Gujarat University
Choice Based Credit System
Revised Syllabus for Post Graduate (M. Sc.) Mathematics
Effective from June-2017

Syllabus in M. Sc. Mathematics gets changed both in structure as well as in content beginning from June-2017 progressively. Since new changed syllabus has structural change, it is not possible to carry forward credits earned in old course to new course or the other way.

Only three trials (i.e. 1 + 2) for old course exam will be given. Old course students will have to clear M. Sc. Mathematics taking benefit of these trials. If they fail to do so, they will have to take fresh admission and earn all new credits from the new course.

Gujarat University
M. Sc. Mathematics Syllabus For
Credit Based Semester System
Revised (2017)

Semester	Course Code	Course Name	Hours per Week	Course Credits
I	**MAT401**	Mathematical Statistics	4	4
	MAT402	Measure & Integration	4	4
	MAT403	Complex Analysis – I	4	4
	MAT404	Ordinary differential Equations	4	4
	MAT405PR	Practical – I (Mathematical Statistics & Matrices and Linear Algebra)	6	4
	MAT406PR	Practical – II (Complex Analysis & ODE)	6	4
		Total	**28**	**24**
II	**MAT407**	Metric Spaces	4	4
	MAT408	Real Analysis	4	4
	MAT409	Complex Analysis – II	4	4
	MAT410	Partial Differential Equations	4	4
	MAT411PR	Practical – I (Matrix Algebra & Real Analysis)	6	4
	MAT412PR	Practical – II (Complex Analysis & PDE)	6	4
		Total	**28**	**24**
III	**MAT501**	Functional Analysis – I	4	4
	MAT502	Algebra – I	4	4
	MAT503EA **MAT503EB**	Advanced Calculus Financial Mathematics	4	4
	MAT504EA **MAT504EB**	Mathematical Programming Computational Mathematics	4	4
	MAT505PR	Practical – I (Functional Analysis-I & Algebra-I)	6	4
	MAT506PR	Practical – II (Based on MAT503 & MAT504)	6	4
		Total	**28**	**24**
IV	**MAT507**	Differential Geometry	4	4
	MAT508	Algebra – II	4	4
	MAT509EA **MAT509EB**	Number Theory Project	4	4
	MAT510EA **MAT510EB**	Quantitative Techniques Functional Analysis – II	4	4
	MAT511PR	Practical – I (Differential Geometry & Algebra-II)	6	4
	MAT512PR	Practical – II (Mathematical Methods)	6	4
		Total	**28**	**24**
		Total		**96**

MAT401: Mathematical Statistics

Objectives and Outcome:

Statistical methods used in practice are based on the foundations of statistical theory. One branch of this theory uses the tools of probability to establish important distributional results that are used throughout statistics. Another major branch of statistical theory is statistical inference. This basic course toward the first branch is concerned with the fundamental theory of probability, random variables, Expectation, Distributions. Students will be familiar with many common distributions, continuous or discrete, univariate or multivariate, which provides rich families for modeling real data.

UNIT I: An introduction to Probability: Review of sets, Experiments and Sample spaces, Events, Probability Definition and Assignment, Finite Sample spaces and enumeration, Conditional Probability, Partitions, Total Probability and Bayes' Theorem.
One-Dimensional Random Variables: The Distribution Function, Discrete Random Variables, Continuous Random Variables, Characteristics of Distributions, Chebyshev's Inequality.

UNIT II: Functions of One Random Variable and Expectation: Equivalent Events, Functions of a Discrete Random Variable, Continuous functions of a continuous random variable, Expectation, Approximations to E[H(x)] and V[H(X)], Moment Generating Function.
Joint Probability Distributions: Joint Distribution for Two-Dimensional Random variables, Marginal Distributions, Conditional Distributions, Conditional Expectation.

UNIT III: Discrete Distribution: Bernoulli Trials and the Bernoulli Distribution, Binomial Distribution, Pascal Distribution, Hypergeometric Distribution, Poisson Distribution.
Continuous Distributions: The Uniform Distribution, Exponential Distribution, Weibull Distribution.

UNIT IV: Gamma Distribution, Beta Distribution, The Normal Distribution, The reproductive property of normal distribution, Central Limit Theorem, The Normal Approximation to the Binomial Distribution, The Lognormal Distribution.

Textbook:

This course is roughly covered by Chapters 1, 2, 3, 5, 6, 7 of Probability and Statistics in Engineering 4th edition – Hines, Montgomery, Goldsman and Borror, published by Wiley (India Edition).

References

1. A first course in probability by Sheldon Ross, Pearson Education.
2. Probability and Statistics for Engineers by Richard Johnson, Prentice Hall of India Publication.
3. Fundamentals of Mathematical Statistics by Kapoor & Gupta, Sultan Chand and Sons.

MAT402 – Measure and Integration

Objectives and Outcome:

The initial objective of the course is to introduce the concept of Lebesgue measure for bounded subsets of R. This concept of Lebesgue measure is later used in developing the theory of (Lebesgue) integration which gives stronger (and better) results as compared to the theory of Riemann integration.

Unit I: The structure of open sets in R, Length of open sets and closed sets, Inner and outer measure of bounded sets, Measurable sets and some of its properties.

Unit II: Further properties of measurable sets, Non-measurable sets, Definition and the properties of Measurable functions.

Unit III: A quick review of the definition of Riemann integral, Lebesgue integral for bounded functions and its comparison with Riemann integral, properties of Lebesgue integral for bounded functions.

Unit IV: The Lebesgue integral of non-negative and unbounded functions, its properties, Lebesgue dominated convergence theorem, Fatou's Lemma and its consequences like Monotone convergence theorem and the countable additivity of the Lebesgue integral, A very brief introduction to Lebesgue integral on $(-\infty,\infty)$ and in plane.

Text book:

The course is based on the book "Methods of Real Analysis" by Richard Goldberg, Oxford & IBH Publishing Company, 1964.

Reference books:

1. "Theory of Functions of a real variable" Volume-I by I. P. Natanson, Frederic Ungar Publishing Co., New York 1964.
2. "Real Analysis" by H. L. Royden (3rdedition), Pearson Prentice Hall (2007).
3. "Measure and Integration" by I. K. Rana, Narosa Publishing House (1997).

MAT403 – Complex Analysis-I

Objectives and outcome:

The main aim is to make students familiar with complex numbers, their properties and the study of functions of a complex variable. It is expected that on successful completion of this course the students will be able to handle complex numbers and complex valued functions of complex variables with Mathematical Maturity.

Unit I: Basic Definitions and notations, Algebraic properties, Polar coordinates and Euler's formula, Products and Quotients in exponential form. Roots of complex Numbers. Continuous complex functions. Limits Involving Point at Infinity.

Unit II: Differentiable complex functions, Cauchy Riemann equations. Harmonic functions of two variables, Reflection principle.

Unit III: Elementary functions, Contours, Contour integrals, Anti-derivatives.

Unit IV: Cauchy-Goursat theorem, Simply connected domain, Multiply connected domains. Cauchy's integral formula and its Extension. Liouville's theorem, Fundamental theorem of Algebra, Maximum moduli principle of functions.

Text book:

The course is roughly covered by "Complex variables and Applications" (8th edition) J. W. Brown and R. V. Churchill, McGraw Hills. International Edition 2009.
ISBN: 978-007-126328-3. OR MHID: 007-126328-4.

Reference books:

1. "Introduction to Functions of Complex Variable" C. J. Hamilton, Marcel Dekker Inc. New York.
2. "Complex Analysis" I. Stewart and David Tall, Cambridge University Press.
3. "Complex Analysis" J. C. Duncan, John Wiley & Sons, London.
4. "Complex Analysis" Lars Ahlfors, McGraw Hills. Indian Edition.

MAT404 – Ordinary Differential Equations

Objectives and outcome:

The objective of this course is to continue the study of ordinary differential equations begun in B. Sc., with an emphasis on second degree equations which occur in applications.

Unit I: Review of second order linear equations. Series solutions of first order equations. Second order linear equations: ordinary points.

Unit II: Second order linear equations: regular singular points; Gauss's hypergeometric equation; the point at infinity.

Unit III: Hermite polynomials. Chebyshev polynomials and the minimax property. Legendre polynomials; properties of Legendre polynomials.

Unit IV : Bessel functions; properties of Bessel functions; Bessel's integral formula. Existence and uniqueness of solutions: the method of successive approximations; Picard's theorem; systems of equations.

Text book:

"Differential Equations with Applications and Historical Notes" (2nd Edition)
- G. F. Simmons, Tata McGraw-Hill Publishing Co. Ltd., 2010.
Chapter 5 (Omit Appendices C and E),
Chapter 8 (Omit Appendices A and B),
Chapter 13.

Reference books:

1. "Introduction to Ordinary Differential Equations"
   - A. L. Rabenstein, Academic Press.
2. "Advanced Engineering Mathematics" (10th Edition)
   - Erwin Kreyszig, Wiley-India, 2011.

MAT405PR –Practical-1

Practicals Based on **Mathematical Statistics**

1) Probability and Bayes' Theorem
2) The Distribution Function – Discrete and Continuous Random Variables
3) Expectation and Moments
4) Bernoulli Trials and the Bernoulli Distribution, Binomail Distribution
5) Hypergeometric Distribution, Poisson Distribution
6) The Uniform Distribution, Exponential Distribution,
7) Gamma Distribution, Beta Distribution, Weibull Distribution
8) Normal Distribution

Textbook:

This course is roughly covered by Chapters 1, 2, 3, 5, 6, 7 of Probability and Statistics in Engineering 4^{th} edition – Hines, Montgomery, Goldsman and Borror, published by Wiley (India Edition)

References:

1. A first course in probability by Sheldon Ross, Pearson Education
2. Probability and Statistics for Engineers by Richard Johnson, Prentice Hall of India Publication
3. Fundamentals of Mathematical Statistics by Kapoor & Gupta, Sultan Chand and sons

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Practicals Based on **Matrices and Linear Algebra:**

Practical 1: Algebra of Matrices.
Practical 2-3: Determinants.
Practical 4 -5: Elementary transformations and Rank of a Matrix.
Practical 6: Vector Space of n-tuples.
Practical 7: Linear transformations and Matrices.
Practical 8: System of linear homogenous equations

Reference books:

1. A textbook of Matrices by Shanti Narayan and P. K. Mittal, S. Chand & Company Ltd.
2. Matrix and Linear Algebra by K. B. Dutta, PHI Learning Ltd.
3. Calculus and Matrix Algebra by S. K. Patel, B. P. Patel, H. R. Kataria and B. L. Ghodadra, University Granth Nirman Board, Ahmedabad.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT406PR –Practical-2

Practicals Based on **MAT403: Complex Analysis-I and MAT404: Ordinary Differential Equations**

Objectives and outcome:

The objective here is to acquaint students to develop and consolidate their problem solving skills with the problems related to the notions that they have familiarize themselves in Complex Analysis-I and Ordinary Differential Equation courses. It is expected that on successful completion of this course the students will be able to handle problems related to the topics mentioned in the title with enhanced Mathematical Maturity.

Practicals Based on **MAT403: Complex Analysis-I**

Practical 1: Problems Based on Finding Argument, Sketching the sets, Finding roots and sketching them. Also problems on finding limit involving infinity.

Practical 2: Problems Based on C-R equations and the sufficient condition for differentiability. Also in Polar Form.

Practical 3: Rough sketches of images of Horizontal and Vertical lines under the exponential map e^z. Examples on Finding Harmonic Conjugate. Examples on Reflection Principle.

Practical 4: Examples Based on e^z, Log z, z^c.

Practical 5: Problems Based on trigonometric, Hyperbolic functions and their inverses.

Practical 6: Examples on Contour Integrals and their upper bound. Examples Based on deformation of paths.

Practical 7: Examples Based on Cauchy Integral Formula and its Extension.

Practical 8: Examples Based on Maximum Modulus Principle. And Miscellaneous Problems.

Practicals Based on **MAT404: Ordinary Differential Equations**

Practical 1: First order linear equations, second order linear homogeneous equations with constant coefficient, the use of a known solution to find another solution.

Practical 2: Second order linear nonhomogeneous equations (Method of undetermined coefficients and Method of variation of parameters).

Practical 3-4: Second order linear equations (Power series method and Frobenius method).

Practical 5: Hermite polynomials, Chebyshev polynomials and Legendre polynomials.

Practical 6-7: Bessel functions.

Practical 8: The Picard's method of successive approximations.

Reference Books:

1. "Differential Equations with Applications and Historical Notes" (2nd Edition) - G. F. Simmons, Tata McGraw-Hill Publishing Co. Ltd., 2010
2. "Introduction to Ordinary Differential Equations" - A. L. Rabenstein, Academic Press.
3. "Advanced Engineering Mathematics" (10th Edition) - Erwin Kreyszig, John Wiley and Sons Inc., 2011.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT407 – Metric Spaces

Objectives and outcome:

The objective of this course is to give a very streamlined development of a course in metric space topology emphasizing only the most useful concepts, concrete spaces and geometric ideas, which are useful in almost all courses of mathematics.

Unit I: Metric and Metric Spaces, Metric from an inner product and a norm, Open balls and Open sets, Equivalent metrics, Interior of a set, Subspace topology, Closed sets.
Omit proofs of Cauchy-Schwarz, Young's, Hölder's and Minkowski Inequalities.

Unit II: Convergence of a sequence, Limit and Cluster points, Bolzano Weierstrass Theorem, Cauchy sequences and Completeness, Bounded sets, Dense sets, Basis, Boundary of a set.

Unit III: Continuous functions, Equivalent definition of continuity, Distance between two sets, Urysohn's Lemma for metric space, Gluing Lemma, Topological property, Uniform continuity, Limit of a function, Open and closed maps.

Unit IV: Compact spaces and their properties, Continuous functions on Compact spaces, Characterization of compact metric spaces. Connected spaces, Product of two connected spaces, Path connected spaces.

Text book:

Chapter 1 to 5 from "Topology of Metric Spaces" (2nd Edition)
- S. Kumaresan, Narosa Publishing House, 2011.

Reference books:

1. "Introduction to Real Analysis"
   - R. G. Bartle and D. R. Sherbert (3rd edition), John Wiley and Sons (ASIA), 2000
2. "Principles of Mathematical Analysis"
   - Walter Rudin (3rd edition), International Student Edition, McGraw-Hill, 1985.
3. "Metric Spaces"
   - Satish Shirali and Harkrishan L. Vasudeva, Springer International Edition, 2006.
4. "Metric Spaces"
   - Micheál Ó Searcóid, Springer International Edition, 2007.

MAT408 – Real Analysis

Objectives and Outcome:

The main objective of the course is to study the differential properties of functions of finite variation and absolutely continuous functions and characterize the absolutely continuous functions in terms of the indefinite integral of Lebesgue integrable functions.

A part of the course is also devoted to the study of the structure of measurable functions and study of Fourier series of L_1 and L_2 functions.

Unit I: Convergence in measure and the related important results, Approximations of measurable functions by bounded measurable functions and continuous functions, Weierstrass approximation theorems.

Unit II: Square-summable functions, Schwarz and Minkowski's inequality, Completeness of $L_2[a,b]$, Dense subsets of $L_2[a,b]$, $L_p[a,b]$ as a generalization of $L_2[a,b]$, a quick introduction of sequence spaces l_2 and l_p.

Unit III: Monotonic function and its differentiability, functions of finite (bounded) variation on [a,b] and its properties, Absolutely continuous functions on $[a,b]$, differential properties of absolutely continuous function.

Unit IV: The indefinite Lebesgue integral and the fundamental theorem of calculus, Definition of Fourier series and convergence problem, (C,1) summability of Fourier series, the L_2 theory of Fourier series, Convergence of Fourier series.

Text books:

The course is based on the following books:

1. "Theory of Functions of a real variable" Volume-I by I. P. Natanson, Frederic Ungar Publishing Co., New York 1964.
2. "Methods of Real Analysis" by Richard Goldberg, Oxford & IBH Publishing Company, 1964.

Reference books:

1. "Real Analysis" by H. L. Royden (3rd edition), Pearson Prentice Hall (2007).
2. "Measure and Integration" by I. K. Rana, Narosa Publishing House (1997).

MAT409 – Complex Analysis-II

Objectives and outcome:

The main aim is to make students familiar with Contour Integrals and Residue Theory for finding Contour Integrals. It is expected that on successful completion of this course the students will be able to handle Contour Integrals and its applications with Mathematical Maturity.

Unit I: Convergence of Taylor series, Laurent series and Uniqueness, Convergence of sequences and series, Uniform and absolute convergence of power series. Multiplication and Division of Power Series.

Unit II: Residue, Cauchy's Residue theorem, Residue at Infinity. Types of isolated singular points, Residues at poles, Zeros and poles of order m, Behavior of f near removable and essential singular points.

Unit III: Evaluation of improper integrals from Fourier Analysis using Residues. Jordan's Lemma. Indented Paths. Indentation around a Branch cut. Integration along a Branch Cut. Definite integrals involving Sines and Cosines using Residues.

Unit IV: Argument Principle, Rouché's Theorem and Möbius Transformations (Bi-linear transformation).

Text book:

The course is roughly covered by "Complex variables and Applications" (8th edition) J. W. Brown and R. V. Churchill, McGraw Hills. International Edition 2009.
ISBN: 978-007-126328-3. OR MHID: 007-126328-4.

Reference books:

1. "Introduction to Functions of Complex Variable" C. J. Hamilton, Marcel Dekker Inc. New York.
2. "Complex Analysis" I. Stewart and David Tall, Cambridge University Press.
3. "Complex Analysis" J. C. Duncan, John Wiley & Sons, London.
4. "Complex Analysis" Lars Ahlfors, McGraw Hills. Indian Edition

MAT410 Partial Differential Equations

Objectives and outcome:

The objective of this course is to introduce partial differential equations, particularly the second order equations of mathematical physics.

Unit I: Review of curves and surfaces; genesis of first order PDE; classification of integrals; linear equations of the first order; Pfaffian differential equations; compatible systems of first order PDE, Charpit's method.

Unit II: Jacobi's method; integral surface through a given curve; quasi-linear equations (characteristic curves and the initial value problem), Non-linear first order PDE (characteristic curves and the initial value problem).

Unit III: Genesis of second order PDE; classification of second order PDE, Introduction to the initial and boundary value problems, One dimensional wave equation; vibrations of an infinite string; Vibrations of a semi-infinite string, Vibrations of a string of finite-length, Heat conduction problem: infinite rod; finite rod.

Unit IV: Duhamel's principle, Laplace's equation: boundary value problems; maximum and minimum principles; the Dirichlet problem for a circle, for the upper half plane, for a rectangle, Neumann's problem for the upper half plane and for a circle, Harnack's theorem; Green's function, Families of equipotential surfaces.

Text book:

"An Elementary Course in Partial Differential Equations" (2nd Edition) – T. Amaranath, Narosa Publishing House Pvt. Ltd., 2005.

Reference books:

1. Elements of Partial Differential Equations: Ian Sneddon, Mc-Graw-Hill International Editions.
1. Ordinary and Partial Differential Equations: Theory and Application – Nita H Shah, PHI Learning Pvt Ltd.
2. Partial Differential Equations: Methods, Applications and Theories – Harumi Hattori, World Scientific.
3. Elements of Partial Differential Equations (2nd Edition) – Pavel Drabek, Gabriela Holubova, DE GRUYTER.
5. Linear Partial Differential Equation for Scientists and Engineers: by Tyn Myint-U and Lokenath Debnath, Fourth Edition, Birkauser Publications.
6. Methods of Mathematical Physics Vol.2, - R. Courant and D. Hilbert, Wiley Eastern Pvt. Ltd., 1975.

MAT411PR – Practical-1

Based on Matrix Algebra:

Practical 1: System of linear non-homogenous equations.

Practical 2: Eigenvalues and Eigenvectors of a square matrix.

Practical 3: Cayley-Hamilton theorem and applications; Minimal equation of a matrix.

Practical 4: Orthogonal and Unitary matrices; Eigenvalues and Eigenvectors of some special matrices.

Practical 5-7: Bilinear, Quadratic and Hermitian forms.

Practical 8: Matrix Norms.

Reference books:

1. A textbook of Matrices by Shanti Narayan and P. K. Mittal, S. Chand & Company Ltd.
2. Matrix and Linear Algebra by K. B. Dutta, PHI Learning Ltd.
3. Calculus and Matrix Algebra by S. K. Patel, B. P. Patel, H. R. Kataria and B. L. Ghodadra, University Granth Nirman Board, Ahmedabad.
4. Linear Algebra in Action, Harry Dyn: Vol.78 GSM. AMS.

Based on Real analysis:

Practical 1: Outer and Inner measure, measurable sets and measurable functions.

Practical 2: Sequences of measurable functions.

Practical 3: Square-summable and p-summable functions.

Practical 4: Holder's and Minkowski's inequality for functions and numbers.

Practical 5: Derived numbers and derivatives.

Practical 6: Increasing functions and functions of finite variation.

Practical 7: Cantor set and Cantor function.

Practical 8: Fourier series.

Reference books:

1. "Theory of Functions of a real variable" Volume-I by I. P. Natanson, Frederic Ungar Publishing Co., New York 1964.
2. "Methods of Real Analysis" by Richard Goldberg, Oxford & IBH Publishing Company, 1964.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT412PR –Practical-2

(Based on MAT409: Complex Analysis-II and MAT410: Partial Differential Equations)

Objectives and outcome:

The objective here is to acquaint students to develop and consolidate their problem solving skills with the problems related to the notions that they have familiarize themselves in Complex Analysis-II and Partial Differential Equation courses. It is expected that on successful completion of this course the students will be able to handle problems related to the topics mentioned in the title with enhanced Mathematical Maturity.

Practicals Based on MAT409: Complex Analysis-II

Practical 1: Examples based on finding Laurent series, Taylor series. Division of Power Series.

Practical 2: Examples based on finding Residues; three types of isolated singular points. Examples Based on Cauchy's Residue theorem.

Practical 3: Examples Based on Residues at Infinity and its application (i.e. Theorem on Page 238 of the Textbook).

Practical 4: Examples on finding residues at poles i.e. Based on ϕ Method. Examples based on zeroes, poles and special method for finding Residues at a simple Pole (i.e. Based on Theorem 2 on page 253).

Practical 5: Practical Based on finding improper integrals using Residue Theory.

Practical 6: Practical Based on finding integrals from Fourier Analysis and Based on Indented Path Technique.

Practical 7: Practical Based on finding definite integrals involving SINES and COSINES using residue theory.

Practical 8: Practical based on, Rouché's Theorem and Möbius Transformations (Bi-linear transformation). Miscellaneous Problems.

Based on MAT410: Partial Differential Equations

Practicals Based on

1) Lagrange's equation and Pfaffian Differential Equations
2) Charpit's Method and Jacobi's Method
3) Integrals Surfaces through a given curve
4) Cauchy Problem for Quasi Linear Equation and Non-Linear First Order PDE
5) Method of Separation of Variables
6) Various Initial and Boundary Value Problems for the Wave Equation
7) Various Initial and Boundary Value Problems for the Heat Equation
8) Various Initial and Boundary Value Problems for the Laplace Equation

Text book:

"An Elementary Course in Partial Differential Equations" (2nd Edition)
– T. Amaranath, Narosa PublishingHouse Pvt. Ltd., 2005.

Reference books:

1. Elements of Partial Differential Equations: Ian Sneddon, Mc-Graw-Hill International Editions
2. Ordinary and Partial Differential Equations: Theory and Application – Nita H Shah, PHI Learning Pvt Ltd.
3. Partial Differential Equations: Methods, Applications and Theories – Harumi Hattori, World Scientific
4. Elements of Partial Differential Equations(2^{nd} Edition) – Pavel Drabek, Gabriela Holubova, DE GRUYTER
5. Linear Partial Differential Equation for Scientists and Engineers: by Tyn Myint-U and Lokenath Debnath, Fourth Edition, Birkauser Publications
6. Methods of Mathematical Physics Vol.2, - R. Courant and D. Hilbert, Wiley Eastern Pvt. Ltd., 1975.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT501 – Functional analysis-I

Objectives and Outcome:

To introduce the elementary aspects of Banach Spaces and operators.

Unit I: Review of linear spaces, quotient linear spaces, direct sums of linear subspaces, basis of a linear space - existence using Zorn's lemma, linear transformations from a linear space to another, projections on a linear space.

Unit II: Normed linear spaces, Banach spaces, quotient of a normed linear space by a closed linear subspace, continuous linear transformations from a normed linear space to a normed linear space, finite dimensional normed linear spaces.

Unit III: Conjugate space of a normed linear space, Hahn-Banach theorem with consequences, the natural imbedding of a normed linear space in its second conjugate space, Reflexive spaces, open mapping theorem, projections on a Banach space, closed graph theorem.

Unit IV: The uniform boundedness theorem, conjugate of an operator on a Banach space, Hilbert spaces, orthogonal complements, complete orthonormal sets in a Hilbert space**.**

Text book:

Introduction to topology and modern analysis by G. F. Simmons, McGraw - Hill Book Co.1963; Chapter 8 (42 onwards) to Ch.10 (upto 54).

Reference books:

1. "Functional analysis" by B. V. Limaye, New Age International Limited publishers.
2. "An introduction to Hilbert Spaces" by S. K. Berberian, Oxford Uni. Press, 1959. D.Van Nostrand Co. Inc. Princeton, N.J., 1967, also available in paperback, edition by Springer.
3. "A Hilbert space problem book" by P. R. Halmos.
4. "An introductory functional analysis with application" by E.Kreyszig, WSE edition, 1989, paperback.
5. "Linear Analysis" An Introductory course by Bela Bollobas, Foundation Books, Delhi (Cheap edition), 1994.

MAT502 Algebra - I

Objectives and Outcome:

The objective of this course is to make students familiar with group structures and some related applications of the group. It also provides the basis for further studies.

Unit I: Introduction to Groups, Symmetries of a Square, The Dihedral Groups , Elementary Properties of Groups , Finite Groups, Subgroups, Subgroup Tests , Cyclic Groups, Classification of Subgroups of Cyclic Groups.

Unit II: Permutation Groups, Cycle Notation, Properties of Permutations, Isomorphisms, Cayley's Theorem, Properties of Isomorphisms, Automorphisms, Properties of Cosets,Lagrange's Theorem and consequences and further applications. External Direct Products and their properties. The Group of Units Modulo n as an External Direct product and further applications.

Unit III: Normal subgroups, Factor groups, Applications of Factor groups. Internal Direct products, Group homomorphisms and their properties, the First Isomorphism Theorem. Fundamental theorem of finite Abelian groups, Isomorphism classes of Abelian groups.

Unit IV: The Conjugacy classes, The Class Equation, Sylow theorems and their applications. Finite Simple groups, Nonsimplicity Tests, The simplicity of the group A_5.

Text Book:

"Contemporary Abstract Algebra" (8^{th} Edition) by Joseph A Gallian, Cengage Learning, 2013.
Chapters: 1 to 11; 24 and 25.

References:

(1) "Basic Abstract Algebra" (2nd Edition)- PB Bhattacharya, SK Jain, SR Nagpaul, Cambridge Uni Press, 1995.
(2) "Algebra"---Michael Artin, PHI Learning Pvt Ltd, New Delhi.
(3) "A Course in Algebra"— EB Vinberg, American Mathematical Society, 2003.
(4) "Algebra"--- Thomas W Hungerford, Springer, 2004.

MAT503EA – Advance Calculus

Objectives:

To do the theory and applications of Differential and Integral Calculus in several variables, and to gain facility with calculations.

Unit I: Differentiability in several variables; the chain rule; the mean value theorem; higher order partial derivatives; Taylor's theorem; critical points; extreme value problems; Frechet derivatives.

Unit II: The Implicit Function Theorem; curves and surfaces; transformations and coordinate systems; functional dependence.

Unit III: Integration in higher dimensions; multiple integrals and iterated integrals; change of variables for multiple integrals; functions defined by integrals.

Unit IV: Arc length and line integrals; Green's theorem; surface area and surface integrals; vector derivatives; the divergence theorem; some applications to physics; Stoke's theorem.

Text book:

Advanced Calculus by Gerald B. Folland, Pearson India Education Services Pvt. Ltd., 2012, Chapters 2-5.

Reference books:

1. Advanced Calculus by David V. Widder, Prentice - Hall of India Pvt. Ltd., New Delhi, 1968.
2. Advanced Calculus by Patrick M. Fitzpatrick, The Sally Series. Indian Edition. AMS. ISBN 978-0-8218-5209.

MAT503EB – Financial Mathematics

Objectives and outcome:

The course aims to introduce the basic concepts and products of modern financial mathematics. Basic principles to understand and think about finance mathematically are introduced. The topics expose the user to fundamental concepts such as cash flows, present value, future value, yield and probability that form the basis for further advanced learning. The importance of the assumptions underlying the models leading to correct evaluation of risk are introduced and the central problem of finance i.e the quantification of risk and thereby the creation and pricing of contracts is introduced. It intends to provide the students an introduction to the theoretical foundations and main tools used in the pricing of bonds, European, American and Exotic Options, Futures and options on Futures.

UNIT I: **Basic Concepts:** Arbitrage, Return and Investment, Time Value of Money, Bonds, Shares and Indices, Models and Assumptions.

Deterministic Cash Flows: Net Present Value, Internal Rate of Return, Comparison of IRR and NPV, Bonds: Price and Yield, Clean and Dirty Price, Price-Yield curves, Duration, Term Structure of Interest rates, Immunisation, Convexity, Callable Bonds.

UNIT II: **Random Cash Flows:** Random Returns, Portfolio Diagrams and Efficiency, Feasible Set, Markowitz Model, Capital Asset Pricing Model, Diversification, CAPM as a pricing formula, Numerical Techniques.

Forwards and Futures: Forwards and Futures, Price and Contract, Method of Replicating Portfolios, Hedging with futures, Currency futures, Stock Index Futures.

UNIT III: **Stock Price Models:** Lognormal, Geometric Brownian Motion, Binomial Tree Mode Options: Call and Put, Call-Put Parity, Binomial Options Pricing Model, Pricing American Options, Factors Influencing Option Premiums, Options on Assets with Dividends, Dynamic Hedging, Risk-Neutral Valuation,

The Black-Scholes Model: Risk-Neutral Valuation, The Black-Scholes Formula, Options on Futures, Options on Assets with Dividends.

UNIT IV: **The Black-Scholes Model:** Black-Scholes and BOPM, Implied Volatility, Dynamic Hedging, The Greeks, The Black-Scholes PDE, Speculating with options.

Value at Risk: Definition of VAR, Linear Model, Quadratic Model, Monte Carlo Simulation, The Martingale.

Text Book:

The course is covered by Chapters 1-8 of The Calculus of Finance: by Amber Habib, Universities Press

References

1. Hull, J. C. Options, Futures and Other Financial Derivatives, Prentice Hall, 8th edition.
2. Pascucci, A. Bocconi, PDE and Martingale Methods in Option Pricing. Springer Series, 2011.
3. R. U. Seydel, Tools for Computational Finance, University text, 3rd Edition Springer 2000.
4. J.B. Hunt and J.E. Kennedy, Financial Derivatives in Theory and Practice, Wiley, 2005.
5. M. Baxter and A. Rennie, Financial Calculus: An introduction to Derivative Pricing (Cambridge, UK), 1996.
6. R. J. Williams, Introduction to the Mathematics of Finance, AMS, 2011.
7. Victor Goodman & Joseph Stampfli, The Mathematics of Finance: Modelling and Hedging, AMS.

MAT504EA - Mathematical Programming

Objectives and Outcome:

The objective of this course is to explore various mathematical programming algorithms to solve real life problems.

Unit I: Modelling with linear programming, Simplex method, Dual linear programming, Integer programming.

Unit II: Transportation and Assignment problems.

Unit III: Non-linear programming, Lagrangian method, Kuhn-Tucker conditions, Quadratic programming, Wolfe's method, Beale's method.

Unit IV: Dynamic programming, Fractional programming.

Text book:

Syllabus is roughly covered by "OPERATIONS RESEARCH" by Nita H. Shah, Ravi M. Gor and Hardik Soni, PHI Publications, New Delhi, 2007.

Reference books:

1. OPERATIONS RESEARCH: AN INTRODUCTION (Eighth edition) by H. A. Taha, PHI Publications, New Delhi, 2006.
2. INTRODUCTION TO OPERATIONS RESEARCH by F. S. Hiller and G. J. Liberman, McGraw Hills Publication.

MAT504EB–Computational Mathematics

Objectives and outcome:

To study the advanced computational methods.

UNIT I: Computer Arithmetic: Floating point numbers and round off errors, Absolute and relative errors, Polynomial Interpolation: Hermite's interpolation formula with error analysis, Richardson interpolation, splines and spline interpolation, Aitken extrapolation.

UNIT II: Numerical differentiation, Gaussian quadrature, Romberg integration, adaptive quadrature, Solution of system of Linear equations: Matrix inversion, Jordan's method, Escalator method and iterative method, The LU and Cholesky factorizations, Pivoting and constructing an algorithm Based on Gaussian elimination method.

UNIT III: Algebraic Eigen value problem, Properties of eigen values and eigen vectors, Power method, Inverse power method, Orthogonal factorization, QR algorithm for eigen value problem.

UNIT IV: Eigen values of complex matrix and complex eigen vectors, Numerical Solution of ODE: single step method-Runge Kutta methods, Multistep method - Milne Simpson's method, System of non-linear equations: Newton Raphson's method.

Reference Books:

1. C. E. Froberg: Introduction to Numerical Analysis, Addision Wesley publishing Company, sixth edition, 1981.
2. Nita H Shah: Numerical Methods with C++ programming & Matlab, Second Edition, PHI.
3. S.S. Sastri: Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi, 1997.
4. E.V. Krishnamurthy and S. K. Sen: Computer based numerical Algorithms, East–West press Pvt. Ltd. 1976.
5. Conte S. D and Carl deboor: Elementary Numerical Analysis: an algorithmic approach, Mc Graw Hill company, Third edition, 1981.
6. M. K. Jain: Numerical analysis for scientists and Engineers, New Age International Ltd. Publishing, 1992.
7. J. D. Faires and R. Burden: Numerical methods, second edition, Brooks/cole publishing Co., 1998.
8. E.Hairer, E. P. Norsett and G. Wanner: Solving ordinary differential equations I and II, Springer series in computational mathematics 8, Springer Berlin, 1993.

MAT505PR–Practical I

Based on Functional analysis - I:

Practical 1: Vector space and related concepts.

Practical 2: Linear transformations.

Practical 3: Examples of normed linear spaces and Banach spaces.

Practical 4: Continuous Linear transformations.

Practical 5: The conjugate and the second conjugate spaces of normed linear spaces.

Practical 6: The open mapping and the closed graph theorems; the uniform boundedness principle.

Practical 7-8: Hilbert space and related concepts.

Reference books:

1. Introduction to topology and modern analysis by G. F. Simmons, McGraw - Hill Book Co. 1963.
2. Functional analysis by B. V. Limaye, New Age International Limited publishers.

Based on Algebra-1 (Group Theory)

Practical 1: Dihedral groups D_n.

Practical 2: Properties of groups and subgroups.

Practical 3: Permutations groups, Isomorphisms.

Practical 4: Cosets and Lagrange's theorem, External direct products.

Practical 5: Normal subgroups and Factor groups.

Practical 6: Group homomorphisms, Isomorphism classes of finite Abelian groups.

Practical 7: Applications of Sylow theorems.

Practical 8: Finite simple groups.

Reference books:

1. "Basic Abstract Algebra" (2^{nd} Edition) - P B Bhattacharya, S K Jain, S R Nagpaul, Cambridge Uni Press, 1995.
2. "Algebra" - Michael Artin, PHI Learning Pvt Ltd, New Delhi.
3. "A Course in Algebra" - EB Vinberg, American Mathematical Society, 2003.
4. "Algebra" - Thomas W Hungerford, Springer, 2004.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT506PR – Practical II

Based on Advanced Calculus, MAT503EA

Practical: 1-2 Differentiability in several variables;
Practical: 3-4 The implicit function theorem and its applications.
Practical: 5-6 Integration in higher dimensions;
Practical: 7-8 Line and Surface Integrals.

Based on MAT503EB Financial Mathematics:

1. Basic Concepts: Arbitrage, Return and Investment, Time Value of Money, Bonds, Shares and Indices, Models and Assumptions
2. Deterministic Cash Flows: Net Present Value, Internal Rate of Return, Comparison of IRR and NPV, Bonds: Price and Yield, Clean and Dirty Price, Price-Yield curves, Duration, Term Structure of Interest rates, Immunisation, Convexity, Callable Bonds
3. Random Cash Flows: Random Returns, Portfolio Diagrams and Efficiency, Feasible Set, Markowitz Model, Capital Asset Pricing Model, Diversification, CAPM as a pricing formula, Numerical Techniques
4. Forwards and Futures: Forwards and Futures, Price and Contract, Method of Replicating Portfolios, Hedging with futures, Currency futures, Stock Index Futures
5. Stock Price Models: Lognormal, Geometric Brownian Motion, Binomial Tree Model
6. Options: Call and Put, Call-Put Parity, Binomial Options Pricing Model, Pricing American Options, Factors Influencing Option Premiums, Options on Assets with Dividends, Dynamic Hedging, Risk-Neutral Valuation, The Black-Scholes Model: Risk-Neutral Valuation, The Black-Scholes Formula, Options on Futures, Options on Assets with Dividends
7. The Black-Scholes Model: Black-Scholes and BOPM, Implied Volatility, Dynamic Hedging, The Greeks, The Black-Scholes PDE, Speculating with options
8. Definition of VAR, Linear Model, Quadratic Model, Monte Carlo Simulation, The Martingale.

Text Book:
The course is covered by Chapters 1-8 of The Calculus of Finance: by Amber Habib, Universities Press

References:
1. Hull, J. C. Options, Futures and Other Financial Derivatives, , Prentice Hall, 8th edition.
2. Pascucci, A. Bocconi, PDE and Martingale Methods in Option Pricing. & Springer Series, 2011.
3. R. U. Seydel, Tools for Computational Finance, University text, 3rd Edition Springer 2000.
4. J.B. Hunt and J.E. Kennedy, Financial Derivatives in Theory and Practice, Wiley, 2005.
5. M. Baxter and A. Rennie, Financial Calculus: An introduction to Derivative Pricing (Cambridge, UK), 1996.

[Cont.]

Based on MAT504EA Mathematical Programming

Objectives and Outcome:

The objective of this paper is to apply techniques studied in MAT504EA to solve problems.

Practical 1: Formulation of LPP.

Practical 2: Solve problem using Simplex method.

Practical 3: Solve problems using Big – M method and Two-phase method.

Practical 4: Solve transportation problem using North-West Corner method, Least cost method and Vogel's method.

Practical 5: Solve transportation problems using MODI's method.

Practical 6: Solve LPP for integer requirement.

Practical 7: Obtain quadratic form of NLPP. Solve NLPP using KT – conditions, Lagrange's multiplier, Wolfe method and Beales method.

Practical 8: Solve NLPP using dynamic programming algorithm and fractional programming.

Based on MAT504EB Computational Mathematics

1. Polynomial Interpolation: Hermite's interpolation formula with error analysis.
2. Richardson interpolation, Splines and spline interpolation, Aitken extrapolation.
3. Jordan's method.
4. The LU and Cholesky factorizations.
5. Pivoting and constructing an algorithm Based on Gaussian elimination method.
6. Algebraic Eigen value problem.
7. Orthogonal factorization, QR algorithm for eigen value problem.
8. Numerical Solution of ODE.

Reference Books:

1. C. E. Froberg: Introduction to Numerical Analysis, Addision Wesley publishing Company, sixth edition, 1981.
2. Nita H Shah: Numerical Methods with C++ programming & Matlab, Second Edition, PHI
3. S. S. Sastri: Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi, 1997.
4. E. V. Krishnamurthy and S.K.Sen: Computer based numerical Algorithms, East-West press Pvt. Ltd. 1976
5. Conte S. D and Carl deboor: Elementary Numerical Analysis: an algorithmic approach, Mc Graw Hill company, Third edition, 1981
6. M.K. Jain: Numerical analysis for scientists and Engineers, New Age International Ltd. Publishing, 1992
7. J. D. Faires and R. Burden: Numerical methods, second edition, Brooks/cole publishing Co., 1998.
8. E. Hairer, E. P. Norsett and G. Wanner: Solving ordinary differential equations I and II, Springer series in computational mathematics 8, Springer Berlin, 1993.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT507 – Differential Geometry

Objectives:

To study curves and surfaces. The approach is straight-forward, and may help in teaching geometry in schools.

Unit I: Concept of a curve; tangent to a curve; osculating planes; envelope of a family of plane curves; natural parametrization; curvature; torsion; Frenet formulas.

Unit II: Concept of a surface; tangent planes; osculating paraboloid; classification of surface points.

Unit III: Area of a surface; normal curvature; lines of curvature; mean and Gaussian curvature; a surface of constant negative Gaussian curvature.

Unit IV: Intrinsic geometry of surfaces; Gaussian curvature is intrinsic; geodesic lines; extremal property of geodesics; Gauss-Bonnet theorem; closed surfaces.

Text book:

Geometry by A. Pogorelov, Mir Publishers, 1987.
Chapters VIII – XII.

Reference books:

1. Elementary Differential Geometry, by Andrew Pressley, Spinger 2001.
2. Differential Geometry of Curves and Surfaces; by Manfredo P. do Carmo. Prentice-Hall Inc., New Jersey.
3. Differential Geometry, by A. V. Pogorelov; (Publisher) P. Noordhoff N. V. - Groningen - The Netherlands.

MAT508 – Algebra II

Objectives :

To study ring theory further, and to introduce Galois theory with some applications.

Unit I: A brief review; ideals and factor rings; ring homomorphisms.

Unit II: Polynomial rings; irreducibility tests; unique factorization in Z[X]; divisibility in integral domains.

Unit III: Splitting fields; finite extensions of fields; properties of algebras extensions; finite fields; geometric constructions.

Unit IV: Fundamental theorem of Galois theory; solvability of polynomials by radicals; insolvability of a quantic; cyclotomic polynomials.

Text book:

Contemporary Abstract Algebra (Eighth Edition) by Joseph A. Gallian, Cengage India Learning Private Limited, 2013.
Chapters : 12-23, 32,33

Reference books:

(1) A Course in Algebra by

- E. B. Vinberg, American Mathematical Society, 2003.

(2) Basic Abstract Algebra (Second Edition) by

- P. B. Bhattacharya, S. K. Jain, S. R. Nagpal.

Cambridge University press, 1995.

MAT509EA - Number Theory

Objectives and outcome:

The main objective is to give a simple account of elementary classical number theory.

Unit I: Review of Divisibility, Arithmetical Functions: The function [x], multiplicative functions, Euler's (totient) function φ(n), The Mobius function μ(n), The functions τ(n) and σ(n), Average orders, Perfect numbers.

Unit II: Congruences: Definitions, Chinese-Remainder theorem, The theorems of Fermat and Euler, Wilson's theorem, Lagrange's theorem, Primitive roots, indices.

Unit III: Quadratic residues, Legendre's symbol, Euler criterion, Gauss's lemma, Law of quadratic reciprocity, Jacobi's symbol.

Unit IV: Dirichlet theorem, Continued Fractions, Rational approximations, Quadratic irrationals, linear Diophantine equations ax+by=c, Pell's equations, Pythagorean triples,

Text book:

A Concise introduction to the Theory of Numbers by Alan Baker, Cambridge Uni. Press, Cambridge.

Reference books:

1. "An introduction to the Theory of Numbers (5th edition) by Ivan Nivan, H. S. Zuckerman, H .L. Montgomery, John Wiley & Sons Inc., 2000.
2. Elementary Number theory (6^{th} Edition) by David M. Burton, Tata McGraw-Hill, 2007.

MAT509EB - Project

Objectives and Outcome:

Through project, students will explore real-world problems and challenges, simultaneously developing cross-curriculum skills. This type of learning is filled with active and engaged learning, it inspires students to obtain a deeper knowledge of the subjects they're studying. The student will attain the knowledge gained through this approach far more readily than through traditional textbook-centered learning. In addition, students develop confidence and self-direction as they do independent work.

MAT510EA - Quantitative Techniques

Objectives and Outcome:

The objective of this course is to explore various techniques to solve real life problems.

Unit I: Inventory theory: Concept, classification of inventory models, EOQ model, EPQ model, EOQ model with shortages, EOQ model with constraints

Unit II: Queueing models: Introduction, Queueing components, ((M/M/1): (∞/FCFS)), ((M/M/1): (N/FCFS)), ((M/M/c) : (∞/FCFS)), ((M/Ek/1): (∞/FCFS)), ((M/M/R) : (K/GD)), K > R

Unit III: Replacement models: Introduction, types of replacement models, replacement of items those deteriorate, replacement of items which fails completely, Sequencing problems

Unit IV: Simulation and its applications in solving queueing and inventory problems

Text Book:

Syllabus is roughly covered by "OPERATIONS RESEARCH" by Nita H. Shah, Ravi M. Gor and Hardik Soni, PHI Publications, New Delhi, 2007.

Reference Books:

1. ANALYSIS OF INVENTORY SYSYTEMS by G. Hadley and T. M. Whitin, Prentice Hall.
2. INVENTORY SYSTEMS by E. Naddor, John Wiley Publications, 1964.
3. SIMULATION by Gordan, Prentice Hall.

MAT510EB - Functional Analysis II

Objectives and outcome:

To analyse the concepts related to Hilbert spaces and Banach spaces.

Unit I: Conjugate space of a Hilbert space, Adjoint of an operator on a Hilbert space, Self-adjoint operators, Normal & unitary operators.

Unit II: Projections on a Hilbert space, Invariant subspaces. Spectral resolution of an operator on a finite dimensional Hilbert space. The spectral theorem for finite dimensional Hilbert spaces and its consequences.

Unit III: Classification of the spectrum of an operator on a Banach space, Spectrum of the Shift operator, Multiplication operator etc. Gelfand - Mazur theorem, The Spectral radius formula.

Unit IV: Compact operators. The Spectrum of compact operators.

Text Books:

1. "Introduction to Topology and Modern analysis" by G. F. Simmons, McGraw – Hill Book Co. 1963.

   Chapter 10 (55 onwards), Chapter 11 (61 to 63).
2. "Functional analysis" by B. V. Limaye, New Age International Limited publishers, 1996. (Second Edition). Chapter 3(Article 12), Chapter 5(Article 17, 18).

References:

1. "An introduction to Hilbert Spaces" by S. K. Berberian, Oxford Uni. Press, 1959, D. Van Nostrand Co. Inc. Princeton, N.J., 1967, also available in paperback, edition by Springer.
2. "A Hilbert space problem book" by P. R. Halmos.
3. "An Introductory Functional Analysis with application" by E. Kreyszig, WSE edition, 1989, paperback.

MAT511PR Practical I

Based on Differential Geometry MAT 507

Practical 1: Tangent and osculating planes of a curve.
Practical 2: Curvature and torsion of a curve.
Practical 3 -4: Tangent plane and osculating paraboloid of a surface.
Practical 5-6: Surface curvature
Practical 7-8: Intrinsic geometry of a surface.

Reference books:

1. Elementary Differential Geometry, by Andrew Pressley, Spinger 2001.
2. Differential Geometry, by A. V. Pogorelov; (Publisher) P. Noordhoff N. V, - Groningen - The Netherlands.

Based on Algebra II, MAT 508

Practical 1: Ideals and factor rings.
Practical 2: Ring Homomorphisms.
Practical 3: Polynomial rings and factorization.
Practical 4: Divisibility in integral domains.
Practical 5: Field Extensions
Practical 6: Finite fields; geometric constructions.
Practical 7-8: Galois theory; cyclotomic polynomial

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.

MAT512PR Practical II

Based on Mathematical Methods:

Section I

Practical 1: Solutions of differential equations through Bessel functions.

Practical 2: Eigenvalues and eigenfunctions of Sturm-Liouville problems.

Practical 3-6: Laplace transform and its Applications.

Practical 7: The eigenvalue-eigenvector method of finding solutions of system of differential equation $\dot{x} = Ax$.

Practical 8: Fundamental matrix solutions of system of differential equation $\dot{x} = Ax$, Stability of linear systems.

Section II

Practical 1-4: Fourier series, Integrals, Transforms and their Applications.

Practical 5-6: Z-Transform and its Applications.

Practical 7-8: Hankel Transform and its Applications.

Reference Books:

1. Advanced Engineering Mathematics, (10^{th} Edition) Erwin Kreyszig, John Wiley and Sons, Inc., 2011.
2. "Differential Equations and their Applications" (2^{nd} Edition), M. Brann, Sringer - Verlag, New York Inc, 1978.
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand 2006.
4. Mathematical methods for physicists 6^{th} edition by Arfken & Weber (Academic press Indian Reprint).
5. Methods of Mathematical Physics (Vol. I & II) by Courant & Hilbert (1953) – New York Interscience.
6. Integral Transforms and their Applications (3^{rd} Edition), Lokenath Debnath and Dambaru Bhatta, CRC Press, 2015.

Note: Whenever possible it is expected that teachers will incorporate and encourage the use of packages like Mathematica/MATLAB/Maple/etc. in solving the problems in practical sessions.