MANGALORE UNIVERSITY
DEPARTMENT OF MATHEMATICS

M.Sc. Mathematics Choice Based Credit System (Semester Scheme)

Preamble

The syllabi in use at present were introduced from the academic year 2003-2004. The syllabi presented here is a slight modification of this syllabi. Some of the papers are redistributed in various semesters so as to accommodate a choice based paper in the third semester. The first paper in the third semester is a choice based paper which is offered only to the students of other departments. One additional paper (Advanced Topology) has been offered as an alternative to another paper (Multivariate Calculus and Geometry) in the third semester. Also in the fourth semester, students are given an option to take either Graph theory or Lattice theory as one of the papers. The syllabus takes into consideration the recommendations of U.G.C. Curriculum Development Committee and it is meant to be introduced from the academic year 2011-2012.

A. The following shall be the courses of study in the four semesters M.Sc. Mathematics Choice Based Credit System from the academic year 2011-2012.

I Semester

Paper Code	Paper
MT 401	Algebra – I
MT 402	Linear Algebra – I
MT 403	Real Analysis – I
MT 404	Topology
MT 405	Numerical Analysis – I

II Semester

Paper Code	Paper
MT 451	Algebra – II
MT 452	Linear Algebra – II
MT 453	Real Analysis – II
MT 454	Complex Analysis – I
MT 455	Numerical Analysis – II

III Semester

In this semester, the first paper MT 501 is a "Choice Based Paper" which is offered only to students of other departments.

The other five papers are offered to the students of the Department and for the paper MT 505, a student has an option to take either MT 505(a) or MT 505(b).

Paper Code	Paper
MT 501	Differential Equations and Applications
MT 502	Commutative Algebra
MT 503	Ordinary Differential Equations
MT 504	Complex Analysis – II
MT 505	(a) Multivariate Calculus and Geometry OR (b) Advanced Topology
MT 506	Seminar

IV Semester

In this semester the fifth paper can be either MT 555(a) or MT 555(b).

Paper Code	Paper
MT 551	Algebraic Number Theory
MT 552	Partial Differential Equations
MT 553	Measure and Integration
MT 554	Functional Analysis
MT 555	(a) Graph Theory OR (b) Lattice Theory

B. Scheme of Instruction and Examination

I Semester

Paper Code	Instruction hours per week	Duration of Exam. in hours	University Exam. Max.Marks	Internal Assessment Max.Marks	Total Marks	Credits
MT 401	5	3	70	30	100	5
MT 402	5	3	70	30	100	5
MT 403	5	3	70	30	100	5
MT 404	5	3	70	30	100	5
MT 405	5	3	70	30	100	5

II Semester

Paper Code	Instruction hours per week	Duration of Exam. in hours	University Exam. Max.Marks	Internal Assessment Max.Marks	Total Marks	Credits
MT 451	5	3	70	30	100	5
MT 452	5	3	70	30	100	5
MT 453	5	3	70	30	100	5
MT 454	5	3	70	30	100	5
MT 455	5	3	70	30	100	5

III Semester

Paper Code	Instruction hours per week	Duration of Exam. in hours	University Exam. Max.Marks	Internal Assessment Max.Marks	Total Marks	Credits
MT 501	4	3	70	30	100	4
MT 502	5	3	70	30	100	5
MT 503	5	3	70	30	100	5
MT 504	5	3	70	30	100	5
MT 505	5	3	70	30	100	5
MT 506	1	--	--	25	25	1

IV Semester

Paper Code	Instruction hours per week	Duration of Exam. in hours	University Exam. Max.Marks	Internal Assessment Max.Marks	Total Marks	Credits
MT 551	5	3	70	30	100	5
MT 552	5	3	70	30	100	5
MT 553	5	3	70	30	100	5
MT 554	5	3	70	30	100	5
MT 555	5	3	70	30	100	5

Tutorials: 3 hours of tutorials per week for each paper having 5 credits.

Scheme of evaluation of internal assessment marks

Each Theory paper shall carry 30 marks for internal assessment based on two tests. In the III semester for the paper MT 506: Seminar, each student will be assigned a topic and the student has to present it before a panel of teachers in the class.

Pattern of Semester Examination Question Papers

Each question paper shall contain TEN questions out of which FIVE are to be answered.

All questions carry equal marks.

C. SYLLABI OF EACH SEMESTER

I SEMESTER

MT 401 - Algebra I

Unit I

Groups: The definition of a group, Subgroups, Cyclic groups and generators, Isomorphisms, Homomorphisms, Equivalence relations and partitions, Cosets, Restriction of a homomorphism to a subgroup, Products of groups, Modular arithmetic, Quotient groups. 15 Hours

Unit II

Symmetry: Symmetry of plane figures, The group of motions of the plane, Finite groups of motions.

Abstract symmetry: Group operations, The operations on cosets, The counting formula, Permutation representations. 15 Hours

Unit III

More on Group Theory: The operations of a group on itself, Operations on subsets, The Sylow theorems, The groups of order 12, Computation in the symmetric group, Orbits, Cycles and the alternating groups, Factor groups and normal subgroups, Simple groups.

20 Hours

Unit IV

Rings and Fields: Definitions and basic properties, Homomorphisms and isomorphisms, Divisors of zero and cancellation, Integral domains, The characteristic of a ring, The field of quotients of an integral domain, Rings of polynomials, The evaluation of homomorphisms, Factor rings and ideals, Fundamental homomorphism theorems, Prime and maximal ideals. 10 Hours

References:

[1] Michael Artin - Algebra, Prentice Hall of India.
[2] J. B. Fraleigh - A First Course in Abstract Algebra, Addison Wesley, 5th Edition.
[3] I. N. Herstein - Topics in Algebra.
[4] Joseph A. Gallian - Contemporary Abstract Algebra, Narosa Publishing House, 4th Edition.
[5] G. Birkhoff and S. Maclane - A Survey of Modern Algebra, Macmillan, New York, 3rd edition,
[6] S. Lang - Algebra, Reading, Mass, Addison Wesley, 1965.

MT 402 - Linear Algebra I

Unit I

Matrix Operations: The basic operations, Row reduction, Determinants, Permutation matrices, Cramer's rule. 15 Hours

Unit II

Vector Spaces: Real vector spaces, Abstract fields, Bases and dimensions, Computation with bases, Direct sums. 20 Hours

Unit III

Linear Transformations: The dimension formula, The matrix of a linear transformation, Linear operators and eigenvectors, The characteristic polynomial, Orthogonal matrices and rotations, Diagonalisation, Systems of differential equations, The matrix exponential. 25 Hours

References:

[1] Michael Artin - Algebra, Prentice Hall of India.
[2] K. Hoffmann and R. Kunz - Linear Algebra, Prentice Hall of India, 2nd Edition.
[3] S. Lang - Linear Algebra, Addison Wesley, London, 1970.
[4] Larry Smith - Linear Algebra, Springer Verlag.
[5] Katsumi Nomizu - Fundamentals of Linear Algebra, McGraw Hill Company.

MT 403 - Real Analysis I

Unit I

The real and complex number system: Introduction, Ordered sets, Fields, The real field, The extended real number system, The complex field, Euclidean spaces, Inequalities.

Basic topology: Finite, countable and uncountable sets, Metric spaces, Compact sets, Perfect sets, Connected sets. 20 Hours

Unit II

Numerical sequences and series: Convergent sequences, Subsequences, Cauchy sequences, Upper and lower limits, Some special sequences, Series, Series of non-negative terms, The number e, The root and ratio tests, Power series, Summation by parts, Absolute convergence, Addition and multiplication of series, Rearrangements.
15 hours

Unit III

Continuity: Limits of functions, Continuous functions, Continuity and compactness, Continuity and connectedness, Discontinuities, Monotonic functions, Infinite limits and limits at infinity. 15 Hours

Unit IV

Differentiation: The derivative of a real function, Mean value theorems, The continuity of derivatives, L' Hospital's rule, Derivatives of higher order, Taylor's theorems, Differentiation of vector valued functions. 10 Hours

References:

[1] Walter Rudin - Principles of Mathematical Analysis, McGraw Hill, 3rd Edition.
[2] R. G. Bartle - The Elements of Real Analysis, Wiley International Edition, New York, 2nd edition.
[3] T. M. Apostal - Mathematical Analysis, Addison / Wesley, Narosa, New Delhi, 2nd edition.
[4] G. H. Hardy - A Course of Pure Mathematics, S. L. B. S.
[5] R. R. Goldberg - Methods of Real Analysis, Oxford & I. B. H. Publishing Co., New Delhi.

MT 404 - Topology

Unit I

Topological spaces and continuous functions: Topological spaces, Basis for a topology, The order topology, The product topology on $X \times Y$, The subspace topology, Closed sets and limit points, Continuous functions, The product topology, The metric topology, The quotient topology. 30 Hours

Unit II

Connectedness and Compactness : Connected spaces, Connected sets in the real line, Components and path components, Local connectedness, Compact spaces, Compact sets in the real line, Limit point compactness, Local compactness. 30 hours

References:

[1] J. R. Munkres - Topology, Prentice Hall of India, 1975, 2nd edition, 2000.
[2] G. F. Simmons - Introduction to Topology and Modern Analysis, Mc-Graw Hill, Kogakusha,1968.
[3] S. Willard - General Topology, Addison Wesley, New York, 1968.
[4] J. Dugundji -Topology, Allyn and Bacon, Boston, 1966.
[5] J.L.Kelley - General Topology, Van Nostrand Reinhold Co., New York, 1955.

MT 405 - Numerical Analysis I

Unit I

Transcendental and Polynomial Equations: Introduction, Initial approximations, The bisection method, Iteration methods based on first degree equation, Iteration methods based on second degree equation, Rate of convergence, Rate of convergence of secant and Newton-Raphson method, Iteration methods, First order method, Second order method, High order methods, Acceleration of convergence, Methods for multiple roots, Methods for complex roots, Polynomial equations, Synthetic division, The Birge-Vieta method. 15 Hours

Unit II

System of Linear Algebraic Equations and Eigenvalue problems: Introduction, Direct methods, Cramer's rule, Gauss elimination method, Gauss-Jordan Method, Triangularization method, Cholesky method, Iterative improvement of solution, Iteration methods, Jacobi iteration method, Gauss-Seidel iteration method, Convergence analysis, Eigenvalues and eigenvectors. The power method. 15 Hours

Unit III

Interpolation and Approximation: Introduction, Lagrange and Newton interpolations, Linear and higher order interpolation, Finite difference operators, Interpolating polynomials using finite differences, Hermite interpolation, Approximation, Least square approximation. 20 Hours

Unit IV

Numerical Differentiation: Introduction, Methods based on interpolation, Methods based on finite differences, Methods based on undetermined coefficients, Extrapolation methods. 10 Hours

References:

[1] M. K. Jain, S. R. K. Iyengar - R. K. Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern.

[2] C. F. Gerald and P. O. Wheatly - Applied Numerical Analysis, Pearson Education, Inc., 1999.

[3] A. Ralston and P. Rabinowitz - A First Course in Numerical Analysis, 2nd Edition, McGraw - Hill, New York, 1978.

[4] K. Atkinson - Elementary Numerical Analysis, 2nd Edition, John Wiley and Sons, Inc., 1994.

[5] P.Henrici - Elements of Numerical Analysis, John Wiley and Sons, Inc., New York, 1964.

II SEMESTER

MT 451 - Algebra II

Unit I

Divisibility in integral domains: Irreducibles, Primes, Unique factorization domains, Euclidean domains. 8 Hours

Unit II

Factorisation of polynomials: Content of polynomials, Primitive polynomials, Gauss lemma, Irreducibility test mod p, Eisenstein's criterion, Unique factorization in R [X], where R is a U.F.D. 15 Hours

Unit III

Fields: Algebraic and transcendental elements, The degree of a field extension, Construction with ruler and compass, Symbolic adjunction of roots, Finite fields, Algebraically closed fields, The fundamental theorem of algebra.

20 Hours

Unit IV

Galois theory: Splitting fields, Primitive elements, The main theorem of Galois theory.

9 Hours

Unit V

Solvabi1ity of polynomials by radicals: Solvable group, Splitting field of $x^n - a$, Insolvability of a quintic. 8 Hours

References:

[1] Michael Artin - Algebra, Prentice Hall of India.
[2] I. N. Herstein - Topics in Algebra
[3] David S.Dummit and Richard M.Foot- Abstract Algebra
[4] Joseph A. Gallian - Contemporary Abstract Algebra, Narosa Publishing House.
[5] John B. Fraleigh - A First Course in Abstract Algebra, 5th Edition, Addison Wesley Longman, Inc.
[6] Serge Lang - Algebra, 3rd Edition, Addison Wesley Longman, Inc.
[7] I. S. Luthar and I. B. S. Passi - Algebra Volume 2, Rings, Narosa Publishing House.

MT 452 - Linear Algebra II

Unit I

Bilinear Forms: Definition of bilinear form, Symmetric forms, Orthogonality, The geometry associated to a positive form, Hermitian forms, The spectral theorem, The spectral theorem for normal operators, Skew symmetric forms, Summary of results in matrix notation. 30 Hours

Unit II

Modules: The definition of a module, Matrices, Free modules and bases, Diagonalization of integer matrices, Generators and relations for modules, The structure theorem for abelian groups, Application to linear operators.

30 Hours

References:

[1] Michael Artin - Algebra, Prentice Hall of India.
[2] K. Hoffman and R. Kunz - Linear Algebra, Prentice Hall of India, 2nd Edition.
[3] S. Lang - Linear Algebra, Addison Wesley, London, 1970.
[4] Larry Smith - Linear Algebra, Springer Verlag.
[5] Katsumi Nomizu - Fundamentals of Linear Algebra - McGraw Hill Company.

MT 453 - Real Analysis II

Unit I

The Riemann-Stieltjes Integral: Definition and existence of integrals, Properties of integral, Integration and differentiation, Integration of vector-valued functions, Rectifiable curves. 18 Hours

Unit II

Sequences and Series of Functions: Discussion of main problem, Uniform convergence, uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Equicontinuous families of functions, The Stone-Weierstrass theorem. 18 Hours

Unit III

Improper integrals: Definition, Criteria for convergence, Interchanging derivatives and integrals. (Ref: [2]) 10 Hours

Unit IV

Functions of several variables: Differentiation, The contraction principle, The inverse function theorem, The implicit function theorem. (Ref: [1]) 14 Hours

References:

[1] Walter Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw Hill, Student Edition, 1976

[2] Serge Lang, Analysis I, Addison Wesley Publishing Company 1968.

[3] Sokolnikoff, Advanced Calculus, Mc Graw Hill, Student Edition.

[4] R. G. Bartle, The Elements of Real Analysis, 2nd Edition, Wiley International Edition, New York.

[5] T. M. Apostal - Mathematical Analysis, 2nd Edition, Addison Wesley, Narosa, New Delhi.

[6] D.V. Widder - Advanced Calculus, Prentice Hall of India, New Delhi.

MT 454 - Complex Analysis I

Unit I

Complex numbers : The algebra of complex numbers - Arithmetic operations, Square roots, Conjugation, Absolute value, Inequalities.

The geometric representation of complex numbers - Geometric addition and multiplication, The binomial equation, Analytic geometry, The spherical representation.

Complex Functions: Introduction to the concept of analytic function - Limits and continuity, Analytic functions, Polynomials, Rational functions.

Elementary theory of power series, Sequences, Series, Uniform convergence, Power series, Abel's limit theorem.

The exponential and trigonometric functions - The exponential, The trigonometric functions, The periodicity, The logarithm.

Analytic Functions as Mappings: Conformality - Arcs and closed curves, Analytic functions in regions, Conformal mapping, Length and area.

Linear transformation - The linear group. The cross ratio, Symmetry.

25 Hours

Unit II

Complex Integration: Fundamental theorems, Line integrals, Rectifiable arcs, Line integrals as function of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem for a disk.

Cauchy's Integral Formula: The index of a point with respect to a closed curve, The integral formula, Higher derivatives.
Local Properties of Analytical Functions: Removable singularities, Taylor's theorem, Zeros and poles, The local mapping, The maximum principle.

20 Hours

Unit III
The General Form of Cauchy's Theorem: Chains and cycles, Simple connectivity, Homology, The general statement of Cauchy's theorem, Cauchy's theorem (Statement only). Locally exact differentials, Multiply connected regions. 15 Hours

References:

[1] Lars V. Ahlfors - Complex Analysis, McGraw Hill, third edition.
[2] B. R. Ash - Complex Variables, Academic Press, New York.
[3] R. V. Churchill, J. W.Brown and R. F. Verlag - Complex Variables and Applications, Mc Graw Hill.
[4] J. B. Conway - Functions of one Variable, Narosa, New Delhi.
[5] S. Ponnuswamy - Foundations of Complex Analysis, Narosa.

MT 455 - Numerical Analysis II

Unit I
Numerical Integration: Introduction, Methods based on interpolation, Methods based on undetermined coefficients, Gauss-Legendre integration methods, Gauss-Chebyshev integration methods, Gauss-Laguerre integration methods, Gauss-Hermite integration methods, Composite integration methods, Trapezoidal rule, Simpson's rule, Romberg integration. 15 Hours

Unit II
Ordinary Differential Equations: Introduction, Numerical methods, Euler method, Backward Euler method, Mid-point method, Single step methods, Taylor series method, Runge-Kutta methods, Multistep methods, Determination of a_j and b_j, Predictor-corrector methods, Boundary value problems, Difference methods, Boundary value problems for $y'' = f(x, y)$. Trapezoidal, Dahlquist and Numerov methods. 15 Hours

Unit III
Numerical Solution of Second Order Partial Differential Equations: Introduction, Difference methods, Parabolic equations in one space dimension, Schmidt formula, Du Fort-Frankel scheme, Crank-Nicolson and Crandall schemes, Solution of hyperbolic equation in one dimension by explicit schemes, The CFL condition, Elliptic equations, Dirichlet problem, Neumann problem, Mixed problem. 15 Hours

Unit IV
FORTRAN 77 Programming: Flow charting, Fundamentals of programming, Fortran constants and variables, Fortran statements, The assignment statement, List directed read and write statements, Looping with unconditional GOTO statement, The STOP and END statements, Simple programs, Looping and branching, The computed GOTO statement. The arithmetic IF statement. The logical IF statement, Block IF structures, Common mathematical functions, Controlling input and output, The DO statement, Nested DO loops, Implied DO loop, Subscripted variables and arrays, Subprograms, COMMON, EQUIVALENCE and DATA statements. 15 Hours

References:

[1] M. K. Jain, S. R. K. Iyengar, P. K.Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern.
[2] R. H. Hammod, W. B. Rogers, J.B. Crittenden, Introduction to FORTRAN 77 and the personal computer, Mc-Graw Hill Book Company.
[3] C. F. Gerald and P. O. Wheatly, Applied Numerical Analysis, Pearson Education, Inc., 1999.
[4] M. K. Jain - Numerical Solution of Differential Equations, 2nd Edition, New Age International (P) Ltd., New Delhi, 1984.
[5] A. R. Mitchell - Computational Methods in Partial Differential Equations, John Wiley and Sons, Inc., 1969.

III SEMESTER

MT 501 – Differential Equations and Applications

("Choice Based Paper" offered by the Department of Mathematics to the students of other Departments)

Unit I
Recap of Elementary Functions of Calculus - Properties of limits, derivatives and integrals of elementary functions of Calculus, Polynomials, Rational functions, exponential and logarithmic functions, trigonometric and inverse trigonometric functions, hyperbolic and inverse hyperbolic functions. 10 Hours

Unit II
Special Functions of Mathematical Physics - Bessel functions, Legendre polynomials, Chebyshev polynomials, Hermite polynomials and Laguerre polynomials. Power series solutions of Second Order Linear Differential Equations. Their Mathematical properties. 20 Hours

Unit III
Applications of First Order Ordinary Differential Equations - Simple problems of dynamics – falling bodies and other motion problems, Simple problems of Chemical reactions and mixing, Simple problems of growth and decay. 10 Hours

Unit IV
Applications of Second Order Ordinary Differential Equations - Undamped simple harmonic motion, damped vibrations, Forced vibrations, Problems on simple electric circuits – Laplace transforms. 10 Hours

References:
[1] G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw-Hill, New Delhi, 1991.
[2] E. D. Rainville and P. Bedient– Elementary course on Ordinary Differential Equations, Macmillan, New York, 1972.
[3] R. Courant and D. Hilbert, Methods of Mathematical Physics, Vol. I, Tata McGraw- Hill, New Delhi, 1975.

MT 502 - Commutative Algebra

Unit I
Rings and ideals: Zero divisors, Nilpotent elements, Units, Prime ideals and maximal ideals, Nilradical and Jacobson radical, Operations on ideals, Extensions and contraction of ideals. 15 Hours

Unit II
Modules: Operations on submodules, Isomorphism theorems, Direct sum and product, Finitely generated modules, Nakayama's lemma, Exact sequences (omit tensor products and related results). 10 Hours

Unit III
Rings and modules of fractions: Local properties, Extended and contracted ideals in rings of fractions. 15 Hours

Unit IV
Primary decomposition, Integral dependence and chain conditions: First and second uniqueness theorems, Integral dependence, The going-up theorem, Integrally closed integral domains, The going-down theorem, Noetherian rings and modules, Primary decomposition in Noetherian rings.

20 Hours

References:

[1] M.F. Atiyah and I. G. Macdonald -Introduction to Commutative Algebra, Addison Wesley Publishing Company.
[2] N. Bourbaki - Commutative Algebra, American Mathematical Society.
[3] N. S. Gopalkrishnan - Commutative Algebra, Oxonian Press Pvt., Ltd.
[4] D. G. Northcott - Lesson on Rings, Modules and Multiplicities, Cambridge University Press.
[5] O. Zariski and P. Samuel - Commutative Algebra.

MT 503 - Ordinary Differential Equations

Unit I
Linear Differential Equations of Higher Order: Linear dependence and the Wronskian, Basic theory for linear equations, Method of variation of parameters, Reduction of nth order linear homogeneous equation, Homogeneous and non-homogeneous equations with constant coefficients. 10 Hours

Unit II
Solutions in Power Series: Second linear equations with ordinary points, Legendre equation and Legendre polynomials, Second order equations with regular singular points, Bessel equation. 22 Hours

Unit III
Systems of Linear Differential Equations: Systems of first order equations, Existence and uniqueness theorem. The fundamental matrix, Non-homogeneous linear systems, Linear systems with periodic coefficients. 10 Hours

Unit IV
Existence and Uniqueness of solutions : Equations of the form $x' = f(t,x)$, Method of successive approximation, Lipschitz condition, Picards theorem, Non uniqueness of solutions, Continuation of solutions 8 Hours

Unit V

<u>Boundary Value Problems</u>: Sturm-Liouville problem, Green's function, Non-existence of solutions, Picards theorem. 10 Hours

<u>References:</u>

[1] S. G. Deo and V. Raghavendra, Ordinary Differential Equations and Stability Theory, Tata McGraw Hill, New Delhi.

[2] E. A. Coddington - An Introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi.

[3] E. A. Coddington and N. Levinson - Theory of Ordinary Differential Equations, Tata McGraw Hill, New Delhi.

[4] M. W. Hirsh and S. Smale- Differential Equations, Dynamical Systems and Linear Algebra, Academic Press, New York, 1974.

[5] V. I. Arnold - Ordinary Differential Equations, MIT Press, Cambridge, 1981.

MT 504 - Complex Analysis II

Unit I

<u>The Calculus of Residues:</u> The Residue theorem, The argument principle, Evaluation of definite integrals.

<u>Harmonic Functions:</u> Definition and basic properties, The mean value property, Poisson's formula, Schwarz's theorem, The reflection principle.

15 Hours

Unit II

<u>Series and Product Developments:</u> Power series expansions - Weierstrass's theorem, The Taylor series, The Laurent series. 15 Hours

Unit III

<u>Partial Fractions and Faclorization:</u> Partial fractions, Infinite products, Canonical products, The Gamma function, Jensen's formula, Product development of Riemann Zeta function. 15 Hours

Unit IV

<u>Elliptic Functions:</u> Simply periodic functions- Representation by exponentials, The Fourier development, Function of finite order.

<u>Doubly Periodic Functions:</u> The period module, Unimodular transformation, General properties of elliptic functions. The Weierstrass $\wp$ function.

15 Hours

<u>References:</u>

[1] Lars V. Ahlfors - Complex Analysis, McGraw Hill, third edition.

[2] B. R. Ash - Complex Variables, Academic Press, New York.

[3] R. V. Churchill, J. W. Brown and R. F. Verlag - Complex Variables and Applications, Mc Graw Hill.

[4] J. B. Conway - Functions of one Variable, Narosa, New Delhi.

[5] S. Ponnuswamy - Foundations of Complex Analysis, Narosa.

MT 505(a) - Multivariate Calculus and Geometry

Unit I

Level sets and tangent spaces - Lagrange multipliers - Maxima and minima on open sets. (Ref [1])

10 Hours

Unit II
Curves in the plane and in space: Arc-length, Reparametrisation, Curvature, Plane curves, Space curves. Simple closed curves, The isoperimetric inequality, The four vertex theorem. (Ref [2]) 15 Hours

Unit III
Double integration- Green's theorem.
Parametrised surfaces in R^3, Surface area, Surface integrals, Stoke's theorem.
Triple integrals: The divergence theorem. (Ref [1]) 15 Hours

Unit IV
The geometry of surfaces - Lengths of curves on surfaces, the first fundamental form. The second fundamental form, the curvature of curves on a surface. The normal and principal curvatures. Geometric interpretation of principal curvatures. The Gaussian and mean curvatures, The Pseudosphere, Flat surfaces, Surfaces of constant mean curvature, Gaussian curvature of compact spaces, The Gauss map. (Ref [2]) 20 Hours

References:

[1] Sean Dineen - Multivariate Calculus and Geometry, Springer Undergraduate Mathematics Series.
[2] Andrew Pressly - Elementary Differential Geometry, Springer Undergraduate Mathematics Series.
[3] Walter Rudin - Principles of Mathematical Analysis, McGraw Hill, New York, 3rd Edition.
[4] J. A. Thorps - Elementary Topics in Differential Geometry, Undergraduate Texts in Mathematics, Springer Verlag.
[5] W. Klingenberg - A course in Differential Geometry, Springer Verlag.

MT 505(b) - Advanced Topology

Unit I
Countability and separation axioms: The countability axioms, The separation axioms, The Urysohn lemma, The Urysohn metrization theorem, Partitions of unity.
25 Hours

Unit II
The Tychonoff Theorem: The Tychonoff theorem, Completely regular spaces.
Metrization theorems and paracompactness: Local finiteness. The Nagata-Smirnov Theorem (Necessity). Paracompactness. 15 Hours

Unit III
The fundamental group and covering spaces: Homotopy of paths, The fundamental group, Covering spaces, The fundamental group of the circle. The fundamental group of the punctured plane. 20 Hours

References:

[1] J. R. Munkres - Topology, Prentice Hall of India, 1975, 2nd edition, 2000.
[2] G. F. Simmons, Introduction to Topology and Modern Analysis, Mc-Graw Hill, Kogakusha,1968.
[3] S. Willard - General Topology, Addison Wesley, New York, 1968.
[4] J. Dugundji -Topology, Allyn and Bacon, Boston, 1966.
[5] J.L.Kelley - General Topology, Van Nostrand Reinhold Co., New York, 1955.
[6] E.H.Spanier – Algebraic Topology, Mc-Graw Hill.

IV SEMESTER

MT 551 - Algebraic Number Theory

Unit I

Introduction: Elementary results in number theory, Euler's and Fermat's theorems, The Legendre symbol, Euler's criterion, Gauss lemma, Quadratic reciprocity law.

20 Hours

Unit II

Number theoretical applications of unique factorization: Algebraic integers, Quadratic fields, Certain Euclidean rings of algebraic integers, Some Diophantine equations, Ramanujan-Nagell theorem. 20 Hours

Unit III

Factorization of Ideals: Dedekind domains, Fractional ideals, Invertible ideals, Prime factorization of ideals, Class group and class number, Finiteness of the class-group, Class number computations. 20 Hours

References:

[1] Karlheinz Spindler - Abstract Algebra with Applications, Vol. II, Rings and Fields, Marcel Dekkar, Inc.

[2] I. N. Stewart and David Tall - Algebraic Number Theory, Chapman and Hall.

[3] Jody Esmonde and M. Ramamurthy - Problems in Algebraic Number Theory, Springer Verlag.

[4] I. S. Luthar and I. B. S. Passi - Algebra Vol. II: Rings, Narosa Publishing House.

[5] Tom M. Apostal - Introduction to Analytic Number Theory, Springer Verlag.

MT 552 - Partial Differential Equations

Unit I

First order partial differential equations: Methods of solution of $dx/P = dy/Q = dz/R$, Orthogonal trajectories of a system of curves on a surface, Pfaffian differential forms and Pfaffian differential equations and solutions, Origin of first order partial differential equations, The Cauchy problem for first order equations, Linear equations of first order, Integral surfaces passing through a given curve, Surfaces orthogonal to a given system of surfaces, Nonlinear equations of first order, Cauchy's method of characteristics, Charpit's method, Special types of first order equations, Linear partial differential equations with constant coefficients. 35 Hours

Unit II

Second Order Partial Differential Equations: Classification of second order PDE, Canonical forms, Adjoint operators, Riemann's method.

Elliptic Differential Equations: Dirichlet problem for a rectangle, Neumann problem for a rectangle, interior and exterior Dirichlet problem for a circle, Interior Neumann problem for a circle.

Parabolic Differential Equations: Occurrence of the diffusion equation, Elementary solutions of the diffusion equation, Dirac Delta function, Separation of variables.

Hyperbolic Differential Equations: Solution of one dimensional equation by canonical reduction, Initial value problem - D'Alembert's solution, Vibrating string - variable separation method, Forced vibrations. Uniqueness of the solution for the wave equation, Duhamel's principle.

25 Hours

References:

[1] Ian Sneddon - Elements of Partial Differential Equations, Mc-Graw Hill, International student edition.
[2] K. Sankara Rao - Introduction to Partial Differential Equations, Prentice-Hall of India, 1995.
[3] F. John - Partial Differential Equations, Springer Verlag, New York, 1971.
[4] P. Garabedian - Partial Differential Equations, Wiley, New York, 1964.
[5] C. R. Chester - Techniques in Partial Differential Equations, McGraw Hill, New York, 1971.

MT 553 - Measure and Integration

Unit I
Algebras of sets - Borel sets.
Outer measure, Measurable sets and Lebesgue measure. Example of a nonmeasurable set. Measurable functions. 15 Hours

Unit II
The Riemann integral. The Lebesgue integral of a bounded function over a set of finite measure. The integral of a nonnegative function. The general Lebesgue integral.
15 Hours

Unit III
Differentiation and Integration. Differentiation of monotone functions. Functions of bounded variation. Differentiation of an integral. Absolute continuity. 15 Hours

Unit IV
Measure and outer measure. The extension theorem of Caratheodary. The product measures. The Fubini theorem.
15 Hours

References:

[1] H.L.Royden - Real Analysis, Prentice - Hall, Third Edition.
[2] G. D. Barra - Introduction to Measure Theory - Van Nostrand
[3] Walter Rudin - Real and Complex Analysis, Tata McGraw Hill Publishing Company.
[4] P.R Halmos - Measure Theory, Springer Verlag
[5] F. Hewitt and K. Stromberg - Real and Abstract Analysis, Springer Verlag.
[6] Inder K. Rana - An Introduction to Measure and Integration, Narosa Publishing House.

MT 554 - Functional Analysis

Unit I
Review of metric spaces: Convergence, Completeness and Baire's theorem.
Banach spaces: Definition and some examples, Continuous linear transformations, The Hahn Banach theorem, The natural embedding of N in N**, The open mapping theorem, Uniform boundedness principle. 30 Hours

Unit II
Hilbert spaces: Definition and examples, Orthogonal complements, Orthonormal sets, The conjugate of a Hilbert space, The adjoint operator, Self-adjoint operators, Normal and unitary operators, Projections, Finite dimensional spectral theorem. 30 Hours

References:

[1] George F. Simmons - Introduction to Topology and Modern Analysis, McGraw Hill International Edition.
[2] A. E. Taylor - Introduction to Functional Analysis, John Wiley and Sons.
[3] Ward Cheney - Analysis for Applied Mathematics, Graduate Texts in Mathematics.
[4] Walter Rudin - Real and Complex Analysis, 2nd edition, McGraw Hill.
[5] M. Thamban Nair- Functional Analysis A First Course, Prentice-Hall, 2002

MT 555(a) - Graph Theory

Unit I
Graphs: Varieties of graphs, Walks and connectedness, Degrees, The problem of Ramsey, Extremal graphs, Intersection graphs, Operations on graphs. 8 Hours

Unit II
Blocks: Cut points, Bridges, Blocks. 8 Hours

Unit III
Trees: Characterization of trees, Centers, Independent cycles and cocycles. Cycle rank and cocycle rank of graphs. 15 Hours

Unit IV
Connectivity: Whitney's theorem on Connectivity, line-connectivity and minimum degree of a graph. Point form of Menger's theorem. Dirac's theorem on n-connected graphs. Hall's theorem on system of distinct representatives. 10 Hours

Unit V
Traversability: Eulerian graphs, Hamiltonian graphs. 5 Hours

Unit VI
Planarity: Plane and planar graphs. 5 Hours

Unit VII
Colorability: The point independence number, The chromatic number, The five color theorem, The chromatic polynomial of a graph and its description as in [3].
9 Hours

References:

[1] F. Harary - Graph Theory, Addison-Wesley Series in Mathematics, 1969
[2] Narsingh Deo - Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1987.
[3] Bela Bollabas - Modern Graph theory, Springer, 1998
[4] S.A.Choudum - A first course in Graph Theory, Macmillan, 1987.
[5] R.Balakrishnan and K.Ranganathan - A textbook of Graph Theory, Springer-Verlag, 2000.
[6] K. R. Parthasarathy - Basic Graph Theory, The McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
[7] Douglass B. West - Introduction to Graph Theory, Prentice Hall of India, New Delhi, 1996.
[8] O. Ore - Theory of Graphs, American Mathematical Society, Providence, Rhode Island, 1967.

MT 555(b) - Lattice Theory

Unit I

Partia1ly ordered sets: Partially ordered sets (or Posets), Diagrams, Lower and upper bunds, Order homomorphism and order isomorphism, Special subsets of a poset, Axiom of choice(Statement only). Zorn's lemma and Hausdorff's maximal chain principle and proof of the equivalence of these two statements, Length of a poset, The minimum and maximum conditions, Duality principle for posets (Topics selected from Chapter I of [1]).

12 Hours

Unit II

Lattices in general: A lattice as a poset and as an algebra, Diagrams of lattices, Duality principle for lattices, Semilattices, Sublattices, Convex sublattices, Ideals and prime ideals of lattices, Ideal generated by a nonempty subset of a lattice and its description, Representation of convex sublattices in terms of ideals and dual ideals, The ideal lattice and the augmented ideal lattice of a lattice, Bound elements, atoms and dual atoms in a lattice, Atomic lattices, complemented, relatively complemented and sectionally complemented lattices, Homomorphisms, congruence relations and quotient lattices of lattices, The homomorphism theorem. (Topics selected from Chapter II of [1] and Chapter I of [2]).

15 Hours

Unit III

Complete lattices: Complete lattices, fixed point property, Conditionally complete lattices, Compact elements and compactly generated lattices (Topics selected from Chapter III of [1]).

8 Hours

Unit IV

Distributive and modular lattices: Distributive, infinitely distributive lattices, Modular lattices, Characterizations of modular and distributive lattices in terms of sublattices, The isomorphism theorem of modular lattices, The prime ideal theorem for distributive lattices, (Topics selected from Chapters IV and VIII of [1] and Chapter II of [2])

15 Hours

Unit V

Complemented modular lattices and Boolean algebras: Relatively complementedness of a complemented modular lattice. Disributivity of a uniquely complemented relatively complemented lattice, Boolean algebras, De Morgan formulae, Complete Boolean algebras, Boolean algebras and Boolean rings, Distributive lattices and rings of sets, Boolean algebras and fields of sets. (Topics selected from Chapter V, VI, and VIII of [1])

10 Hours

References:

[1] G. Szasz - Introduction to Lattice Theory, Academic Press, N.Y., 1963

[2] G. Gratzer - General Lattice Theory, Birkhauser Verlag, Basel, 1978

[3] P. Crawley and R.P, Dilworth - Algebraic Theory of Lattices, Prentice - Hall Inc., N. J., 1973

[4] G. Birkhoff - Lattice Theory, American Mathematical Society Colloquium Publications, Volume 25, 1995

[5] L. A. Skornjakov - Elements of Lattice Theory, Hindustan Publishing Corporation, 1977.

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