DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade NAAC Re-Accredited (3rd Cycle)

SYLLABUS FOR

M. Sc. II (Mathematics)
(with Specialization in Computational Mathematics)

WITH EFFECT FROM

ACADEMIC YEAR 2017-2018

DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
NORTH MAHARASHTRA UNIVERSITY, JALGAON

Syllabus for M.Sc. II Mathematics (with Specialization in Computational Mathematics)
Syllabus Structure

Semester-III

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination					
					Internal		External		Total	
		Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
MT-301	Functional Analysis	04	--	04	40	--	60	--	100	--
MT-302	Partial Differential Equations	04	--	04	40	--	60	--	100	--
MT-303	Optional Course	04	--	04	40	--	60	--	100	--
MT-304	Optional Course	04	--	04	40	--	60	--	100	--
MT-305	Programming in MATLAB	04	06	10	--	40	--	60	--	100

Th: Theory **Pr:** Practicals/Project **L:** Lectures

List of optional courses to be offered in Semester-III

MT-303(A): Classical Mechanics
MT-303(B): Algebraic Coding Theory
MT-303(C): Special Functions
MT-303(D): Advanced Calculus
MT-303(E): Differential Geometry

Students must choose any one course from the above list as an optional course for MT-303.

MT-304(A): Graph Theory
MT-304(B): Stability Theory
MT-304(C): Probability Theory
MT-304(D): Lattice Theory
MT-304(E): Algebraic Topology

Students must choose any one course from the above list as an optional course for MT-304.

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Syllabus Structure

Semester-IV

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination					
					Internal		External		Total	
		Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
MT-401	Analytic Number Theory	04	--	04	40	--	60	--	100	--
MT-402	Transform Theory	04	--	04	40	--	60	--	100	--
MT-403	Optional Course	04	--	04	40	--	60	--	100	--
MT-404	Optional Course	04	--	04	40	--	60	--	100	--
MT-405	Operations Research with MATLAB	04	06	10	--	40	--	60	--	100

Th: Theory **Pr:** Practicals/Project **L:** Lectures

List of optional courses to be offered in Semester-IV

MT-403(A): Advanced Functional Analysis
MT-403(B): Linear Integral Equations
MT-403(C): Difference Equations
MT-403(D): Cryptography
MT-403(E): Fractional Calculus

Students must choose any one course from the above list as an optional course for MT-403.

MT-404(A): Fuzzy Sets and Applications
MT-404(B): Commutative Algebra
MT-404(C): Wavelet Analysis
MT-404(D): Control Theory
MT-404(E): Fixed Point Theory and Applications

Students must choose any one course from the above list as an optional course for MT-404.

MT 301: Functional Analysis

Unit I: Fundamental of Normed spaces

Normed spaces, Continuity of linear maps, Hahn - Banach theorems. {Chapter II [1], (5, 6, 7)} [**12 Lectures**]

Unit II: Banach spaces and Bounded Linear Maps

Banach Spaces, Uniform bounded principle. {Chapter II [1], (8) & Chapter III [1], (9)} [**12 Lectures**]

Unit III: Open Mapping Theorem

Closed graph theorem, Open mapping theorem, Bounded inverse theorem. {Chapter III [1], (10, 11)} [**12 Lectures**]

Unit IV: Hilbert spaces

Inner product spaces, orthonormal sets, Projection and Riesz representation theorem. {Chapter VI [1], (21, 22, 24)} [**12 Lectures**]

Unit V: Bounded Operators on Hilbert Spaces

Bounded operators, Adjoint, Normal, Unitary and Self Adjoint Operators. {Chapter VII [1], (25, 26)} [**12 Lectures**]

Recommended Text Book:

[1] B. V. Limaye, Functional Analysis, New Age International Limited, New Delhi (1996).

Reference Books:

[1] Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley (2007).

[2] G. F. Simmon, Introduction to General Topology and Modern Analysis, Mc-Graw Hill (2004).

MT-302: Partial Differential Equations

Unit I: Partial Differential Equations of First Order

First order PDE, classification of integrals, Linear equations of first order, Pfaffian differential equations, compatible systems, Cauchy Problem, Integral surfaces through a given curve for partial differential equations, Charpit's method, Jacobi's method.

[**15 Lectures**]

Unit II: Partial Differential Equations of Second Order

Origin of second order partial differential equation, Linear equations with constant coefficients, Equations with variable coefficients, Method of separation of variables, Nonlinear equations of the second order. [**15 Lectures**]

Unit III: Laplace's Equation

The occurrence of Laplace's equation in physics, Elementary solution of Laplace's equation, Families of equipotential surfaces, Boundary value problems, Method of separation of variables, Problems with axial symmetry. [**10 Lectures**]

Unit IV: The Wave Equation

The occurrence of wave equation in physics, Elementary solutions of the one-dimensional wave equation, Riemann-Volterra solution of the one-dimensional wave equation, Method of separation of variables. [**12 Lectures**]

Unit V: The Diffusion Equation

The occurrence of the diffusion equation in physics, Elementary solutions of the diffusion equation, Separation of variables. [**08 Lectures**]

Recommended Text Book:

[1] I. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill Book Company, (1957).

Reference Books:

[1] T. Amarnath: An elementary course in Partial differential equations, Narosa Publishing House, 2nd Edition, (2011).

[2] F. John: Partial Differential Equations, Springer-Verlag, New York, (1982).

[3] D. Bleecker and G. Csordas: Basic Partial Differential Equations, Van Nostrand Reinhold, New York, (1992).

MT-303 (A): Classical Mechanics

Unit I: Variational Problems with Fixed and Boundaries

Variation and its properties, Euler's equation, Variational problems for functional of the form, Functional dependent on Higher order derivatives, Functional dependent on functions on several independent variables, Variational problems in parametric form, Variational problem with a movable boundary for a functional dependent on two functions. ([2], Chap 1: 1.1 to 1.6, Chap 2: 2.1, 2.2). [**16 Lectures**]

Unit II: Survey of the Elementary Principle

Mechanics of a particle and system of particle, Constraints, D'Alembert's principle and Lagrange's equation, Velocity-dependent potential and the dissipation function, Simple applications of the Lagrangian formulation. ([1], Chap 1: 1 to 6). [**10 Lectures**]

Unit III: Variational Principles and Lagrange's Equation

Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic system, Conservation theorems and symmetry properties. ([1], Chap 2: 1 to 6). [**10 Lectures**]

Unit IV: The Hamilton Equation of Motion

Legendre transformations and the Hamilton equations of motion, Cyclic coordinates and conservation theorems, Routh's procedure and oscillations about steady motion, Derivation of Hamilton's equation from a variational principle, The principle of least action. ([1], Chap 8: 1 to 3, 5,6). [**10 Lectures**]

Unit V: Canonical Transformations

The equations of canonical transformation, Examples of canonical transformations, Poisson brackets and other canonical invariants, Equations of motion, infinitesimal canonical transformations and conservations theorems in the poisons bracket formulation. ([1], Chap 9: 1, 2, 4, 5) [**08 Lectures**]

Unit VI: Hamilton-Jacobi Theory

Hamilton-Jacobi equation for Hamilton's principle function, The Harmonic oscillator problem as an example of the Hamilton-Jacobi method. ([1], Chap 10: 1 to 2) [**06 Lectures**]

Recommended Text Books:

[1] Herbert Goldstein, Classical Mechanics, Narosa Publishing House, (1993) (Reprint).

[2] A. S. Gupta, Calculus of Variation with Application, Prentice-Hall of India Private Limited, (2005).

Reference Books:

[1] G. Aruldhas, Classical Mechanics, Phi learning Pvt Ltd (First Edition), (2009).

[2] Madhumangal Pal, A Course on Classical Mechanics, Narosa Book Distributors Private Ltd, (2008).

[3] L. N. Katkar, Problems in Classical Mechanics, Alpha Science International Ltd (2 April 2014).

MT-303 (B): Algebraic Coding Theory

Unit-I Group codes:

Elementary properties, Matrix encoding techniques, Generator and parity check matrices.

[**08 Lectures]**

Unit-II Polynomial codes:

Definition of vector space and polynomial ring, Polynomial codes, Generator and parity check matrices-general case. **[10 Lectures]**

Unit-III Hamming codes:

Binary representation of numbers, Hamming codes. **[06 Lectures]**

Unit-IV Finite fields and BCH codes:

Finite fields, Some examples of primitive polynomials, Bose-Chaudhuri-Hocquenghem codes. **[12 Lectures]**

Unit-V Linear codes:

Generator and parity check matrices, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, New codes obtained from given codes. **[12 Lectures]**

Unit-VI Cyclic codes:

Cyclic Codes, Check polynomial, BCH and Hamming codes as cyclic codes, Non-binary Hamming codes, Idempotents, Some solved examples and an invariance property, Cyclic codes and group codes and group algebras, Self-dual binary cyclic codes. **[12 Lectures]**

Recommended Text Book:

[1] Lekh R. Vermani, Elements of Algebraic Coding Theory, Chapman & Hall Mathematics (1996). [Chapters 1 to 6]

Reference Books:

[1] Raymond Hill, A first course in coding Theory, Oxford University Press (1990).

[2] Shu Lin and Daniel Costello, Error Control Coding" (2nd Edition), Pearson.

[3] Rudiger Urbanke and Thomas Richardson, Modern Coding Theory, Cambridge.

[4] F. J. MacWilliams and N. J. A. Salone, The theory of error-correcting codes, North-Holland publishers.

MT-303 (C): Special Functions

Unit I: The Gamma & Beta Functions:

The Gamma and Beta integrals, Functions and their properties, The Euler Reflection formula, Riemann Zeta functions, Gauss's multiplication formula for $\Gamma(mx)$, Integral representation for Log $\Gamma(mx)$, The Bohr-Mollerup theorem. {[1] Chapter 1; 1.1, 1.2, 1.3, 1.5, 1.6, 1.9} [**15 lectures**]

Unit II: Legendre Polynomials:

Solution of Legendre differential equation and Legendre polynomials, Rodrigue's formula, Generating function, Recurrence relations, Orthogonal and orthonormal functions, Orthogonal property of Legendre's polynomials, Fourier Legendre's series. {[2] Chapter 7; **7**.1, 7.2, [3] Chapter 4; 4.2} [**15 lectures**]

Unit III: Bessel's Functions:

Solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, Fourier Bessel's series. {[2] Chapter 7; 7.4, 7.5, [3] Chapter 3; 3.2} [**15 lectures**]

Unit IV: The Hypergeometric Functions:

The Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function. {[1] Chapter 2; 2.1, 2.2, 2.3, 2.4}
[**15 lectures**]

Recommended Text Books:

[1] George E. Andrews, Richard Askey, Ranjana Roy, Special Functions, Cambridge University Press, (2010).

[2] R. K. Jain and S. R. K. Iyengar Advanced Engineering Mathematics, Narosa Publishing House, New Delhi, (2008).

[3] Mark A. Pinsky, Partial Differential Equations and Boundary Value Problem with Applications, McGraw-Hill, Ins. (1991).

Reference Books:

[1] Earl D. Rainville, Special Functions, Chelsea Publishing Company, New York, (1960).

[2] H. M. Srivastava, A Treatise, On Generating Functions, John Wiley & Sons, New York.

MT-303 (D): Advanced Calculus

Unit I: Topology of $\mathbb{R}^n$

Compact and connected subsets of $\mathbb{R}^n$. [**10 Lectures**]

Unit II: Differentiation

Derivative, Continuous differentiable functions, Chain rule, Inverse function theorem (Statement only), Implicit function theorem (Statement only). [**10 Lectures**]

Unit III: Integration

Integral over a rectangle, Existence of the integral, Evaluation of the integral, Integral over a bounded set, Rectifiable sets, Improper integrals. [**10 Lectures**]

Unit IV: Change of Variables

Change of variable theorem (proof of one variable), Statement of n −variables (with illustrations). [**10 Lectures**]

Unit V: Line, Surface and Volume Integrals

Line integrals, Double integrals, Applications to area and volume, Green's theorem in the plane, Change of variables in a double integral, Area of parameter surface, Surface integral, Stokes theorem, Gauss divergence theorem and applications.

[**20 Lectures**]

Recommended Text Books:

[1] J. R. Munkres: Analysis on Manifold, Addition Wesley Pub. Co., (1991). (Sections 3 to 15 and 17 for Units I to IV)

[2] T. M. Apostol: Calculus (Vol. II), Second Edition, John Wiley and Sons, Inc., (1969). (Unit V)

Reference Books:

[1] Walter Rudin: Principles of Mathematical Analysis, McGraw-Hill Book Company, 3rd Edition (2013).

[2] T. M. Apostol: Mathematical Analysis, Narosa Publishing House, 2nd Edition (1977).

[3] David Widder: Advanced Calculus, Prentice Hall; 2nd Revised Edition, (1961).

[4] M. R. Spiegel: Advanced Calculus, Schaum's Outline Series, Mc-Graw Hill Book Company, (1974).

MT 303 (E): Differential Geometry

Unit I: Calculus on Euclidean Space

Euclidean Space, Tangent Vectors, Directional Derivatives, Curves in E^3, 1-Forms, Differential Forms, Mappings. **[08 Lectures]**

Unit II: Frame Fields

Dot Product, Curves, The Frenet Formulas, Arbitrary-Speed Curves, Covariant Derivatives, Frame Fields, Connection Forms. **[12 Lectures]**

Unit III: Euclidean Geometry

Isometries of E^3, The Derivative Map of an Isometry, Orientation, Euclidean Geometry, Congruence of Curves. **[12 Lectures]**

Unit IV: Calculus on a Surface

Surfaces in E^3 , Patch Computations, Differentiable Functions and Tangent Vectors, Differential Forms on a Surface, Mappings of Surfaces, Integration of Forms.

[12 Lectures]

Unit V: Shape Operators and Riemannian Geometry

The Shape Operator of M C E^3, Normal Curvature, Gaussian Curvature, Computational Techniques, Special Curves in a Surface, Surfaces of Revolution, Geometric Surfaces, Gaussian Curvature, Covariant Derivative, Geodesies.

[16 Lectures]

Recommended Text Book:

[1] O'Neill, B., Elementary Differential geometry, Academic Press, London 1966.

Reference Books:

[1] Millman, R. and Parker, G.D., Elements of differential geometry: Prentice-Hall of India Pvt. Ltd. 1977

[2] Hicks, N., Notes of differential geometry, Princeton University Press (1968)

[3] Nirmala Prakash, Differential Geometry, Tata McGraw-Hill 1981

MT-304 (A): Graph Theory

Unit-I: Graphs, Paths and Circuits

Graph, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, Isomorphism, Subgraphs, Walks, Paths, and Circuits, Connected Graphs, Disconnected Graphs, and Components, Euler Graphs, Operations on Graphs, More on Euler Graphs, Hamiltonian Paths and Circuits, The Traveling Salesman Problem. {Chapter 1 [1], Art. 1.1-1.6, and Chapter 2 [1], Art. 2.1-2.10} **[15 Lectures]**

Unit-II: Trees and Cut-Sets

Trees, Some Properties of Trees, Pendant Vertices in a Tree, Distance and Centers in a Tree, Rooted and Binary Trees, On Counting Trees, Spanning Trees, Fundamental Circuits, Finding All Spanning Trees of a Graph, Spanning Trees in a Weighted Graph, Cut-Sets, Some Properties of a Cut-Set, All Cut-Sets in a Graph, Fundamental Circuits and Cut-Sets, Connectivity and Separability, 1-Isomorphism, 2-Isomorphism. {Chapter 3 [1], Art. 3.1-3.10 and Chapter 4 [1], Art. 4.1-4.8} **[15 Lectures]**

Unit-III: Planar Graphs and Matrix Representation

Planar Graphs, Kuratowski's Two Graphs, Different Representations of a Planar Graph, Detection of Planarity, Geometric Dual, Combinatorial Dual, Incidence Matrix, Submatrices of $A(G)$, Circuit Matrix, Fundamental Circuit Matrix and Rank of B, Cut-Set Matrix, Relationships among A_f, B_f, C_f, Path Matrix, Adjacency Matrix. {Chapter 5 [1], Art. 5.1-5.7 and Chapter 7 [1], Art. 7.1-7.9} **[15 Lectures]**

Unit-IV: Coloring, Covering and Partitioning

Chromatic Number, Chromatic Partitioning, Chromatic Polynomial, Matchings, Coverings, The Four-Color Problem. {Chapter 8 [1], Art. 8.1-8.6} **[07 Lectures]**

Unit-V: Directed Graphs

Directed Graph, Some Types of Digraphs, Digraphs and Binary Relations, Directed Paths and Connectedness, Euler Digraphs, Trees with Directed Edges, Fundamental Circuits in Digraphs, Matrices A, B, and C of Digraphs, Adjacency Matrix of a Digraph. {Chapter 9 [1], Art. 9.1-9.11} **[08 Lectures]**

Recommended Text Book:

[1] N. Deo, Graph Theory with applications to Engineering and Computer Science, Prentice Hall of India (2015).

Reference Books:

[1] Douglas B. West, Introduction to Graph Theory Prentice- Hall, New Delhi (1999).

[2] John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991).

[3] Nora Harsfield and Gerhard Ringel , Pearls Theory, Academic Press (1990).

MT-304 (B): Stability Theory

Unit I: Linear Systems:

Coupled and uncoupled systems, fundamental theorem, Linear System in P^2, phase space, Phase portrait, Critical points classification, Complex eigenvalues. {[1] Chapter-1: 1.1, 1.2, 1.4-1.9} [**15 Lectures**]

Unit II: Nonlinear Systems:

Critical points of nonlinear systems, maximum interval of existence, Flow defined by differential equations, Linearization, Stable manifold theorem, Center manifold theorem, Stability and Liapunov functions. {[1] Chapter-2: 2.4-2.9} [**15 Lectures**]

Unit III: Stability and Perturbation Theory:

Asymptotic stability & instability solutions, Stability of periodic solution of autonomous equations, Introduction to perturbation theory, Näive expansion, Poincare theorem. {[2] Chapter-7: 7.1-7.3, Chapter-9: 9.1-9.3} [**15 Lectures**]

Unit IV: Bifurcations:

Saddle node bifurcation, Andronov-Hopf bifurcation, Saddle connections, Semi stable limit cycle, Bifurcation in one parameter families. {[3] Chapter-9: 9.1-9.4} [**15 Lectures**]

Recommended Text Books:

[1] Lawrence Perko, Differential Equations and Dynamical Systems, Springer-Verlag (1998).

[2] Ferdinand Verhulst, Nonlinear Differential Equations and Dynamical Systems, Springer-Verlag (2000).

[3] J. H. Hubbard and B. H. West, Differential Equations: A Dynamical System Approach (Higher Dimensional Systems), Springer-Verlag (1995).

Reference Books:

[1] Hahn, Stability of Motion, Springer-Verlag.

[2] T. A. Burton, Periodic Solutions of Ordinary and Fundamental Differential Equations, Academic Press (1985).

[3] David R. Merkin, *Introduction to the Theory of Stability,* Springer-Verlag.

MT-304 (C): Probability Theory

Unit I: Introduction to Probability Theory

Introduction, Sample Space and Events, Probabilities Defined on Events, Conditional Probabilities Independent Events, Bayes' Formula. {1 [chapter 1 (1.1-1.6)]} **[12 Lectures]**

Unit II: Random Variables

Discrete Random Variables (The Bernoulli, The Binomial, The Geometric, The Poisson), Continuous Random Variables (The Uniform, Exponential, Gamma, Normal), Expectation of a Random Variable (The Discrete Case, The Continuous Case), Expectation of a Function of a Random Variables. {1 [chapter 2 (2.1-2.4)]} **[12 Lectures]**

Unit III: Jointly Distributed Random Variables

Joint Distribution Functions, Independent Random Variables, Joint Probability Distribution of Functions of Random variables, Moment Generating Functions, Limit Theorems. {1[chapter 2 (2.5-2.7)]} **[12 Lectures]**

Unit IV: Conditional Probability and Conditional Expectation

Introduction, The Discrete Case, The Continuous Case. {1[chapter 3 (3.1-3.3)]**[12 Lectures]**

Unit V: Computing

Computing Expectations by Conditioning, Computing Variances by Conditioning, Computing Probabilities by Conditioning, Some Applications, A List Model, A Random Graph, Uniform Priors, Polya's Urn Model, and Bose–Einstein Statistics. {1[chapter 3 (3.4-3.6)]} **[12 Lectures]**

Recommended Text Book:

[1] Sheldon Ross: Introduction to Probability Models *Tenth Edition*, Academic Press, 2010.

Reference Books:

[1] Hoel, P. G., Port, S. C. and Stone, C. J, Introduction to Probability Theory, Universal Book Stall, New Delhi, Reprint 2003.

[2] Chung, K. L., A Course in Probability Theory, Academic Press, San Diego, USA, 2001.

[3] Pierre Bremaud, An Introduction to Probabilistic Modeling, Springer, 1998.

MT-304 (D): Lattice Theory

Unit I: First Concepts

Two Definitions of Lattices, How to Describe Lattices, Some Algebraic Concepts, Inequalities, Special Elements. {Chapter 1[1] (1, 2, 3, 4,6)} [**20 Lectures**]

Unit II: Distributive and Modular Lattices

Characterization Theorems and Representation Theorems, Congruence Relations, Boolean Algebras R-generated by Distributive Lattices, Distributive Lattices with Pseudocomplementation. {Chapter 2[1] (1, 3, 4,6)} [**20 Lectures**]

Unit III: Congruences and Ideals

Congruences, Standard and Neutral Elements, Standard. and Neutral Ideals, Structure. {Chapter 3[1] (2, 3, 4)} [**20 Lectures**]

Recommended Book:

[1] George Gratzer, General Lattice Theory, Pure and Applied Maths. Ser. Academic Press, New York, 1978.

Reference Books:

[1] George Gratzer, Lattice Theory: First concepts and distributive lattices, W. H. Freeman and company, San Francisco, 1971.

[2] G. Birkhoffs, Lattice theory, Amer. Math. Soc. Coll. Publications, Third Edition 1973.

MT-304 (E): Algebraic Topology

Unit I: Homotopy and Paths

Category, Functions, Definition and properties of Homotopic mappings, Relative Homotopy, Contractible spaces, Homotopy type, Retractions. Path connected spaces, Equivalent paths. [**15 Lectures**]

Unit II: Fundamental Groups:

Formation of a group, Isomorphism of fundamental groups, Homomorphism of fundamental groups, Induced homomorphism, Introduction to fundamental group of the circles, Lifting lemma, Covering Homotopy lemma, $\Pi_1(S^1)$ is isomorphic to the additive group of integers, Tours, Applications. [**15 Lectures**]

Unit III: Covering Spaces and Fibrations

Definitions, Local homeomorphism, G-spaces, Properties of covering maps, Fundamental group of the covering space, Unique path lifting, Fibrations and equivalent paths, covering map and Fibrations. [**15 Lectures**]

Unit IV: Geometric Simplexes and Complexes

Geometrically independent set, Simplexes, Orientation of simplexes, Complexes, Triangulation, Simplicial mapping, Topological dimension, The Brouwer fixed point theorem, Barycentric subdivision. [**15 Lectures**]

Recommended Text Book:

[1] Lahiri B. K., A First Course in Algebraic Topology, Second Edition, Narosa Publishing House, (2005) [Chapters 2 to 10].

Reference Books:

[1] Croom F. H., Basic Concepts in Algebraic Topology, Springer under Graduate Text.

[2] Singer I. M. and Thorpe J. A., Lecture Notes on Elementary Topology and Differential Geometry, Springer Verlag.

[3] Hatcher Allen, Algebraic Topology, Cambridge University Press

[4] Massey W. S., Algebraic Topology- An Introduction, Harcourt, Brace and World Inc. 1967, SV, 1977.

[5] Greenberg Marnim J. and Harper J. R., Algebraic Topology- A First Course, Addison-Wesley Publishing Co., 1981.

MT-305: Programming in MATLAB

Unit I: MATLAB Environment

MATLAB windows, Variables, Working with Matrices, Saving Variables, Script M-files, Elementary Math functions, Trigonometric functions, Data analysis functions, Random numbers, Defining matrices, using the colon operator, Special values and functions. {Chapter 2 [1], Art. 2.1-2.3 and Chapter 3 [1], Art. 3.1-3.4} **[15 Lectures]**

Unit II: Plotting

Introduction, Two dimensional plots, Basic plotting, Line, color, and mark style, Axes scaling, Other types of two-dimensional plot, Three dimensional plotting, Three dimensional line plot, Surface plots. {Chapter 4 [1], Art. 4.1-4.4} **[10 Lectures]**

Unit III: Programming in MATLAB

Introduction, Problems with two variables, Input/output, User defined Input, Output options, Functions, Statement level control structures, Relational and logical operators, Loops. {Chapter 5 [1], Art. 5.1-5.4} **[10 Lectures]**

Unit IV: Matrix Computations

Matrix operations and functions, Solutions to system of linear equations, Special Matrices. {Chapter 6 [1], Art. 6.1-6.3} **[10 Lectures]**

Unit V: Symbolic Mathematics and Numerical Techniques

Symbolic Algebra, Equation Solving, Differentiation and Integration, Interpolation, Numerical Integration, Numerical Differentiation. {Chapter 7 [1], Art. 7.1-7.3 and Chapter 8 [1], Art. 8.1-8.5} **[15 Lectures]**

Recommended Text Book:

[1] Delores M. Etter, David C. Kuncicky and Holly Moore, Introduction to MATLAB, Dorling Kindersley (India) Pvt. Ltd. New Delhi, (2009).

Reference Books:

[1] Brian R. Hunt, Ronald L. Lipsman and Jonathan M. Rosenberg, A Guide to MATLAB, Cambridge University Press, (2008).

[2] Y. Kirani Singh and B. B. Chaudhari, MATLAB Programming, PHI Learning Private Ltd., New Delhi, (2010).

[3] Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, Oxford University Press, (2010).

List of Programs based on Basic MATLAB and Partial Differential Equations

1. Simple program in MATLAB for area.
2. Program for Use of linspace command.
3. Program for Calculate the Drag coefficient.
4. Program for vapor saturation pressure & for water diff.
5. Program for vapor saturation pressure & for water diff with graph.
6. Program for find the force acting on the balloon.
7. Program for find use max min function.
8. Program for find use men median function.
9. Program for find calculate the range of ballistics projectile.
10. Program for plot the bar graph and pie chart.
11. Find the cube of a number use of function.
12. Print matrix for calculate velocity acceleration distance with motions.
13. Nested if else for temperature.
14. Find grade of score using function.
15. Find the factorial of number use of function fact ().
16. Find multiplication and power of matrix.
17. Find division of matrix.
18. Program for determine mass.
19. Solving simultaneous equation.
20. Use of symbolic expressions.
21. Use of Differentiation function.
22. Use of Integration function.
23. Use of Tic Toc function in program.
24. Program for solution of single PDE with constant coefficients
25. Program for solution of single PDE with constant coefficients
26. Program for solution of system of PDE with constant coefficients
27. Finite difference numerical explicit forwarded time centered space method for hyperbolic PDE
28. Finite difference numerical Von Neumann Method for hyperbolic PDE
29. Finite difference numerical Lax Method for hyperbolic PDE
30. Finite difference numerical Staggered Leapfrog method for hyperbolic PDE

MT-401: Analytic Number Theory

Unit I: The fundamental theorem of arithmetic:

Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The Euclidean algorithm, The gcd of more than two elements. [**8 Lectures**]

Unit II: Arithmetic functions and Dirichlet multiplication:

The Mobious function $\mu(n)$, The Euler totient function $\phi(n)$, A relation connecting μ, ϕ, A product $\phi(n)$, Dirichlet product of arithmetic functions, Dirichlet inversion and Mobious inversion formula, The Mangoldt function $\Lambda(n)$, Multiplicative functions and Dirichlet multiplication, The inverse of completely multiplicative function, Liouville function, The divisor function, Generalized convolution. [**15 Lectures**]

Unit III: Congruences:

Definition and basic properties of congruences, Residue classes and complete residue system, Linear congruences, Reduced residue system and Euler-Fermat theorem, Polynomial congruences modulo p, Lagrange theorem, Application of Lagrange's theorem: Simultaneous linear equations, The Chinese remainder theorem and its applications, Polynomial congruences and prime power modulli. [**15 Lectures**]

Unit IV: Quadratic residues and Quadratic reciprocity law:

Quadratic residue, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The quadratic reciprocity law, Application of reciprocity law, The Jacobi symbol. [**10 Lectures**]

Unit V: Primitive roots:

The exponent of a number modulo m, Primitive roots, Primitive roots and reduced residue system, The non-existence of primitive roots and mod 2^{α} for $\alpha \geq 3$, The existence of primitive roots mod p, The non-existence of primitive roots mod m, The primitive roots and quadratic residues, The index calculus. [**12 Lectures**]

Recommended Text Book:

[1] T. M. Apostol, Introduction to Analytic Number Theory, Narosa Publishing House (1980).

Reference Books:

[1] Ivan Niven and H. S. Zuckerman, An Introduction to the Theory of Numbers, Wiley East (2001).

[2] D.M. Burton, Elementary Number Theory, Tata McGraw Hill Education Private Limited (2009).

MT-402: Transform Theory

Unit I: Laplace Transform:

Properties of Laplace Transform, Laplace Transform of the derivatives of function, Inverse Laplace transform, Properties of inverse Laplace transform, Inverse Laplace transform of derivatives, Convolution theorem, Heaviside's expansion theorem. Application of Laplace Transform, Solution of ODEs and PDEs. [**14 Lectures**]

Unit II: Fourier Integrals & Fourier Transforms:

Fourier integral theorem, Fourier transform Pairs, Properties of Fourier transform, Fourier cosine transform, Inverse Fourier Transform, Inverse Fourier sine Transform, Inverse Fourier cosine Transform, Properties of Fourier Transforms, Modulation theorem, Convolution theorem, Fourier Transform of the derivatives of functions, Parseval's identity, Application of Fourier Transforms to the solution of initial & boundary value problems. [**14 Lectures**]

Unit III: Mellin Transform:

Evaluation of Mellin transforms, Complex variable method and Applications.

[**10 Lectures**]

Unit IV: The Henkel Transforms:

Evaluation of Henkel transforms, Applications of transform. [**10 lectures**]

Unit V: Finite Transforms:

Finite Fourier transform, Z- transform, Solutions of difference equations using Z-Transform. [**12 Lectures**]

Recommended Text Book:

[1] Larry Andrews, Bhimsen Shivamoggi, Integral Transforms for Engineers, Prentice Hall of India, New Delhi, 2005.

Reference Books:

[1] I. N. Sneddon, Fourier Transforms, McGraw Hill, 1951.
[2] Bracemell, Fourier Transforms and Its Applications, McGraw-Hill, 3rd Edition, 1999.

MT 403 (A): Advanced Functional Analysis

Unit I: Topological Vector Spaces

Topological Vector Spaces, Separation, Properties, Linear mappings, Finite-dimensional spaces, Metrization, Boundedness and continuity, Seminorms and local convexity, Quotient spaces. {Chapter 1[1]} [**12 Lectures**]

Unit II: Topological Vector Spaces

Completeness, Baire category, The Banach-Steinhaus theorem, The open Mapping theorem, The closed graph theorem, Bilinear mappings. { Chapter 2[1]} [**12 Lectures**]

Unit III: Convexity:

The Hahn-Banach theorems, Weak topologies, Compact convex sets, Vector-valued integration, Holomorphic functions. { Chapter 3[1]} [**12 Lectures**]

Unit IV: Duality in Banach Spaces:

The normed dual of a normed space, Adjoints, Compact operators. { Chapter 4[1]}

[**12 Lectures**]

Unit V: Banach Algebras:

Complex homomorphisms, Basic properties of spectra, Symbolic calculus, The group of invertible elements, Lomonosov's invariant subspace theorem.{Chapter 6[1]}[**12 Lectures**]

Recommended Text Book:

[1] W. Rudin, Functional Analysis, Tata McGraw-Hill, 2007.

Reference Book:

[1] A. P. Robertson, W. Robertson, Topological Vector Spaces, Cambridge Tracts in Mathematics 53, Cambridge University Press, 1980.

MT-403(B): Linear Integral Equations

Unit I: Fredholm and Volterra Integral Equations

Regularity conditions, Special kinds of kernels, Eigen values and eigen functions, Convolution integral, Reduction to a system of algebraic equations, Fredholm alternative, An approximate method, Examples, Iterative scheme, Volterra integral equation, Some results about the Resolvent kernel, Examples. [**15 Lectures**]

Unit II: Classical Fredholm Theory

The method of solution of Fredholm, Fredholm's first theory, Examples. [**8 Lectures**]

Unit III: Applications to Ordinary Differential Equations

Initial value problems, Boundary value problems, Adjoint equation of second order linear equation and self adjoint equation, Dirac delta function, Green's function approach, Green's function for N^{th} – order ordinary differential equation, Modified Green's function, Examples. [**12 Lectures**]

Unit IV: Integral Equations with Symmetric Kernels

Introduction, Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels, Expansion in eigenfunctions and bilinear form, Hilbert-Schmidt theorem and some immediate consequences, Solution of a symmetric integral equation, Examples.

[**15 Lectures**]

Unit V: Singular Integral Equations and Integral Transform Methods

Abel's equations, Inversion formula for singular integral equations, Laplace transform, Applications to Volterra integral and integrodifferential equations with convolution type kernels, Abel's integral equation, Fourier transform, Solution by Fourier transform method. [**10 Lectures**]

Recommended Text Book:

[1] R. P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press (1971).

Reference Books:

[1] S. G. Mikhlin, Integral Equations, Pergamon Press, Oxford (1957).
[2] A. M. Wazwaz, A first Course in Integral Equations, World Scientific, (1997).
[3] J. A. Cochran, The Analysis of Linear Integral Equations, Mc-Graw Hill, (1972).
[4] L. G. Chambers, Integral Equations: A Short Course, International Text Book Co., (1976).
[5] M. A. Krasnow, Kislov and G. Hakaronke, Problems and Exercises in Integral Equations, Mir Publications (1971).

MT-403(C): Difference Equations

Unit I: Difference Calculus:

Introduction, The Difference Operator, Summation, Generating Functions and Approximate Summation. [**15 Lectures**]

Unit II: Linear Difference Equations:

First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can Be Linearized, The z-Transform. [**15 Lectures**]

Unit III: Stability Theory:

Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior. [**15 Lectures**]

Unit IV: Asymptotic Methods:

Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations.

[**15 Lectures**]

Recommended Text Books:

[1] Walter Kelley and Allan Peterson, Difference Equations, An Introduction with Applications, Academic Press (1991).

[2] Calvin Ahlbrant and Allan Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations, Kluwer (1996).

Reference Book:

[1] Saber Elaydi, An Introduction to Difference Equations, Springer (1999).

MT 403 (D): Cryptography

Unit I: An Introduction to Cryptography:

Simple substitution ciphers, Divisibility and greatest common divisors, Modular arithmetic, Prime numbers, unique factorization, and finite fields, Powers and primitive roots in finite fields, Cryptography before the computer age, Symmetric and asymmetric ciphers. {Chapter 1 [1], 1.1. to 1.7} [**15 Lectures**]

Unit II: Discrete Logarithms and Diffie–Hellman:

The birth of public key cryptography, The discrete logarithm problem, Diffie–Hellman key exchange, The ElGamal public key cryptosystem. The discrete logarithm problem, A collision algorithm for the DLP, The Chinese remainder theorem, The Pohlig–Hellman algorithm. {Chapter 2[1], 1.1. to 1.7} [**15 Lectures**]

Unit III: Integer Factorization and RSA:

Euler's formula and roots modulo pq, The RSA public key cryptosystem, Implementation and security issues, Primality testing, Pollard's $p-1$ factorization algorithm, Factorization via difference of squares, Smooth numbers and sieves, The index calculus and discrete logarithms, Quadratic residues and quadratic reciprocity, Probabilistic encryption. {Chapter 3[1], 3.1. to 3.10} [**15 Lectures**]

Unit IV: Elliptic Curves and Cryptography:

Elliptic curves, Elliptic curves over finite fields, The elliptic curve discrete logarithm problem, Elliptic curve cryptography, The evolution of public key cryptography, Lenstra's elliptic curve factorization algorithm {Chapter 5[1], 5.1. to 5.6} [**15 Lectures**]

Recommended Book:

[1] Jeffrey Hoffstein Jill Pipher Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer Science & Business Media, LLC, 2008.

Reference Books:

[1] Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press.

[2] Hans Delfs, Helmut Knebl, Introduction to Cryptography, Principles and Applications, Springer Verlag.

MT-403(E): Fractional Calculus

Unit I: Special Functions of the Fractional Calculus

Brief review of Special Functions of the Fractional Calculus: Gamma Function, Mittag-Leffler Function, Wright Function, Gamma function, Properties of Gamma function, Limit representation of the Gamma function, Beta function, Mittag-Leffler Function, Derivative of the Mittag-Leffler Function, Differential equations Mittag-Leffler Function, Summation formulas, Integration of the Mittag-Leffler Function. [**15 Lectures**]

Unit II: Fractional Differential and Integral Operators

Riemann–Liouville Integrals, Riemann–Liouville Derivatives, Relations Between Riemann–Liouville Integrals and Derivatives, Grünwald–Letnikov Operators, Caputo's Approach, Nonclassical representations of Caputo Operators. [**15 Lectures**]

Unit III: Existence and Uniqueness of solutions to Fractional Differential Equations

Linear Fractional Differential Equations, Fractional Differential Equation of a General Form, Existence and Uniqueness Theorem as a Method of Solution, Dependence of a Solution on Initial Conditions, Standard Fractional Differential Equations, Sequential Fractional Differential Equations, Fractional Green's Function, Definition and Some Properties, One-Term Equation, Two Term Equation, Three-Term Equation, Four-Term Equation, General Case: n-term Equation. **[20 Lectures**]

Unit IV: **Various Methods for the Solutions to Fractional Differential Equations**

The Laplace transform method, The Mellin transform method, Power series method, Babenko's symbolic calculus method, Method of orthogonal polynomials. [**10 Lectures**]

Recommended Text Books:

[1] Igor Podlubny, Fractional Differential Equations. San Diego: Academic Press; (1999).

[2] Kai Diethelm, The Analysis of Fractional Differential Equations, Springer Heidelberg Dordrecht London, New York, (2010).

Reference Books:

[1] A. Kilbas, H. M. Srivastava and J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, (2006).

[2] L. Debnath, D. Bhatta, Integral Transforms and Their Applications, CRC Press, (2010).

[3] Shantanu Das, Functional Fractional Calculus, Springer-Verlag Berlin Heidelberg, (2011).

[4] K. S. Miller, B. Ross, An Introduction to the Fractional Calculus, John Wiley, New York, (1993).

[5] K. B. Oldham, J. Spanier, The Fractional Calculus. Academic Press, New York, (1974).

MT-404(A): Fuzzy Sets and Applications

Unit I: Fuzzy sets:

Fuzzy sets and their types, Basic concepts on fuzzy sets, Properties of α −cuts, Representation of fuzzy sets, Extension principle of fuzzy sets. {Chapter 1[1] (1.3, 1.4) & Chapter 2[1] (2.1, 2.2, 2.3) } [**12 Lectures**]

Unit II: Operations on fuzzy sets:

Fuzzy complements, Fuzzy intersections: t-norms, Fuzzy unions: t-conorms. { Chapter 3[1] (3.2, 3.3, 3.4) } [**12 Lectures**]

Unit III: Combination of operations:

Combination of operations, Aggregation operation. { Chapter 3[1] (3.5, 3.6) }

[**12 Lectures**]

Unit IV: Fuzzy arithmetic:

Fuzzy numbers, Arithmetic operations on intervals, Arithmetic operations on fuzzy numbers, Fuzzy equations.{ Chapter 4[1] (4.1,4.3,4.4, 4.6) } [**12 Lectures**]

Unit V: Fuzzy relations:

Fuzzy relations, Binary relations, Fuzzy equivalence relations, Fuzzy compatibility relations, Sup-t Compositions of fuzzy relations, inf ω_t compositions of fuzzy relations. { Chapter 5[1] (5.1,5.3,5.4, 5.5, 5.6, 5.9,5.10) } [**12 Lectures**]

Recommended Text Book:

[1] G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall India, New Delhi, (1997).

Reference Books:

[1] H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Springer, (2001).

[2] Didier Dubois and Henri Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press, (1980).

MT-404(B): Commutative Algebra

Unit I: Modules

Free modules, Projective modules, Tensor products, Flat modules. {[1] Chapter-I, 1.1-1.4}
[12 Lectures]

Unit II: Localization

Ideals, Local rings and localization. {[1] Chapter-II, 2.1-2.3} [12 Lectures]

Unit III: Noetherian Rings

Noetherian modules, Primary decomposition, Artinian modules. {[1] Chapter-III, 3.1-3.3}
[12 Lectures]

Unit IV: Integral Extensions

Integral elements, Integral extensions, integrally closed domains. {[1] Chapter-III, 3.1-3.3} [12 Lectures]

Unit V: Dedekind Domains

Valuation rings, Discrete valuation rings, Dedekind domains. {[1] Chapter-III, 3.1-3.3}
[12 Lectures]

Recommended Text Book:

[1] N. S. Gopalkrishnan, Commutative Algebra, Oxonian Press, New Delhi (1984).

Reference Books:

[1] M. F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison-Wesley, Reading, MA (1969).
[2] H. Matsumura, Commutative Algebra, Benjamin, New York (1970).

MT 404(C): Wavelet Analysis

UNIT I: Preliminaries

Linear Algebra, Hilbert's spaces, Fourier series, Fourier integral & signal processing. {1[Chapter 1 (1.1-1.4)]} [**12 Lecture**]

UNIT II: Windowed Fourier Transforms

Motivation & definition, Time Frequency localization, The reconstruction formula. {1[chapter 2 (2.1-2.3)]} [**12 Lecture**]

UNIT III: Continuous Wavelet Transforms

Motivation & definition of the wavelet transforms, the construction formula, Frequency localization. {1[chapter 3 (3.1-3.3)]} [**12 Lecture**]

UNIT IV: Generalized frames

From resolution of unity to frames, Reconstruction formula & consistency condition, Recursive construction. {1[chapter 4 (4.1, 4.2, 4.4)]} [**12 Lecture**]

UNIT V: Discrete time frequency analysis

Shannon Sampling theorem, Sampling in the time frequency domain, Time sampling verses frequency sampling. {1[chapter 5(5.1-5.3)]} [**12 Lecture**]

Recommended Text Book:

[1] Gerald Kaiser, A friendly guide to wavelets, Birkhauser, 1994.

Reference Books

[1] Eugenio Hernandez, Guido Weiss: A first course on Wavelets, CRC Press 1996.
[2] C.K. Chui, An introduction to Wavelets, Academic Press, 1992.
[3] M.W. Wong, Wavelet transforms & localization operators, Berkhauser Verlag.

MT-404 (D): Control Theory

Unit I: Observability

Linear Systems – Observability Grammian – Constant coefficient systems– Reconstruction kernel – Nonlinear Systems. [**10 Lectures**]

Unit-II: **Controllability**

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems –Steering function – Nonlinear systems. [**15 Lectures**]

Unit-III: Stability

Stability – Uniform stability – Asymptotic stability of linear systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems. [**15 Lectures**]

Unit-IV: Stabilizability

Stabilization via linear feedback control – Bass method – Controllable subspace– Stabilization with restricted feedback. [**10 Lectures**]

Unit-V: Optimal Control

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems. [**10 Lectures**]

Recommended Text Book:

[1] K. Balachandran and J.P. Dauer: Elements of Control Theory, Narosa Publishing House, New Delhi, 2nd Edition, (2012). (Unit-I : Chapter 2, Unit-II : Chapter 3: Sections: (3.1-3.3), Unit-III: Chapter 4, Unit-IV: Chapter 5, Unit-V : Chapter 6)

Reference Books:

[1] R. Conti: Linear Differential Equations and Control, Academic Press, London, (1976).

[2] R. F. Curtain and A.J. Pritchard: Functional Analysis and Modern Applied Mathematics, Academic Press, New York, (1977).

[3] J. Klamka: Controllability of Dynamical Systems, Kluwer Academic Publisher, Dordrecht, (1991).

[4] D. L. Russell, Mathematics of Finite Dimensional Control Systems, Marcel Dekker, New York, (1979).

MT-404(E): Fixed Point Theory and Applications

Unit 1. Introductory Concepts

Topological Preliminaries, Metric Spaces, Hilbert Spaces, Topological Vector Spaces, Locally Convex Spaces, Normal Structure. {[1], Ch. 1: 1.1, 1.2} [**10 Lectures**]

Unit 2. Fixed Point Theorems

Fixed Points, The Banach Contraction Principle, Fixed Point Theorems for Nonexpansive Mappings, Quasi-nonexpansive Mappings and Fixed Points, Densifying Maps and Fixed Points {[1], Ch. 1: 1.3 to 1.7} [**20 Lectures**]

Unit 3. Fixed Points For Multivalued Mappings

Multivalued Mappings and Fixed Points, Integral Equations {[1], Ch. 1: 1.8, 1.9}

[**15 Lectures**]

Unit 4. Successive Approximations

The Method of Successive Approximations, The Iteration Process for Continuous Functions, The Mann Iterative Process, The Sequence of Iterates of Nonexpansive Mappings, Convergence Criteria in Convex Metric Spaces, Iterative Methods for Variational Inequalities. {[1], Ch. 1: 1.10, 1.11} [**15 Lectures**]

Recommended Text Book:

[1] Sankatha Singh, Bruce Watson and Pramila Srivastava, Fixed Point Theory and Best Approximation: The KKM-map Principle, Springer Science Business Media Dordrecht (1997), Originally published by Kluwer Academic Publishers in 1997.

Reference books:

[1] Vasile I. Istrătescu, Fixed Point Theory, An Introduction, D. Reidal Publishing Company, Holland, (2001).
[2] Mohamed A. Khamsi and William A. Kirk, An Introduction to Metric Spaces and Fixed Point Theory, Hohn Wiley and Sons, Inc, New York (2001)

MT-405: Operations Research with MATLAB

Unit I: Convex Set and Functions

Convex set, Supporting and separating hyperplanes, Convex polyhedron and polytope, Convex functions, Generalized convexity. {[1], Chap 2: 2.1 to 2.5} [**10 Lectures**]

Unit II: Linear Programming Problems

Linear programming model, Graphical solution of some linear programs, Standard Linear Program and basic Solution, Simplex Algorithm and Simplex method, Charnes M-Technique, Applications, Dual Linear program, Simplex multipliers, Duality Theorems and Dual Simplex method {Chap 3: 3.1 to 3.6, Chap 4: 4.1 to 4.3, 4.5} [**15 Lectures**]

Unit III: Integer Programming Problems

Gomory's algorithm for pure integer linear programs, Branch and bound methods. {Chap 6, 6.4, 6.6} [**10 Lectures**]

Unit IV: Nonlinear Programming Methods

Frank Wolfe method, Reduced Gradient method, Kelley's cutting plane method, method of approximate programming, Gradient projection method, Generalized Lagrange multiplier technique, Separable programming, Linear fractional programming, Nonlinear fractional programming. {Chap 11, 11.1 to 11.9}

[**15 Lectures**]

Unit V: Game Theory

Game theory problem, Two person zero sum game, Finite matrix game, Graphical method for $2 \times n$ and $m \times 2$ matrix game, Some theorems, Dominance principle, {Chap 16, 16.1 to 16.6} [**10 Lectures**]

Recommended Text Book:

[1] N. S. Combo, Mathematical programming Techniques, Affiliated East-West Press PVT, New Delhi, (1991).

Reference books:

[1] H. A. Taha, Operations Research: An Introduction, Prentice Hall of India, (1997).

[2] Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, new Delhi, (1991).

List of Programs based on Operations Research and Difference Equations

1. Linear programming problem with equality constraints
2. Linear programming problem with inequality constraints
3. Linear programming problem with mixed constraints
4. Linear programming problem with inequality constraints (adding constant)
5. Non- Linear programming problem with equality constraints
6. Non- Linear programming problem with inequality constraints
7. Non- Linear programming problem with mixed constraints
8. Non- Linear programming problem with inequality constraints (adding constant)
9. Binary integer programming problem with equality constraints
10. Binary integer programming problem with inequality constraints
11. Binary integer programming problem with mixed constraints
12. Binary integer programming problem with equality constraints (adding constant)
13. Mathematical modelling through difference equations in Economics
14. Mathematical modelling through difference equations in Finance
15. Mathematical modelling through difference equations in population dynamics
16. Mathematical modelling through difference equations in population genetics
17. Mathematical modelling through difference equations in population probability

Equivalent Theory & Practical Courses of M. Sc. (Mathematics) (with Specialization in Computational Mathematics)

Semester-I				
Sr. No.	Subject Code	Old Course	Subject Code	New Course (To be implemented from April 2018)
1	MT-101	Real Analysis	MT-101	Real Analysis
2	MT-102	Topology	MT-102	Topology
3	MT-103	Discrete Mathematics	MT-304 (A)	Graph Theory
4	MT-104	Abstract Algebra	MT-104	Abstract Algebra
5	MT-105	Lab Course	MT-105	Programming in C++
Semester-II				
Sr. No.	Subject Code	Old Course	Subject Code	New Course (To be implemented from December 2018)
1	MT-201	Complex Analysis	MT-201	Complex Analysis
2	MT-202	Measure and Integration Theory	MT-202	Measure and Integration Theory
3	MT-203	Ordinary Differential Equations	MT-203	Ordinary Differential Equations
4	MT-204	Advanced Abstract Algebra	MT-204	Advanced Abstract Algebra
5	MT-205	Lab Course	MT-205	Numerical Methods with C++
Semester-III				
Sr. No.	Subject Code	Old Course	Subject Code	New Course (To be implemented from April 2019)
1	MT-301	Functional Analysis	MT-301	Functional Analysis
2	MT-302	Partial Differential Equations	MT-302	Partial Differential Equations
3	MT-303 (A)	Classical Mechanics	MT-303 (A)	Classical Mechanics
4	MT-303 (B)	Commutative Algebra	MT-404 (B)	Commutative Algebra
5	304(A):	Operations Research	MT-304 (D)	Lattice Theory
6	MT-305	Lab Course	MT-305	Programming in MATLAB
Semester-IV				
Sr. No.	Subject Code	Old Course	Subject Code	New Course (To be implemented from December 2019)
1	MT-401	Analytic Number Theory	MT-401	Analytic Number Theory
2	MT-402	Transform Theory	MT-402	Transform Theory
3	MT-403(B)	Linear Integral Equations	MT-403(B)	Linear Integral Equations
4	MT-404(A)	Fuzzy Sets and Applications	MT-404(A)	Fuzzy Sets and Applications
5	MT-404(B)	Non-Commutative Rings	MT-303 (B)	Algebraic Coding Theory
6	MT-405	Lab Course	MT-405	Operations Research with MATLAB