard's method, Adomian decomposition method.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Larry C. Andrews, Elementary Partial Differential Equations with Boundary Value Problems.
2. Paul DuChateau and David Zachmann , Applied Partial Differential Equations.
3. Richard Haberman, Elementary Partial Differential Equations with Fourier series and BVPs.
4. M. Rahman, Integral Equations and their Applications (WIT press).

AMTH 304: Mathematical Methods 4 credits

1. Series solution of differential equations: Series solution about ordinary and singular point, regular and irregular singular point of a linear ODE, distinct roots not differing by an integer, repeated root of an indicial equation, distinct roots differing by an integer, Frobenius method for 2^{nd} order ODE, Derivative method.
2. Eigenfunction methods and Strum-Liouville Theory: Adjoint, eigenfunction properties, regular Strum-Liouville boundary value problems. Nonhomogeneous boundary value problems. Singular Strum-Liouville boundary value problems. Oscillation and comparison theory.
3. Green's function and Fredholm alternative: Solution by eigenfunction expansion, Inverse of differential operator, Green's function via Delta function, General linear boundary value problem, General Green's Function,Applications to steady state heat equation and wave equations in 1D, steady state heat equation and potential flow problems (Laplace) in 2D and 3D, Fredholm alternative.
4. Special functions: Bessel functions (differential equations; series solutions; integral representations), Bessel functions of 1^{st} and 2^{nd} kind, applications; Legendre equations and

Legendre functions and their properties, generalization, applications; orthogonal polynomials: Legendre/Jacoby; Hermite; Laguerre, Chebyshev, Hypergeometric, confluent Hypergeometric and their applications.

5. Laplace transform and Inverse Laplace Transform: Definition, Laplace transform of some elementary functions; sufficient conditions for the existence of Laplace transform; some important properties of Laplace transform: translations, derivatives of a transform, transforms of integrals; initial and final value theorem; Laplace transforms of some special functions (periodic functions, Dirac Delta functions).Inverse Laplace, some important properties of the inverse Laplace transform; partial function decompositions; convolution theorem; Heaviside's expansion formula; evaluation of integrals.
6. Applications of Laplace transform: Solving differential equations (ordinary and partial) using the Laplace transform, solving differential equations involving unit step functions and the Dirac Delta function, solving systems of ODEs using Laplace Transforms. Use of Laplace Transform techniques to model application problems from the physical sciences.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. I. Stakgold, MJ Holst, Green's Functions and Boundary Value Problems.
2. Erwin Kreyszig, Advanced Engineering Mathematics.
3. N. N. Lebedev- Special functions and their applications.
4. M. R. Spiegel - Laplace Transform.
5. KT Tang – Mathematical methods for Engineers and Scientists.

AMTH 305: Numerical Methods II 3 credits

1. Curve fitting and Approximation: Spline Interpolation and Cubic Splines, Least Squares Approximation.
2. Approximating Eigenvalues: Eigenvalues and eigenvectors, the power method, Convergence of Power method, Inverse Power method, Rayleigh Quotient Method, Householder's method, Q-R method.
3. Nonlinear system of equations: Fixed point for functions of several variables, Newton's method, Quasi-Newton's method, Conjugate Gradient Method, Steepest Descent techniques.
4. Initial value problems for ODE (Single-step methods) : Euler's and modified Euler's method, Higher order Taylor's method, Runge-Kutta methods.
5. Extrapolation methods-higher order differential equations and systems of differential equations
6. Multi-step methods: Adams-Bashforth, Adams-Moulton, Predictor-Corrector and Hybrid methods, variable step-size multi-step methods, error and stability analysis.
7. Boundary value problem for ODE: Shooting method for linear and nonlinear problems, Finite difference methods for linear and nonlinear problems. The Sturm–Liouville eigenvalue problem.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. R.L. Burden & J.D. Faires, Numerical Analysis.
2. M.A. Celia & W.G. Gray, Numerical Methods for Differential Equations.
3. H M Antia, Numerical methods for scientists and engineers.
4. L.W. Johson & R.D. Riess, Numerical Analysis.

AMTH 306 Mechanics 3 credits

1. Newtonian Mechanics: Newton's law of motion, Inertial frames and the law of inertia, Law of multiple interactions, Center of mass.
2. Dynamics of a particle: Rectangular coordinates: Kinematics, kinetics: force-mass acceleration method, Dynamics of rectilinear motion, curvilinear motion.
3. Planetary motion: Equation of motion under a central force, Differential equation for the orbit, Orbits under an inverse square law.
4. Vibrations: Free vibrations of particles, forced vibrations of particles, Rigid body vibrations
5. Mass Moments and Product of Inertia: Moments of inertia of thin plates, Mass moment of inertia by integration, Mass product of inertia; Parallel axis theorem, Products of inertia by integration; thin plates, Principal moments and principal axes of inertia.
6. Planar kinematics of Rigid Bodies: Plane angular motion, rotation about a fixed axis, relative motion of two points in a rigid body, motion relative to a rotating reference frame.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Mary Lun, A first course in Mechanics.
2. R. Douglas Gregory, Classical Mechanics.
3. Andrew Paytel, Engineering Mechanics: Dynamics.
4. David Acheson, From Calculus to Chaos An Introduction to Dynamics.

AMTH 307: Hydrodynamics 3 credits

1. Water and its properties, Steady and Unsteady flows, Uniform and Non-uniform flows, Rotational and Irrotational flows, Compressible and Incompressible flows, Flow visualization: Streamlines, Streaklines, and Pathlines.
2. Hydrostatics, Liquid flow under conservative force, Bernoulli's theorem, Applications of Bernoulli's equation: Torricelli's theorem, Sluice gate and its applications, Discharging a tank, etc.
3. Concept of control volume, Equations of continuity, Viscous and Inviscid flows, Euler's equation of motion, The hydrodynamic equations, The shallow-water equations. Vorticity, Helmholtz's vorticity equation, Circulation.
4. Potential flow, Stream function and Velocity potential in Cartesian and Polar-coordinates, Relation between stream function and velocity potential, Three-dimensional potential flows: Velocity potential, Stoke's stream function.
5 Joukowki's transformation: Transformation of circle into straight line and ellipse, Method of images, Circle's theorem, Flow past a circular cylinder with circulation and without circulation, Pressure distribution and Pressure coefficient on the surface of the Cylinder.
6. Complex potential and complex velocity, Stagnation points, Uniform flows, Source, Sink, Vortex and Doublet. Complex potential due to source, sink, vortex and doublet.
7. General characteristics of Open-Channel Flow. Froude number effects. Uniform flow approximations, The Chezy and Manning Equations, Classification of surface shapes, The Hydraulic jump.
8. Surface waves, Small amplitude plane waves, Propagation of surface waves, Complex potential for travelling waves. Sound waves, Finite amplitude waves in shallow water.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References:

1. L. M. Milne-Thomson, Theoretical Hydrodynamics.
2. Hugh L. Dryden, Francis D. Murnaghan, H. Bateman. Hydrodynamics.
3. H. R. Vallentine, Applied Hydrodynamics, Springer.
4. A.J. Hermans, Water Waves and Ship Hydrodynamics, Springer.
5. Bruce R. Munson, Donald F. Young, Theodore H. Okiishi, Fundamentals of Fluid Mechanics.
6. G. Currie, Fundamental mechanics of fluids.

AMTH 308: Introduction to Financial Mathematics 3 credits

1. Overview of basic concepts in securities markets: Exchange-traded markets; Over-the-counter markets; Forward contracts; Future contracts; Options; Types o f traders, etc.
2. Stochastic models for stock prices: Continuous-time stochastic processes; Wiener processes; The process for a stock price; The parameters; Ito's lemma; THe lognormal property of stock prices.
3. Hedging strategies and managing market risk using derivatives: Financial derivatives; European call and put options; Payoff diagrams, short selling and profits; Trading strategies: Straddle, Bull Spread, etc; Bond and risk-free interest rate; No arbitrage principle; Put-call parity; Upper and lower bounds on call options.
4. Binomial option pricing model: One-step binomial model and a no-arbitrage argument; Risk-neutral valuation; Two-steps binomial trees; Binomial model for stock price; Option pricing on binomial tree; Matching volatility _ with u and d; American put option pricing on binomial tree.
5. Risk-neutral Portfolio: Risk-neutral valuation, replication and pricing of contingent claims.
6. Black-Scholes analysis: Black-Scholes model; Black-Scholes Equation; Boundary conditions for call and put options; Exact solution to Black-Scholes equation; Delta-hedging; the Greek letters; Black-Scholes equation and replicating portfolio; Static and dynamic risk-free portfolio; Option on dividend-paying stock; 2American put option.
7. Interest rate models: Bond pricing with known interest rates and dividend payments; Zero-coupon bond pricing; Measure of future values of interest rate; Term structure of interest rate (Yield curve); Asian options: Derivation of PDE for option price.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. J. Hull, Options, Futures and Other Derivatives.
2. P. Wilmott, S. Howison and J. Dewynne, The Mathematics of Financial Derivatives: A Student Introduction.

AMTH 309: Optimization Techniques 4 credits

1. Introduction to linear programming: Basic definitions, Formulation of linear programming problems, Graphical solutions.
2. Simplex method and duality: Simplex method, Two phase method, Big-M simplex method, Duality of linear programming and related theorems (No Proof), Dual simplex method.
3. Sensitivity analysis: Analysis of the effect of changing various parameters in linear programming problems such as right hand side of the constraints, cost coefficients, addition of a new constraint, deletion of a constraint etc.
4. Nonlinear Programming: Introduction, Unconstrained problem, Lagrange Method for Equality constraint problem, Kuhn-Tucker Method for Inequality constraint problem, Quadratic programming problem.

5. Transportation and assignment problem: Introduction, Formulation, Solution procedure, applications.
6. Integer programming: Introduction, Branch and Bound algorithm, Cutting-plane algorithm, applications.
7. Decision theory and games: Introduction, Minimax-maximin pure strategies, Mixed strategies and Expected payoff, solution of *2X2* games, solution *2Xn* and *mX2* games, solution of *m x n* games by linear programming, Brown's algorithm.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Hamdy. A. Taha. Operation Research.
2. A. Ravindran , D.T. Phillips, J.J. Solberg. Operations Research.
3. B.E. Gillett. Introduction to Operations Research.
4. Anderson, Sweeney, Williams. An Introduction to Management Science.

AMTH 350: MATH LAB III — 3 credits

Problem solving in concurrent courses on First year to Third year using MATLAB Programming.
Lab Assignments: There are at least 15 assignments.

Evaluation: Internal assessment (Laboratory works) 40 Marks.
Final examination (Lab, 3 hours) 60 Marks.

AMTH 399: Viva Voce. — 2 credits

Viva Voce on courses taught in Third Year
.

AMTH 401: Applied Analysis — 3 credits

Part A: Topology

1. Topological Spaces: Definition and examples (discrete, indiscrete, cofinite, cocountable topologies), closed and open set, interior, exterior and boundary points, derived set, cluster point of a set, dense set, relative topology, neighborhood system. Continuity.
2. Separation axioms. Properties of Hausdorff spaces. Product spaces. Countability of topological spaces.
3. Properties of metric spaces: Complete and incomplete metric spaces, Baire's category theorem. Necessary and sufficient condition for compactness. Heine-Borel theorem. Finite intersection property. Equivalence of sequential compactness, Bolzano-Weierstrass property, Totally boundedness, Lebesgue number and compactness in a metric spaces. Cantor set.
4. Connectedness in metric spaces, totally disconnected spaces, components of space, locally and path wise connected spaces.

Part B: Functional Analysis

5. Normed Linear Spaces: Definitions and examples, Cauchy-Schwarz inequality, Parallelogram law, Metric derived from a norm. Holder and Minkowski inequalities for finite and infinite sums, and integrals. l^p space in a metric space, Norm of L_p , l^p and Sobolev spaces, Banach spaces. Riez's lemma.

6. Linear operators: Boundedness and continuity, Linear operators in finite dimensional spaces. Spaces of bounded linear operators. Open mapping theorem, closed graph theorem, and their applications, Uniform boundedness principle.
7. Inner products, Inner product space and Hilbert Space, polarization identity, orthogonal and orthonormal sets in Hilbert space, Bessel's inequality.
8. Fixed point theorems: Contraction mapping, Banach fixed point theorem, Applications of fixed point theorems.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. G.F. Simmons, Introduction to Topology and Modern Analysis.
2. S.Lipschutz, General Topology.
3. Fatema Chowdhury and Munibur Rahman Chowdhury, Essentials of Topology and Functional Analysis.
4. E. Kreyszig, Introduction to Functional Analysis with Applications.
5. D.H. Griffel, Applied Functional Analysis.
6. J N Reddy, Applied Functional Analysis and Variational Methods in Engineering.

AMTH 402: Fluid Dynamics 3 credits

1. Fundamental concepts: Fluid as a continuum, Newton's law of viscosity, Newtonian and non-Newtonian fluids, Body and surface forces, Stress and Rate of strain and their relation.
2. Navier-Stokes equations in different coordinate systems, Vorticity Transport Equation, Nondimensionalization, Dimensionless parameters, Reynolds similarity.
3. Unidirectional Flow, Exact solutions of the Navier-Stokes equations: Couettee flows, plane Poiseuille flow, Flow through a circular pipe, the Hagen-Poiseuille flow, Flow between two coaxial cylinders and concentric circular cylinders, Pulsating flow between parallel surfaces, Stoke's first and second problems.
4. Very Viscous Flow: Introduction, Low Reynolds number flow past a sphere, Swimming at low Reynolds number, Uniqueness and reversibility of slow flows, Flow in a thin film, Lubrication theory.
5. Boundary layers: General concepts and properties of boundary layer. Prandtl's boundary layer equations, boundary layer Separation, Similar and nonsimilar solutions of the boundary layer equations, Flow in a convergent channel, Flow past a wedge, Boundary layer on a flat plate, Boundary layer flow with pressure gradient, Karman's integral equation, Karman-Pohlhausen method.
6. Thermal boundary layer: Energy equation, Thermal boundary layer simplifications, Natural and Forced flows, Parallel forced flow past a flat plate at zero incidence, Natural flow past a horizontal vertical plates.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. D.J. Acheson, Fluid Dynamics.
2. I.G. Currie, Fundamental Mechanics of Fluids.
3. Frank M. White, Viscous Fluid Flow.
4. H. Schlichting, Boundary Layer Theory.

AMTH 403: Physical Meteorology 3 credits

1. Meteorological Concepts: Meteorology, synoptic meteorology, Climatology, Physical meteorology, Dynamic meteorology, Agricultural meteorology, Applied meteorology.
2. Atmosphere: Origin of the atmosphere, Layering of the atmosphere; troposphere, stratosphere, mesosphere, thermosphere, exosphere and other layers of atmosphere, Composition of the atmosphere.
3. Thermodynamics of dry air: Pressure, temperature and ideal gas law; The Maxwell-Boltzamann distribution, hydrostatic equilibrium, surface pressure and mass of the atmosphere, surface pressure and sea level pressure, Heating, working and the First law; Enthalpy and the second law.
4. Thermodynamics of moist air: Six ways of quantify moister content, potential pressure, potential temperature, static stability of moister non-condensing air. The Claussius-Clapeyvon equation, level of cloud formation.
5. Cloud and cloud formation: Cloud formation, cloud classification, various types of clouds, cloud droplet growth, droplet growth by diffusion and condensation, terminal velocity of falling drops.
6. Atmospheric Radiation: Solar radiation, Characteristic of Sun, nature of solar radiation, Geographical and seasonal distribution of solar radiation, Deposition of solar radiation with and without cloudy skies. Solar radiation and Earth-troposphere system, Greenhouse effects, Causes of greenhouse effects, future trends of G H effects, Sea level changes, Impact of 1-meter sea level rise in Bangladesh.
7. Tropical Cyclone: Formation stage, Immature stage, mature stage, terminal stage; Climatological conditions for tropical cyclone formation, North Indian Ocean, Large scale conditions associated with tropical cyclone formation.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. J. Houghton, The Physics of Atmospheres.
2. Rodrigo Caballero, Lecture notes in Physical Meteorology.
3. R. R. Rogers and M. K. Yau, A short course in cloud physics.
4. Grant W. Petty, A first course in Atmospheric Radiation.

AMTH 404: Elementary Hydrology 3 credits

1. Definition and Introduction: Definition and scope of Hydrology, Hydrologic Cycle, Hydrologic System model, Hydrologic model classification, the development of Hydrologic Black Box model, Historical development, the Global water Budget.
2. Hydro-metrology: Introduction, constituents of the atmosphere vertical structure of the atmosphere, solar radiation, the general circulation formulation of precipitation, types of precipitation, forms of precipitation. Climate and weather seasons in this subcontinents. Metrological observations.
3. Topography, watershed delineation, topographic effect (altitude, temperature) on precipitation.
4. Evaporation and transpiration, evapotranspiration.
5. Water in soils: infiltration and redistribution, vadose zone and soil moisture.
6. Ground water in hydrologic cycle.
7. Rainfall and runoff relations and its application. Source of stream flow, excess rainfall and direct runoff. Abstraction using infiltration equation, SCS method for abstraction, Φ index method and problem solve, travel time, stream flow.
8. Hydrograph and Unit hydrograph methods and their applications.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.

Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. P. Jaya Rami Reddy, A text book of Hydrology.
2. V. Subramaniya, Engineering Hydrology.
3. Rafael L. Bras, Hydrology.
4. H.M Raghunath, Hydrology.
5. V.P. Sing, Elementary Hydrology.
6. S. Lawrence Dingman, Physical Hydrology.

AMTH 405: Differential Geometry and Tensor Analysis 4 credits

Part A: Differential Geometry

1. Curves in Space: Vector functions of one variable and two variables, space curves, arc length, Tangent, Osculation plane, Normal, Principal normal, Binormal and fundamental planes. Curvature and torsion, Serret Frenet formula, Helics and their properties, Involute and Evolute.
2. Surface: Parametric curves, Tangent plane, normal and envelope, two and three parameter family of surfaces, First and second fundamental forms, Direction coefficients, orthogonal trajectories, Double family of curves. Curvature and directions, Rodrigue's formula, Euler's theorem.
3. Geodesics: Definitions, Differential equation of geodesics, geodesics on plane, sphere, right circular cone, cylinder, geodesic on a surface of revolutions.

Part B: Tensor Analysis

1. Vectors, Tensors and Co-ordinate transformations: Kronecker delta, Covariant and contravariant vectors, Mixed and invariant tensors, addition, subtraction and multiplication of tensors, contraction, symmetric and skew-symmetric tensors, Quotient Law.
2. Riemannian Metric and Metric Tensors: Conjugate and associated tensors. Christoffel's symbols and their transformation laws.
3. Covariant Differentiations of Tensors: Covariant derivative of a tensor and higher rank tensors, intrinsic derivative, Tensor forms of gradient, divergence, curl and Laplacian, Riemann Christoffel tensor, Curvature tensor, Ricci tensor, Bianchi identity, Flat space and Einstein space and Applications.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 4 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. T.J. Willmore, An Introduction to Differential Geometry.
2. S. Stamike, Differential Geometry.
3. M.M. Lispchutz, Theory and Problems of Differential Geometry.
4. B. Spain, Tensor Calculus.
5. M. R. Spiegel, Vector and Tensor Analysis.

AMTH 406: Asymptotic Analysis and Perturbation Methods 3 credits

1. Asymptotic equivalence, Asymptotic expansions. Taylor expansion as a conventional converging power series and as an example of an asymptotic expansion. Asymptotic expansions for definite integrals with the upper or lower limits of integration depending on small or large parameters. Functions defined by real integrals. Laplace's method for definite integrals, Watson's Lemma.
2. Generalisation for functions defined by contour integrals. Steepest descent. Applications. Asymptotic solutions of second-order linear equations (expansions near an irregular singularity, expansion for large arguments, equations containing a large parameter, equations involving a small parameter).

3. Singular perturbations, Method of strained coordinates, Inner and outer solutions. Overlap region. Matching of the asymptotic expansions. Ordinary differential equations with singular perturbations.
4. Method of multiple scales. Quasi-periodic solutions of second order ordinary differential equations developing non-uniformity at large time. Uniformly valid solutions. Amplitude equations. WKB Method.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. C. M. Bender and S.A. Orzag, Advanced Mathematical Methods for Scientists and Engineers.
2. J.D. Murry, Asymptotic Analysis.
3. F. W. J. Olver, Asymptotics and Special Functions.
4. Ali Hassan Nayfeh, Introduction to Perturbation Techniques.

AMTH 407: Stochastic Calculus 3 credits

1. The Wiener process (standard Brownian motion): Review of various constructions. Basic properties and theorems. Brownian paths are of unbounded variation.
2. The Ito's integral with respect to a Wiener process: Definition and basic properties. Continuous local martingales. The quadratic variation process. The Kunita-Watanabe inequality. Continuous semimartingales. The Ito's integral with respect to a continuous semimartingale: Definition and basic properties. Stochastic dominated convergence theorem.
3. The Ito's formula: Statement and proof. Integration by parts formula. The Levy characterization theorem. The Cameron-Martin-Girsanov theorem (change of measure). The Dambis-Dubins-Schwarz theorem (change of time).
4. The Ito-Clark theorem. The martingale representation theorem. Optimal prediction of the maximum process.
5. Stochastic differential equations. Examples: Brownian motion with drift, geometric Brownian motion, Bessel process, squared Bessel process, the Ornstein-Uhlenbeck process, branching diffusion, Brownian bridge. The existence and uniqueness of solutions in the case of Lipschitz coefficients.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Rogers, L. C. G. and Williams, D., Di_usions, Markov Processes and Martingales.
2. Revuz, D. and Yor, M., Continuous Martingales and Brownian Motion.
3. Karatzas, I. and Shreve, S. E., Brownian Motion and Stochastic Calculus.
4. Durrett, R., Stochastic Calculus.

AMTH 408: Econometrics 3 credits

1. The Nature of Econometrics and Economic Data: Econometrics, Steps in Empirical Economic Analysis, The Structure of Economic Data, Causality and the Notion of Ceteris Paribus in Econometric Analysis.

2. The Simple Regression Model: Definition of the Simple Regression Model, Deriving the Ordinary Least Squares Estimates, Properties of OLS on Any Sample of Data, Units of Measurement and Functional Form, Expected Values and Variances of he OLS Estimators, Regression through the Origin.
3. Multiple Regression Analysis: Estimation: Motivation for Multiple Regression,The Model with Two Independent Variables, The Model with k Independent Variables, Mechanics and Interpretation of Ordinary Least Squares, The Expected Value of the OLS Estimators, The Variance of the OLS Estimators, Efficiency of OLS: The Gauss-Markov Theorem.
4. Multiple Regression Analysis: Inference: Sampling Distributions of the OLS Estimators, Testing Hypotheses about a Single Population Parameter: The t Test, Confidence Intervals, Testing Hypotheses about a Single Linear Combination of the Parameters, Testing Multiple Linear Restrictions(The F Test), Reporting Regression Results.
5. Multiple Regression Analysis: OLS Asymptotics: Consistency, Deriving the Inconsistency in OLS , Asymptotic Normality and Large Sample Inference, Asymptotic Efficiency of OLS, Effects of Data Scaling on OLS Statistics(Beta Coefficients), More on Functional Form(Logarithmic Functional Forms, Models with Quadratics, Models with Interaction Terms)
6. Basic Regression Analysis with Time: Series Data: The Nature of Time Series Data, Some of Time Series Regression Models: Static Models , Finite Distributed Lag Models, A Convention about the Time Index, Finite Sample Properties of OLS under Classical Assumptions, Functional Form, Dummy Variables, and Index Numbers, Trends and Seasonality.
7. Further Issues in Using OLS with Time Series Data: Stationary and Weakly Dependent Time Series, Stationary and Nonstationary Time Series, Weakly Dependent Time Series , Asymptotic Properties of OLS, Using Highly Persistent Time Series in Regression Analysis, Highly Persistent Time Series, Transformations on Highly Persistent Time Series, Deciding Whether a Time Series Is I(1) , Dynamically Complete Models and the Absence of Serial Correlation.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Jeffrey M. Wooldridge,Introductory Econometrics: A Modern Approach.
2. Joshua D. Angrist & Jˆrn-Ste§en Pischke, Mostly Harmless Econometrics: An Empiricistís Companion.
3. Johnston J. and DiNardo, J. , Econometric Methods.

AMTH 409: Actuarial Mathematics 3 credits

1. Survival models: Survival models, Some actuarial concepts in survival analysis, Force of Mortality, Expectation of life, Curtate failure, Selected survival models, Common Analytical Survival Models, Mixture models.
2. Life Tables: Life tables, Actuarial Models, Deterministic survivorship group and random survivorship group, Continuous computations, Interpolating life tables, Select and Ultimate Tables.
3. Life insurance: Introduction to life insurance, Payments paid at the end of the year of death. Further properties of the APV for discrete insurance, Non-level payments paid at the end of the year, Payments at the end of the m-thly time interval, Level benefit insurance in the continuous case. Further properties of the APV for continuous insurance, Non-level payments paid at the end of the year, Computing APV's from a life table.
4. Life annuities: Whole life annuity, n-year deferred annuity, n-year temporary annuity, n-year certain annuity, Contingencies paid m times a year, Non-level payments annuities, Computing present values from a life table.

5. Benefit premiums: Funding a liability. Fully discrete benefit premiums. Benefits paid annually funded continuously. Benefit premiums for fully continuous insurance. Benefit premiums for semicontinuous insurance. Benefit premium for an n-year deferred annuity. Premiums paid m times a year. Non-level premiums and/or benefits. Computing benefit premiums from a life table, Premiums found including expenses.
6. Benefit reserves: Benefit reserves, Fully discrete insurance. Fully continuous insurance, Reserves for insurance paid immediately and funded discretely, Reserves for insurance paid discretely and funded continuously, Benefit reserves for general fully discrete insurance, Benefit reserves for general fully continuous insurance, Benefit reserves for m-thly payed premiums. Benefit reserves including expenses. Benefit reserves at fractional durations.
7. Multiple life functions : Multivariate random variables, Joint life status, Last survivor status, Joint survival functions, Common shock model, Insurance for multi--life models, Problems for recent actuarial exams,
8. Markov chains: Stochastic processes. Markov chains, Random walks, Hitting probabilities, Gambler's ruin problem, Some actuarial applications.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References:

1. S. David Promislow – Fundamentals of Actuarial Mathematics.
2. Newton L. Bowers, Hans U. Gerber – Actuarial Mathematics, Society of Actuaries.
3. http://www.math.binghamton.edu/arcones/450/syllabus.html.

AMTH 410: Heat Transfer 3 credits

1. Basics of Heat Transfer: Thermodynamics and Heat Transfer, Heat and Other Forms of Energy, The First Law of Thermodynamics, Heat Transfer Mechanisms: Conduction, Convection and Radiation, Simultaneous Heat Transfer Mechanisms. Thermal Insulation.
2. Heat Conduction: Introduction, The conduction equation, Steady state conduction in Simple Geometries. Extended surfaces, Multidimensional Steady Conduction, Transient Heat Conduction.
3. Numerical Methods in Heat Conduction: Why Numerical Methods? Numerical solution of One-Dimensional Steady Heat Conduction, Two-Dimensional Steady Heat Conduction and Transient Heat Conduction Problems.
4. Fundamentals of Thermal Radiation: Introduction, Thermal Radiation, Blackbody Radiation, Radiative properties, The Green House Effect, Atmospheric and Solar Radiation.
5 Fundamentals of Convection: Physical mechanism of Convection, Classification of Fluid Flows, Velocity Boundary Layer, Thermal Boundary Layer, Laminar and Turbulent Flows, Derivation of Differential Convection Equations, Nondimensionalized Convection Equations and Similarity. Forced and Natural Convections.
6. Natural Convection: Introduction, Boussinesq Approximation, Physical mechanism of Natural Convection, Equation of motion and the Grashof Number. Natural Convection over surfaces. Natural Convection inside Enclosures.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. J. P. Holman, Heat Transfer.
2. Yunus A. Cengel, Heat Transfer, A Practical Approach.
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn, Principles of Heat Transfer.
4. M. Necati Ozisik, Heat Transfer, A Basic Approach.
5. Adrian Bejan and Allan D. Kraus, Heat Transfer Handbook.

AMTH 411: Modern Astronomy 3 credits

1. Celestial Sphere: Sphere and spherical triangles, the celestial sphere, problems connected with diurnal motion.
2. Astronomical Co-ordinate: The first system of coordinates, The Second system of coordinates, The Third system of coordinates, Transformation Co-ordinates, Astronomical Refraction, The ecliptic and the first point of Aries.
3. Kepler's laws: Equations of time, unit of time.
4. Geocentric parallax: The moon, Local line, Eclipses.
5. The Solar System: Planets, Bode's Law, Sidreal Period and synodic period of a Planet, General Description of Solar System.
6. The Moon: Moon;s Librations, Relation between Sidreal months and synodic months, Phases of Moon, Moon's Nodes and Nodal period, Daily retardation of moon-rise.
7. Precession and mutation, Annual parallax, Aberration of light.
8. The stellar universe,Modern finding of astronomical objects, Working process of the Hubble telescope and its finding.

Evaluation : Incourse Assessment 30 Marks. Final examination (Theory, 3 hours) 70 Marks.
Eight questions will be set, of which any **five** are to be answered.

References

1. K.R. Khan & A.Z. Sikder, Astronomy.
2. W.R. Smart, Spheical Astronomy.
3. G.V. Ramnchandran, A Text Book of Astronomy.

AMTH 412: Quantum Theory and Special Relativity 3 credits

1. Wave-particle duality; Schrödinger's equation; stationary states; quantum states of a particle in a box, infinite square well potential, finite square wells, boundary conditions at a potential step, bound states in a finite well, reflection and transmission by a finite step, and by a barrier, tunnelling.
2. The one-dimensional harmonic oscillator; higher-dimensional oscillators and normal modes; degeneracy.
3. The basic postulates of quantum mechanics; Commutation relations and compatibility of different observables; Heisenberg's uncertainty principle.
4. Angular momentum in quantum mechanics, angular momentum operators; Orbital angular momentum, particle in two dimensions (eigenfunctions and eigenvalues of L_z), particle in three dimensions (eigenfunctions and eigenvalues of L^2 and L_z), rotational states of a diatomic molecule; Spherical harmonics
5. Hydrogen Atom: Central potential, Energy levels, size and shape of energy eigenfunctions, effect of finite mass of nucleus, EM spectrum, hydrogen-like systems.
6. Electron spin, Sten-Gerlach experiment, quantum states of two identical particles, spin and space wave functions and origin of the Pauli Exclusion Principle. Energy states of the He atom.
7. Constancy of the speed of light. Galilean relativity, Maxwell's equations, wave equation in electromagnetism, Principles of Einstein's special relativity, Lorentz transformations, time dilation, length contraction, simultaneity, space-time separation, the Twin paradox, causality.
8. Tensor equations, Index notation, four-vectors, four-velocity and four-momentum; equivalence of mass and energy: $E = mc^2$; particle collisions and four-momentum conservation; Photons and Compton scattering, mass transport by photons, particle production and decay, four-acceleration and four-force, Lorenz force, the example of the constant-acceleration world-line, the relativistic Doppler effect.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References:

1. B.H. Bransden and C.J Joachain Quantum Mechanics.
2. P.C.W. Davies and D.S. Betts, Quantum Mechanics.
3. R.P Feynman, R.B Leighton, M. Sands The Feynman Lectures on Physics.
4. A.I.M. Rae, Quantum Mechanics.
5. N. M. J. Woodhouse, Special Relativity.
6. W Rindler, Introduction to Special Relativity.

AMTH 413: Mathematical Modelling in Biology and Physiology **3 credits**

1. Introduction to Modelling in Biology.
2. Modelling Chemical Reaction Networks.
3. Biochemical Kinetics.
4. Analysis of Dynamic Mathematical Models (cases: Deterministic ODE models and Deterministic PDE Models).
5. Introduction to Physiology.
6. Enzyme Kinetics.
7. Basics of mathematical modelling.
8. Cellular homeostasis.
9. Membrane ion channels.
10. The Hodgkin-Huxley model.
11. Excitability.
12. Neural networks.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Brian Ingalls, Mathematical Modelling in Systems Biology: An Introduction.
2. Fr´ed´eric Cazals, Pierre Kornprobst, Modeling in Computational Biology and Biomedicine: A Multidisciplinary Endeavor.
3. James Keener and James Sneyd, Mathematical Physiology.
4. S. J. Chapman, A. C. Fowler & R. Hinch, An Introduction to Mathematical Physiology.
5. Johnny T. Ottesen, Mette S. Olufsen, Jesper K. Larsen, Applied mathematical models in human physiology.

AMTH 414: Mathematical Neuroscience **3 credits**

1. Introduction to Neurons,
2. Neural encoding and decoding
3. The Hodgkin–Huxley Equations
4. Dynamical Systems and Neuronal Dynamics
5. The Variety of Channels
6. Bursting Oscillations
7. Propagating Action Potentials
8. Synaptic plasticity
9. Neural Oscillators
10. Neuronal Networks: Fast/Slow Analysis
11. Firing Rate Models

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. G. Bard Ermentrout, David H. Terman, Mathematical Foundations of Neuroscience.
2. Alla Borisyuk, Avner Friedman, Bard Ermentrout, David Terman - Tutorials in Mathematical Biosciences I.
3. Peter Dayan, L. F. Abbott -Theoretical Neuroscience Computational and Mathematical Modeling of Neural Systems-The MIT Press (2005).
4. H. Wilson - Spikes, Decisions and Actions, Visual Sciences Center, University of Chicago.

AMTH 415: Industrial Mathematics 3 credits

1. Statistical reasoning: Random variables, Uniform distributions, Gaussian distributions, The binomial distribution, The Poisson distribution, Taguchi quality control.
2. Data acquisition and manipulation: The z-transform, Linear recursions, Filters, Stability, Polar and Bode plots, Aliasing, Closing the loop, Why decibels?
3. The Discrete Fourier Transform: Real time processing, Properties of the DFT, Filter Design, The first Fourier Transform, Image Processing, Applications.
4. Cost benefit analysis: Present value, Life cycle costing.
5. Microeconomics: Supply and demand, Revenue, cost, and profit, Elasticity of demand, Duopolistic competition, Theory of production, Leontiev input/output.
6. Frequency domain methods: The frequency domain, Generalized signals, Plants in cascade, Surge impedance, Stability, Filters, Feedback and root-locus, Nyquist analysis, Control.
7. Splines: Why cubics? m-Splines, Cubic splines.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

Reference

1. C. R. MacCluer, Industrial Mathematics: modeling in industry, science, and government.

AMTH 416: Computational Science and Engineering 3 credits

1. Applied Linear Algebra: Four Special Matrices, Differences, Derivatives, and Boundary Conditions, Elimination Leads to K = LDL^T, Inverses and Delta Functions , Positive Definite Matrices , Numerical Linear Algebra: LU, QR, SVD.
2. A Framework for Applied Mathematics: Equilibrium and the Stiffness Matrix, Oscillation by Newton's, Law, Least Squares for Rectangular Matrices, Graph Models and Kirchhoff's Laws, Networks and , Transfer Functions, Nonlinear Problems , Structures in Equilibrium, Covariances and Recursive Least , Squares, Graph Cuts and Gene Clustering.
3. Boundary Value Problems: Differential Equations of Equilibrium, Cubic Splines and Fourth Order Equations, Finite Differences and Fast Poisson Solvers, Elasticity and Solid Mechanics.
4. Fourier Series and Integrals: Convolution and Signal Processing, Deconvolution and Integral Equations, Wavelets and Signal Processing.
5. Analytic Functions, Famous Functions and Great Theorems, The Laplace Transform and z-Transform, Spectral Methods of Exponential Accuracy .
6. Initial Value Problems: Introduction, Finite Difference Methods for ODE's, Accuracy and Stability for u_t = c u_x, The Wave Equation and Staggered Leapfrog, Diffusion, Convection, and Finance, Nonlinear Flow and Conservation Laws, Fluid Mechanics and Navier-Stokes, Level Sets and Fast Marching.
7. Solving Large Systems: Elimination with Reordering, Iterative Methods, Multigrid Methods, Conjugate Gradients and Krylov Subspaces.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

References

1. Gilbert Strang, Computational Science and Engineering.
2. Gilbert Strang, Introduction to Applied Mathematics.

AMTH 430: Special Topics **3 credits**

Any mathematical topic not covered in other courses may be offered under this title. The course-teacher will prepare an outline of the course and obtain the approval of the departmental academic committee.

Evaluation: Incourse Assessment 30 Marks, Final examination (Theory, 3 hours) 70 Marks.
Eight questions of equal value will be set, of which any **five** are to be answered.

AMTH 450: MATH LAB IV (Application softwares) **3 credits**

AMTH 460: Honours Project **3 credits**

Each student is required to work on a project and present a project report for evaluation. Such projects should be extensions or applications of materials included in different honours courses and may involve field work and use of technology. There may be group projects as well as individual projects.
The Academic Committee shall form a Project Coordination and Evaluation Committee (PCEC) at the beginning of the session. The PCEC shall consist of a project Coordinator (PC) and members as the Academic Committee considers appropriate. The PC shall invite projects from the teachers before the class start. Each teacher should submit three project proposal should include a short description of the project. Such projects should be extension or applications of materials included in different courses, and may involve fieldwork and use of technology.
The PCEC shall assign each group a project. The members of each group shall work independently on the assigned project under the supervision of the concerned teacher. The PCEC and the supervisors will monitor the progress of different projects.

Completion of project:
The project must be completed before the termination of the classes. Each student is required to prepare a separate report on the project. Each report should be of around 40 pages typed on one side of A4 size white paper preferably using word processors. Graphs and figures should be clearly drawn preferably using computers. Reports of different students working on the same group project should differ in some details and illustrations.
The Academic Committee will select a date for the submission of the project reports to the PCEC. Each student must submit three printed copies of her/his project report to the PCEC on or before the date announced for such submission.
The PCEC, on receiving the reports will arrange the presentation of reports by individual students before the PCEC. This presentation should take place soon after the completion of the written examination.
Any student who fails to submit the report on the due date or to present the thesis on the fixed date will not get any credit for this course.

AMTH 499: Viva Voce **2 credits**

Viva Voce on courses taught in Fourth Year.