Netaji Subhas Open University
Honours in Mathematics
Programme Code - HMT

Programme Objectives

The objective of learning through this programme is to help the learners to acquire the fundamental concept of higher Mathematics. Keeping in mind the horizons of open and distance learning, this programme aims at augmenting the domain knowledge and comprehension of the learners with the help of our learning resources in a very efficient and innovative manner. This degree will take learner's understanding of the concepts, theories and applications of mathematics to graduate level at per with the regular mode, and alongside give them exposure to concepts of natural sciences including statistics, theoretical physics etc. The syllabus is structured in such a way that a student can acquire the potential of analytical thinking towards solving a real-world problem in a formal mathematical way.

Expected Programme Outcome

- In addition to merely mastering crude problem- solving techniques, learners will also be able to understand the axiomatic approach in mathematics and capable of developing ideas based on them.
- Sound sense of reasoning through rigorous mathematical approach will be inculcated.
- Learners will be able to characterize various mathematical phenomena as well as appreciate and produce counter-examples when no characterization is possible.
- Learners will be able to translate different real- life problems into rigorous mathematical problems and solve as well as analyse them to understand the concerned real- life problems.
- Learners will be equipped with a wide range of mathematical methods/tools suitable for other scientific and engineering domains.
- Advanced knowledge of the domain and augmented analytical capability in pure as well as applied mathematics will empower the learners to pursue higher studies and research at reputed academic institutions.
- Learners will be instilled with aptitude and attitude required for lifelong continuous education process.
- Learners will become eligible to be employed in various job sectorsincluding teaching, banking, insurance, risk management etc.

Programme Structure

	SEM	CODE	Course Name	Theory/ Prac.	Credit	Study Hours	TEE Full Marks	Assignment Full Marks	Total Marks	Pass Marks 30%
1st Year	I	CC-MT-01	Algebra	Theory	6	180	50	20	70	21
		CC-MT-02	Analytical Geometry	Theory	6	180	50	20	70	21
		AE-BG-11 /AE-EG-12	Bengali /English*	Theory	2	60	50	20	70	21
		#GEC-01	Refer Table Below	Theory	6	180	50	20	70	21
	II	CC-MT-03	Calculus	Theory	6	180	50	20	70	21
		CC-MT-04	Real Analysis	Theory	6	180	50	20	70	21
		AE-ES-21	Environmental Studies	Theory	2	60	50	20	70	21
		#GEC - 02	Refer Table Below	Theory	6	180	50	20	70	21
2nd Year	III	CC-MT-05	Numerical Methods	Theory	6	180	50	20	70	21
		CC-MT-06	Computer Programming & Numerical Methods Lab	Practical	6	180	70	00	70	21
		CC-MT-07	Differential Equations	Theory	6	180	50	20	70	21
		SE-MT-11	Logic and Sets	Theory	2	60	50	10	60	18
		#GEC- 03	Refer Table Below	Theory	6	180	50	20	70	21
	IV	CC-MT-08	Theory of Real Functions and Functions of Several Variables	Theory	6	180	50	20	70	21
		CC-MT-09	Riemann Integration and Series of Functions	Theory	6	180	50	20	70	21
		CC-MT-10	Group Theory	Theory	6	180	50	20	70	21

		SE-MT-21	Graph Theory	Theory	2	60	50	10	60	18
		#GEC- 04	Refer Table Below	Theory	6	180	50	20	70	18
3rd Year	**V**	**CC-MT-11**	Multivariate Calculus and PDE	Theory	6	180	50	20	70	21
		CC-MT-12	Ring Theory and Linear Algebra	Theory	6	180	50	20	70	21
		DS-MT-11	Number Theory	Theory	6	180	50	20	70	21
		DS-MT-21	Probability and Statistics	Theory	6	180	50	20	70	21
	VI	**CC-MT-13**	Mechanics	Theory	6	180	50	20	70	21
		CC-MT-14	Metric Spaces and Complex	Theory	6	180	50	20	70	21
		DS-MT-31	Linear Programming	Theory	6	180	50	20	70	21
		DS-MT-41	Integral Transform	Theory	6	180	50	20	70	21
	TOTAL				**140**				**1800**	

Learners will choose anyone from AE-BG-11: Bengali or AE-EG-12: English as Ability Enhancement Compulsory Course 1

#Any one from each group (column) to be selected from the following

Option of GE courses for HMT

Subject	SEM-I: GE-01	SEM-II: GE-02	SEM-III: GE-03	SEM-IV: GE-04
Physics	**GE-PH-11:** Mechanics	**GE-PH-21:** Thermal Physics	**GE-PH-31:** Waves and Optics	**GE-PH-41:** Elements of Modern Physics
Geography	**GE-GR-11:** Rural Development	**GE-GR-21:** Geography of Tourism	**GE-GR-31:** Climate Change: Vulnerability and Adaptations	**GE-GR-41:** Disaster Management
Chemistry	**GE-CH-11:** Basic Physical Chemistry	**GE-CH-21:** Basic Inorganic Chemistry	**GE-CH-31:** Basic Organic Chemistry	**GE-CH-41:** Application Oriented Chemistry
				GE-CH-42: Approved MOOCs'

Examination System Per Semester

Term-End Examination Dec (Odd Sem July-Dec)

Semester I	Semester III	Semester V
CC1 CC2 AECC1 (Beng/ Eng) GE1 Total credit: 20	CC5 CC6 CC7 SEC1 GE3 Total credit: 26	CC11 CC12 DSEC1 DSEC2 Total credit: 24

Term-End Examination June (Even Sem Jan-June)

Semester II	Semester IV	Semester VI
CC3 CC4 AECC2 (ENVS) GEC2 Total credit: 20	CC8 CC9 CC10 SEC2 GEC4 Total credit: 26	CC13 CC14 DSEC3 DSEC4 Total credit: 24

Assignment will be conducted through digital platform on MCQ

Objective and Expected Outcome for Each Course

Course Code	Course Objectives	Expected Outcomes
Core Courses		
CC-MT-01 Algebra	To familiarize the students with basic tools and techniques of classical and linear algebra	After completing this course, learners will able to solve various problems of complex number system, problems related to polynomials, systems of linear equations, eigen values and eigen vector etc.
CC-MT-02 Analytical Geometry	To understand different properties of conic sections and conicoids as well as various topics of vector algebra with their application to geometry.	After completing this course, learners will be able to apply techniques involving orthogonal transformation, classify conic sections, write polar equations of conics and their tangents, normal in two dimensions. Moreover, they will have a good grasp of

		three-dimensional analytical geometry involving equations of planes, straight lines, conicoids and the classification of quadrics. They will also be able to use and apply results of vector algebra to geometry
CC-MT-03 Calculus	To learn and apply differential and integral calculus of real and vector valued functions	This course will enable the learner to understand techniques for higher order derivatives including Leibnitz rule. Apart from this, learners will get to know and use reduction formulae, arc length, area and volume of revolution using integral calculus. They will also learn about vector calculus.
CC-MT-04 Real Analysis	To learn about various properties of a point and subsets of the set of real numbers, sequences andseries of real numbers aswell as power series.	After completing this course, learners will be able to understand cardinality, boundedness of subsets of real numbers; important properties like completeness, Archimedean property of real number system. Ability to determine convergence and divergence of sequence andseries of real numbers, and power series are also among outcomes of this course.
CC-MT-05 Numerical Methods	To learn about how to solve different mathematical problems with the help of numerical operations	This course will provide a primer on algorithms, convergence, errors and computer programming. They will learn different kind of number systems viz. binary, decimal, octal and hexadecimal. The learner will be able to find solutions numerically of polynomial and transcendental equations, system of linear

		algebraic equations. They will learn about interpolations, numerical differentiations and integrations
CC-MT-06 Computer Programming & Numerical Methods Lab	To obtain hands-on experience on computer programming and solving mathematical problems numerically	After completion of this course, learners will be able to grasp several important concepts and techniques of computer programming including variables, expressions, control statements, array etc. They will also learn to how to solve different mathematical problems engaging numerical methods with the help of computer programming
CC-MT-07 Differential Equations	To learn to solve different types of differential equations and system of differential equations and to understand the behaviour of the solutions	After completing this course, learners will be able to find solutions of different types including general, particular, singular solutions etc. of differential equations. Techniques and methods of using integrating factors. Wronskian, undetermined coefficients, variation of parameters etc will be understood. They shall interpret the behaviour of equilibrium points, phase plane etc. They will also be able to analyse rectilinear, simple harmonic motions, damped and forced oscillations etc.
CC-MT-08 Theory of Real Functions and Functions of Several Variables	To learn about the behaviour of real valued functions of single as well as several real variables	After completion of this course, learners will be able to appreciate and apply sequential criteria of limit and continuity of real functions. They will also have a grasp over important concepts of uniform continuity, differentiability, mean value theorems, Taylor's and Maclaurin's series etc. and

		their applications. Moreover, they will also learn about limit, continuity and differentiability of functions of several variables.
CC-MT-09 Riemann Integration and Series of Functions	To learn about various integration concepts and series of functions	After completing this course students can understand the basic concept of Riemann integration and the convergence concept of series of functions.
CC-MT-10 Group Theory	After completing this course students can understand the basic concept of Riemann integration and the convergence concept of series of functions.	After completing this course students can understand various concepts of symmetries and the underlying mathematical concepts.
CC-MT-11 Multivariate Calculus and PDE	To learn about various techniques of multivariable calculus and PDE	After completing this course students can understand various techniques of multivariable calculus and also some applications in real-world problems. Further, they can apply various techniques of PDE in solving various kinds of physical problems
CC-MT-12 Ring Theory and Linear Algebra	To learn about various concepts of rings and linear algebra	After completing this course students can understand various techniques of ring theory. Further, they can understand vector spaces, eigen values, determinants and some of their applications
CC-MT-13 Mechanics	To learn about various concepts of classical mechanics	After completing this course students can understand various techniques of the classical machine and its applications in real-world problems
CC-MT-14 Metric Spaces and Complex Analysis	To learn about various concepts of metric spaces and complex analysis	After completing this course students can understand what the distance actually is. They can generalise the distance concept. This helps them to understand more abstract concepts of mathematics such as topology and differential

		geometry. Also, they can handle some elementary problems of complex analysis
Discipline Specific Elective Courses		
DS-MT-11 Number Theory	To learn about various concepts of number theory	After completing this course students can understand some basic theories of numbers such as congruency, divisibility, integer functions etc and some of their applications in geometry and algebra
DS-MT-21 Probability and Statistics	To learn about various concepts of Probability & Statistics	After completing this course students will be able to apply various concepts of probability in solving real-world problems. Also, they will be capable of doing statistical techniques
DS-MT-31 Linear Programming	To learn various concepts of linear programming and some applications	After completing this course students will be able to tackle various problems such as assignment problems, and transportation problems using various techniques of linear programming such as Simplex method etc
DS-MT-41 Integral Transform	To learn various techniques of integral transform	After completing this course students will be able to learn various concepts of integral transform such as Laplace transformation, Fourier transformation and some their application in solving differential equation
Skill Enhancement Courses		
SE-MT-11 Logic and Sets	To learn about various concepts of logic and sets	After completing this course students can understand some basic logic and set theory that can help them to grasp more complicated concepts of mathematics
SE-MT-21 Graph Theory	To learn about various techniques in graph theory	After completing this course students can apply various techniques of graph theory in real-world problems

Generic Elective Courses		
GE-MT-11 Statistical Techniques	To learn about different concepts of statistics and related techniques	After completing this course, learners will be able to appreciate and apply different concepts and tools of probability, theoretical distributions, survey methodology, estimation theory, testing of statistical hypotheses as well as correlation and regression
GE-MT-21 Dynamical Systems	To learn about different concepts of Dynamical Systems	After completing this course, learners will be able to appreciate and apply different concepts and tools of linear continuous dynamical systems, non-linear autonomous systems and discrete systems
GE-MT-31 Applications of Algebra	To learn about application of algebra to different fields	After completing this course, learners will be able to appreciate and apply different concepts of balanced incomplete block design (BIBD), coding theory, symmetric groups and color patterns, different types of matrices and linear transformations
GE-MT-41 Modelling and Simulation	To learn about mathematical modeling and simulation different real-life problems	After completing this course, learners will be able to explain different real-life problems using discrete and continuous mathematical models. Also, they will be capable of finding numerical solution of the models and their graphical representation using EXCEL both for discrete and continuous cases.

Detailed Syllabus

Semester-I
Core Course-1 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-01, Course Title: Algebra

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Exponential, logarithmic, trigonometric and hyperbolic functions of complex number.
General properties of equations, Descartes's rule of signs, relation between roots and coefficients,
transformation of equations, cubic and biquadratic equations.
The inequality involving AM>GM>HM, Cauchy-Schwartz inequality. Inverse of a matrix, Rank of a matrix,
Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence. characteristic equation of a matrix, Eigen value of a matrix, Eigen vectors, Cayley-Hamilton theorem. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Books Recommended
Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
K.B. Dutta, Matrix and linear algebra, 2004

Semester-I
Core Course-2 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-02, Course Title: Analytical Geometry

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. rotation of axes, General Equation of second degree, classification of conics (including pair of straight lines) using the discriminant. Polar Equations of Conics, Tangent and Normal, Conjugate Diameters

Equation of planes, straight lines, Spheres, Cone, Cylinder, central conicoids, paraboloid, tangent and normals, planes section of conicoids, generating lines, classification of quadrics

Vector Triple product, vector equation and application to geometry

Books Recommended
Loney, Co-ordinate Geometry, Reem Publication Pvt. Ltd.

R. J. T. Bell, An Elementary Treatise on Co-ordinate Geometry, Macmillan & Co. Ltd., 1963.
N. Dutta & R. N. Jana, Analytical Geometry and Vector Algebra, Shreedhar Prakashani, Kolkata

Semester-II
Core Course-3 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-03, Course Title: Calculus

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of Type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, curvature, concavity and inflection points, asymptotes, Envelopes, curve tracing in Cartesian coordinates, tracing in polar coordinates ofstandard curves, L'Hospital's rule, applications in business, economics and life sciences.
Reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^n x\, dx$, $\int cos^n x\, dx$, $\int tan^n x\, dx$, $\int sec^n x\, dx$, $\int (log\ x)^n\, dx$, $\int sin^n x\, sin^m x\, dx$, parametric equations, arc length, arc length of parametric curves, area and volume of surface of revolution.

Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Books Recommended
G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (PearsonEducation), Delhi, 2007.
H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, NewYork, Inc., 1989.

Semester-II
Core Course-4 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-04, Course Title: Real Analysis

Algebraic and Order Properties of *R*, -neighbourhood of a point in *R*, Idea of countable sets, uncountable sets and uncountability of *R*. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of *R*, The Archimedean Property, Density of Rational (and Irrational) numbers in *R*, Intervals. Limit points of a set, isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n-th root test,

Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence, Power series, radius of convergence.

Books Recommended

R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994

Semester-III
Core Course-5 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-05, Course Title: Numerical Methods

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation.
Transcendental and Polynomial equations: Bisection method, Secant method. Regular-falsi method, Newton-raphson method, Rate of convergence of these methods.

System of linear algebraic equations: Gaussian elimination and Gauss-Jordan methods. Gauss-Jacobi, Gauss-Siedel and SOR iterative methods and their convergence analysis.

Interpolation: Lagrange's and Newton's methods (forward difference, backward difference and central difference interpolation), error bounds, finite difference operators. Numerical differentiation.
Numerical Integration: Newton cotes formula, trapezoidal rule, Simpson's rule, Weddle's rule.

Computer Language: Concept of programming languages, Machine language, Assembly language, High-level language, Interpreter, Compiler, Source and Object programs.

Number Systems: Binary, decimal, octal and hexadecimal number systems and their conversions.

Books Recommended

Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering, 2012. Computation, 6th Ed., New age International Publisher, India, 2007.
C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.

Semester-III
Core Course-6 (Practical) Credit-6, Full Marks-70
Course Code: CC-MT-06, Course Title: Computer Programming & Numerical Methods Lab

Programming Language in C or any other language: Character set, Keywords, Basic data types, Numeric constants and variables operators, Expressions, Assignment statements, I/0-statements.

Control Statements: Decision making and Looping statements, break continue and go to statements, Example of simple programs. Subscripted variables: Concept of array variables in programming language, Rules for one dimensional subscripted variable, Simple programs.

List of Practicals (using any software)

(i) Calculate the sum $\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{N}$
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton Raphson Method.
(vi) Secant Method.
(vii) Method of False Position.
(viii) LU decomposition Method.
(ix) Gauss-Jacobi Method.
(x) SOR Method or Gauss-Siedel Method.
(xi) Lagrange Interpolation or Newton Interpolation.
(xii) Simpson's rule, Weddle's rule (or Trapezoidal rule)

Books Recommended

Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
Yashavant Kanetkar, Let Us C , BPB Publications, 2016.

Semester-III

Core Course-7 (Theory) Credit-6, Full Marks-70

Course Code: CC-MT-07, Course Title: Differential Equations

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Clairaut's equations, Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.
Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.
Eigen-value problems, Equilibrium points, Interpretation of the phase plane
Power series solution of a differential equation about an ordinary point, solution about a regular singular point.
Rectilinear Motion and Simple Harmonic Motion. Damped and Forced Oscillation.

Books Recommended

C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
Murray, D., Introductory Course in Differential Equations, Longmans Green and Co, 1897.

Semester-IV

Core Course-8 (Theory) Credit-6, Full Marks-70

Course Code: CC-MT-08, Course Title: Theory of Real Functions and Function of Several Variables

Limits of functions (approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities.

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential andtrigonometric functions, $\ln(1 + x)$,) and $(1 + x)^n$.

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters.

Books Recommended

R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004. A, Mattuck, Introduction to Analysis, Prentice Hall, 1999.
S.R. Ghorpade and B.V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 2002.

Semester-IV
Core Course-9 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-09, Course Title: Riemann Integration and Series of Functions

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.

Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

Improper integrals; Convergence of Beta and Gamma functions.

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.Limit superior and Limit inferior. Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Books Recommended

K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
S. Goldberg, Calculus and Mathematical analysis.

Semester-IV
Core Course-10 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-10, Course Title: Group Theory

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Books Recommended

John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., 1999.
Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., 1995.
I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Semester-V
Core Course-11 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-11, Course Title: Multivariate Calculus and PDE

Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl.

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.

Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Partial differential equations of the first order, Lagrange's solution, nonlinear first order partial differential equations, Charpit's general method of solution, some special types of equations which can be solved easily by methods other than the general method.

Classification of second order linear equations as parabolic, hyperbolic or elliptic and their reduction to canonical forms.

Method of separation of variables.

Books Recommended

G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.

E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.

Semester-V
Core Course-12 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-12, Course Title: Ring Theory and Linear Algebra

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients. Introduction to polynomial ring.

Vector spaces, subspaces, algebra of subspaces, dimension of sub-spaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator. Diagonalizability, invariant subspaces.

Books Recommended

John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., 1999.
Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., 1995.
I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975

Semester-VI
Core Course-13 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-13, Course Title: Mechanics

Co-planar forces, Astatic equilibrium, friction, Equilibrium of a particle on a rough curve, virtual work, forces in three dimensions, general conditions of equilibrium, centre of gravity for different bodies, stable and unstable equilibrium.

Radial and cross-radial, Tangential and Normal components of acceleration, Equation of motion referred to a set of rotating axes.

Central forces, modeling of ballistics and planetary motion, Inverse Square Law, Kepler's laws on Planetary Motion.

Motion of a projectile in a resisting medium (including vertical directionx, stability of nearly circular orbits, slightly disturbed orbits, varying mass. Motion of artificial satellites, constrained motion of a particle on smooth curve.

Degree of freedom, Moments and products of inertia. Momental ellipsoid, principal axes,

D'Alembert's principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces, Conservation of momentum and energy.

Books Recommended

I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, 2006. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2010.
Chorlton, F., Textbook of Dynamics CBS Publishers & Distributors, 2005.
Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, 2017.
Loney, S. L., Elements of Statics and Dynamics I and II, 2004.

Semester-VI
Core Course-14 (Theory) Credit-6, Full Marks-70
Course Code: CC-MT-14, Course Title: Metric Spaces and Complex Analysis

Definition and examples of metric spaces. Open ball. Open set. Closed set as complement of open set. Interior point and interior of a set. Limit point and closure of a set. Boundary point and boundary of a set. Properties of interior, closure and boundary. Bounded set and diameter of a set. Distance between two sets. Subspace of a metric space.

Convergent sequence. Cauchy sequence. Every convergent sequence is Cauchy and bounded, but the converse is not true. Completeness. Cantor's intersection theorem. R is a complete metric space. Q is not complete.
Continuous mappings, sequential criterion of continuity. Uniform continuity
Compactness, Sequential compactness, Heine-Borel theorem in R. Finite intersection property, continuous functions on compact sets.

Concept of connectedness and some examples of connected metric space, connected subsets of R, C.

Stereographic projection. Regions in the complex plane. Limits, limits involving the point at infinity. Continuity of functions of complex variable.

Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, exponential function, logarithmic function, trigonometric functions, hyperbolic functions. Mobius transformation.

Power series : Cauchy-Hadamard theorem. Determination of radius of convergence. Uniform and absolute convergence of power series. Analytic functions represented by power series. Uniqueness of power series.

Books Recommended

S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
James Ward Brown and Ruel V.Churchill, Complex variables and Applications, McGraw Hill, 2013. E.T.Copson, Introduction to the theory of functions of a complex variable, Clarendon press Oxford,1935.

Discipline Specific Elective Courses

Semester-V
Discipline Specific Elective Course-1 (Theory) Credit-6, Full Marks-70
Course Code: DS-MT-11, Course Title: Number Theory

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation$x^2 + y^2 = z^2$, Fermat's Last theorem.

Books Recommended

David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.

Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007

Semester-V
Discipline Specific Elective Course-2 (Practical) Credit-6, Full Marks-70
Course Code: DS-MT-21, Course Title: Probability and Statistics

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Random samples, Sampling distributions, Estimation of parameters, Testing of hypothesis.

Books Recommended

Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
Irwin Miller and Marylees Miller and John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007

Semester-VI
Discipline Specific Elective Course-3 (Theory) Credit-6, Full Marks-70
Course Code: DS-MT-31, Course Title: Linear Programming

Introduction to linear programming problem, graphical solution, convex sets, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, Travelling Salesman Problem.

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002

Semester-VI
Discipline Specific Course 4 (Theory) Credit-6, Full Marks-70
Course Code: DS-MT-41, Course Title: Integral Transform

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplacetransform of periodic functions, error functions, Heaviside unit step function and Dirac delta
function, Applications of Laplace transform to solve ODEs and PDEs.

Finite Laplace Transform: Definition and properties, Shifting and scaling theorem.

Fourier series: Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series.

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

Books Recommended

I.N. Sneddon– The use of Integral Transforms, McGraw-Hill. Singapore 1972.
R.R. Goldberg, Fourier transforms, Cambridge University Press, Cam bridge, 1961.
D. Brain- Integral Transformation and their applications. Springer-Verlag, New York, 2002.
R. Brace wall- The Fourier transform and its applications, McGraw-Hill, New York, 1999.

Skill Enhancement Courses

Semester-III

Skill Enhancement Course 1 (Theory) Credit-2, Full Marks-60

Course Code: SE-MT-11, Course Title: Logic and Sets

Chapter 1: Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

Chapter 2: Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Chapter 3: Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set.

Standard set operations. Classes of sets. Power set of a set.

Chapter 4: Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.

Chapter 5: Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

Books Recommended

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

Semester-IV

Skill Enhancement Course 2 (Theory) Credit-2, Full Marks-60

Course Code: SE-MT-21, Course Title: Graph Theory

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, theadjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Generic Elective Courses
(For learners of Honours programmes other than Mathematics)

Semester-I
Generic Elective Course-1 (Theory) Credit-6, Full Marks-70
Course Code: GE-MT-11, Course Title: Statistical Techniques

Chapter 1. Probability

Unit 1: Basic concepts, Classical definition of probability with its limitations, Axiomatic definition of probability, idea of random variables (with examples).

Unit 2: Empirical and theoretical distribution with their properties, probability mass function and probability density function, mathematical expectation, conditional expectation. Variance and Co- variance.

Unit 3: Moments and moment generating function mgf), properties of mgf, mgf of some distributions.

Unit 4: Markov chain, Chebyshev's inequality and its uses, Characteristic function and its properties

Chapter 2. Theoretical Distribution

Unit 1. Various discrete distributions e.g., Uniform distribution of the discrete type, Binomial, Negative Binomial, Poisson and Geometric distributions.

Unit 2. Various continuous distributions, e.g., Uniform distribution of the continuous type, Exponential, Erlangian, Gamma, Beta, Normal and Log-normal distributions.

Unit 3. Sampling distributions, e.g., Chi-square, t distribution, and F distribution and also their uses. Unit 4. The idea of bivariate distribution, Bivariate normal distribution and its marginal and conditional distributions, Weak Law of Large Numbers (WLLN), Central Limit Theorem (CLT).

Chapter 3. Survey Methodology

Unit 1. Sample Survey and Complete Enumeration, their advantages and disadvantages, sampling and non-sampling errors.

Unit 2: Different types of sampling, simple random sampling with replacement (SRSWR), simple random sampling without replacement (SRSWOR), idea of sampling errors in SRSWR and SRSWOR.

Unit 3. The method of drawing random samples, random numbers – their uses and properties, different tests for random numbers.

Unit 4. Random number generation using inverse transformation technique with reference to some standard distributions, e.g., Cauchy, exponential, gamma, etc.

Chapter 4. Estimation Theory

Unit 1. Statistic and Parameter, properties of good estimator- unbiasedness, consistency, sufficiency and efficiency, with examples. The concept of completeness of a distribution. Basu's Theorem and its application.

Unit 2. Minimum variance unbiased estimator, Cramer-Rao Inequality and its uses. Unit 3: The method of generating minimum variance unbiased estimator (MVUE), Rao- Blackwellisation. Examples with some standard distributions.

Unit 4. Method of Maximum Likelihood, Method of Moments.

Chapter 5. Testing Statistical Hypothesis

Unit 1. Population and sample, Type 1 and Type 2 error, power of a test, level of significance of a test, uniformly most powerful (UMP) test.

Unit 2. Confidence co-efficient and confidence interval, point estimation and interval estimation, Confidence intervals for mean, variance and proportions.

Unit 3. Large sample theory of testing for mean, proportions. Chi-square test for goodness of fit. Unit 4. Tests based on Chi-square, t and F – distributions.

Chapter 6. Correlation and Regression

Unit 1. Association between two random variables, the idea of correlation co-efficient and its properties.

Unit 2. Mathematical relationship between random variables, regression equation, curve fitting by the method of least squares.

Unit 3. Regression equations considering the cases of two variables as well as three variables separately.

Unit 4. Partial and Multiple Correlation (for three variables only).

Books Recommended 1. V.K Rohtagi and A.K. Saleh, An Introduction to Probability and Statistics, 2nd Ed., John Wiley & Sons, 2005.

A.M. Goon, M.K. Gupta and T.S. Dasgupta, Fundamentals of Statistics (Vol. I), 7th Ed., The World Press Pvt. Ltd., 2000.

R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Macmillan Publishing Co. Inc., 1978.

Neil A. Weiss, Introductory Statistics, 7th Ed., Pearson Education, 2007.

Semester-II

Generic Elective Course-2 (Theory) Credit-6, Full Marks-70

Course Code: GE-MT-21, Course Title: Dynamical Systems

Definition: Dynamical System, Continuous dynamical System, Discrete dynamic system, Autonomous and non-autonomous dynamic system.

Linear Continuous Dynamical Systems: First order equations, existence, uniqueness theorem, Single species growth equation, logistic growth, Single species model with harvesting, Planar linear systems, equilibrium points, stability, Classification of equilibrium points, phase space, n- dimensional linear systems, stable, unstable and center subspaces.

Nonlinear autonomous Systems: Motion of pendulum, local and global stability, Liapunov method, periodic solution, Bendixson's criterion, Poincare Bendixson theorem, Gradient and Hamiltonian systems, limit cycle, attractors, index theory, Hyperbolic and non-hyperbolic equilibrium points, center manifolds.

Local Bifurcation of equilibrium points: Fixed points, saddle node, pitchfork, trans-critical bifurcation, Hopf bifurcation, co-dimension.

Discrete systems: Logistic maps, equilibrium points and their local stability, cycles, period doubling, chaos, necessary conditions for chaos, Liapunov exponents, routes to chaos, tent map, Logistic map, horse shoe map. Deterministic chaos: Duffing's oscillator, Lorenz System.

Books Recommended

1. M.W. Hirsch, S. Smale, R.L. Devaney, Differential Equations, Dynamical Systems and an Introduction to Chaos, Academic Press, 2008.
2. S.H. Strogatz, Nonlinear Dynamics and Chaos, Westview Press, 2008.
3. M. Lakshmanan, S. Rajseeker, Nonlinear Dynamics, Springer, 2003.
4. L. Perko, Differential Equations and Dynamical Systems, Springer,1996.
5. J.H. Hubbard, B.H. West, Differential equations: A Dynamical Systems Approach, Springer Verlag, 1995.
6. D. Kaplan, L. Gloss, Understanding Nonlinear Dynamics, Springer, 1995.
7. S. Wiggins, Introduction to Applied Nonlinear Dynamical Systems and Chaos, Springer Verlag, 1990.

Semester-III

Generic Elective Course-3 (Theory) Credit-6, Full Marks-70

Course Code: GE-MT-31, Course Title: Applications of Algebra

Chapter 1: Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets.

Chapter 2: Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Chapter 3: Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs

Chapter 4: Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi- definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

Chapter 5: Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an m×n matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended

1. I. N. Herstein and D. J. Winter, Primer on Linear Algebra, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain, Topics in Applied Abstract Algebra, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, Linear Algebra and its Applications. 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, Matrix theory, Springer-Verlag New York, Inc., New York, 1999.

Semester-IV

Generic Elective Course-4 (Theory) Credit-6, Full Marks-70

Course Code: GE-MT-41, Course Title: Modeling and Simulation

What is Mathematical Modeling? History of Mathematical Modeling, Merits and Demerits of Mathematical Modeling.

Introduction to difference equations, Linear Difference equations, Introduction to Discrete Models,
Linear Models: Exemplifying through growth model, Steady state solution: Exemplifying through
growth models with stocking and harvesting, linear stability analysis, Newton's Law of Cooling, Bank Account Problem, Mortgage problem, Drug Delivery Problem: Decay model and Absorption, Harrod Model of Economic growth, War Model, Lake pollution model, Alcohol in the bloodstream model, Arm Race models, Density dependent growth models with harvesting.

Introduction to Continuous Models, Carbon Dating, Introduction to compartmental models, Drug Distribution in the Body, Growth and decay of current in a L-R Circuit, Vertical Oscillations, Horizontal Oscillations, Damped Oscillation, Damped Forced Oscillation, Dynamics of Rowing, Combat Models, Mathematical Model of Influenza Infection (within host), Epidemic Models (SIR, SIRS, SI, SIS), Spreading of rumour model, Steady State solutions, Linearization, Local Stability Analysis, Exponential growth, logistic growth, Gomperzian model, prey predator model, Competition model.

Fluid flow through a porous medium, heat flow through a small thin rod, Wave equation: Vibrating string, Traffic flow, Theory of Car-following, Crime Model. Numerical Solution of the models and its graphical representation using EXCEL for discrete and continuous cases.

Books Recommended

1. B. Albright, Mathematical Modeling with Excel, Jones, and Bartlett Publishers, 2010.
2. F.R. Marotto, Introduction to Mathematical Modeling using Discrete Dynamical Systems, Thomson Brooks/Cole, 2006.
3. J.N. Kapur, Mathematical Modeling, New Age International, 2005.
4. B. Barnes and G. R. Fulford, Mathematical Modelling with Case Studies, CRC Press, Taylor and Francis Group, 2009.
5. L. Edsberg, Introduction to Computation and Modeling for Differential Equations, John Wiley and Sons.