



DEPARTMENT OF MATHEMATICS
FACULTY OF SCIENCE
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Syllabi
of
M. Sc.





Department of Mathematics
The Maharaja Sayajirao University of Baroda

Syllabus
of
M. Sc. Mathematics



Department of Mathematics
Faculty of Science, The Maharaja Sayajirao University of Baroda
Sayajigunj, Vadodara 390002, Phone: 0265-2795329
Vadodara – 390 002

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M. Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2102 – The Lebesgue measure and Integration			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Algebra and σ -algebra of sets, Borel sets, F_σ -sets and G_δ -sets, Outer measure (of sets in $\mathbb{R}$) and its properties namely, translation invariance, countably sub additivity, and related results.				15	
2	The Lebesgue measure and its properties, non-measurable sets. Measurable functions, Simple functions, Littlewood's three principles and their associated theories (statements only).				15	
3	Convergence of sequence of measurable functions, Egoroff's theorem. Lebesgue integral of simple function and bounded functions, Bounded convergence theorem.				15	
4	Lebesgue integral of nonnegative measurable functions, Fatou's lemma, Monotone convergence theorem. Integral of a Lebesgue measurable functions, Lebesgue convergence theorem, Convergence in measure.				15	
References						
1.	G. D. De Barra, Measure and Integration, Wiely Eastern Limited, 1981.					
2.	P. R. Halmos, Measure Theory, Van Nostrand Publishers, 1979.					
3.	I. P. Natanson, Theory of Functions of a Real Variable, Vol.I, Frederick Ungar Publishing Co., 1964.					
4.	I. K. Rana, An Introduction to Measure and Integration, Narosa Publishing House,2004.					
5.	H. L. Royden, Real Analysis, Macmaillan Publishing Company, 1995.					
6.	Walter Rudin, Real and complex Analysis, Tata-Mc Graw-Hill Publishing Co. Ltd.,1987.					
7.	J. H. Williamson, Lebesgue Integration, Holt, Rienhart and Winston Inc., 1962.					

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M. Sc. (Mathematics): Regular Programme							
Year		I	Core: MAT2111 – Complex Analysis – I			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Limit, Continuity, Derivative of a function of complex variable, Cauchy-Riemann equations, Analytic function, Analyticity of elementary functions. Harmonic functions.					15	
2	Contour integration, anti-derivatives, Cauchy-Goursat theorem for simply and multiply connected domains.					15	
3	Cauchy integral formula, Higher order derivatives of analytic function. Morera's theorem, Cauchy's inequality, Liouville's theorem, Fundamental theorem of Algebra, Maximum (minimum) modulus theorem.					15	
4	Convergence of sequence and series, Taylor series, Laurent series, Power series: Absolute and Uniform convergence, Integration and Differentiation, Uniqueness, Multiplication, division of Power series.					15	
References							
1.	J. W. Brown and Ruel V. Churchill, Complex variables and Applications, McGraw-Hill, Inc. 1996.						
2.	John B. Conway, Functions of One Complex Variable, Narosa Publishing house, 2002.						
3.	S. Ponnusamy Foundations of Complex Analysis, Narosa Publishing house, 2005.						
4.	H. S. Kasana, Complex Variables (Theory and applications), Prentice-Hall of India Pvt. Ltd., 2006.						

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2104 – Ordinary Differential Equations			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Existence and uniqueness of solutions of first order equations: The method of successive approximations, The Lipschitz condition, Convergence of successive approximations.				15	
2	Non-local existence of solutions, Approximations to and uniqueness of solutions, Equations with complex valued functions, Extension to system of equations and nth order equations.				15	
3	Linear system of first order equations, Basic theory of homogeneous system, Fundamental matrix, Abel-Liouville formula, Non-homogenous linear system. Homogeneous equations with analytic coefficients.				15	
4	Power series method, Equations with regular singular points, Euler equations, Frobenius method, Bessel's equation, Bessel's functions and its properties, Regular singular points at infinity.				15	
References						
1.	E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 2001.					
2.	S. G. Deo, V. Lakshmikantham and V. Raghavendra, Text Book of Ordinary Differential Equations, Tata McGraw Hill Book Co., 1997.					
3.	S. L. Ross, Differential Equations, John Wiley & Sons, 2004.					

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2105 – Topology - I			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Topological spaces, Basis and Sub-basis, The order and product topologies, Closed sets and limit points, Hausdorff spaces.				15	
2	Continuous functions and homeomorphisms, Metric topology, Quotient topology, Connected and path connected spaces, Their properties and applications.				15	
3	Components and path components, Locally connected and locally path connected spaces, Totally disconnected spaces, Compact spaces and their properties, Tychonoff theorem.				15	
4	Locally compact spaces, Limit point compactness (Bolzano Weierstrass Property), Sequential compactness and their equivalency with compactness for metric spaces, Uniform continuity theorem.				15	
References						
1.	J. Dugundji, Topology, Prentice-Hall of India, 1966.					
2.	A. Hatcher, Algebraic Topology, Cambridge University Press, 2005.					
3.	J. R. Munkres, Topology - A First course, Prentice-Hall of India, 2000.					
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2004.					
5.	S. Willard, General Topology, Addison-Wesley, 2004.					

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2107 – Galois Theory			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Dual spaces and dual basis, Dimension of an annihilator of a subspace and its application to homogeneous linear equations, Extension fields, Finite extensions, Algebraic element and its degree.				15	
2	Algebraic extensions, Roots of polynomials, Splitting fields and Algebraic closures, Constructions with straight edge and compass, Multiple roots, Simple extensions, Finite fields.				15	
3	Groups of automorphisms of a field and their fixed fields, Normal extension and Separable extensions of a field, Theorem on symmetric polynomials.				15	
4	Fundamental theorem of Galois Theory, Solvability by radicals, Solvable groups, Abel’s Theorem, Galois group over the rationals.				15	
References						
1.	D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley Ltd, 2004.					
2.	Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publishing House, 2009.					
3.	I. N. Herstein, Topics in Algebra, Vikas Publishing House Pvt. Ltd, 2006.					
4.	N. Jacobson, Lectures in Abstract Algebra Vol. I(1951) ,II(1952), Van Nostrand Co., New York.					
5.	S. H. Weintraub , Galois theory , Springer-Verlag, 2006.					

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M.Sc. (Mathematics): Regular Programme							
Year		I	Core: MAT2108 – Computing Techniques in Mathematics using C++ : I			Credits	02
Semester		I					
Unit No.	Topics					Contact Hours	
1	Principles of Object Oriented Programming, Review of basic concepts of C++ language. Classes and objects, data member and member functions, access specifiers, constructor and destructors, copy constructor, Encapsulation and data hiding, pointer to object, this pointer. Operator overloading: friend functions, overloading unary, binary and input-output operators, type conversion.					15	
2	Curve fitting using least-square methods: fitting a straight line, a power function, an exponential function, a hyperbolic function and a polynomial function. Curve fitting using interpolation: Cubic spline interpolation. Gaussian Integration, Gauss-Legendre n-point formula for n = 2, 3, 4, 5, Eigen value and eigen vector of a matrix using Power Method.					15	
References							
1.	E. Balagurusamy, Object-Oriented programming with C++, Mc Graw-Hill Publishing Company, 2008.						
2.	Robert Lafore, Object-Oriented programming with C++, Galgotia Publications Pvt. Ltd, 2009.						
3.	Stephen Prata, C++ Primer Plus, Galgotia Publications Pvt. Ltd, 2001.						
4.	S. S. Sastry, Introductory methods of Numerical Analysis, Prentice-Hall of India, 2006.						

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2109 – C++ Programming Practicals – I			Credits	02
Semester	I					
	Object Oriented Programming In C++ on					
1	C++ Basics : control structures, Functions, default arguments, pointer.					
2	Objects and classes					
3	Operator Overloading: overloading assignment operator, arithmetic operators, overloading the arithmetic assignment operators, relational operators, the stream operators, increment and decrement operators. type conversion					
4	Numerical methods for curve fitting using least square methods					
5	Numerical method for curve fitting using cubic spline interpolation method					
6	Numerical methods for integration using Gauss -Legendre n point formula for n=2,3,4,5.					
7	Numerical method for finding dominant eigen value and corresponding eigen vector using Power Method					
References						
1	E. Balagurusamy, Object-Oriented programming with C++, The Mc Graw-Hill Publishing Company, 2008.					
2	John R. Hubbard, Schaum's Outline of Theory and Problems of Programming with C++, Tata McGraw-Hill.					
3	Robert Lafore, Object Oriented programming in Turbo C++, Galgotia Publications Pvt. Ltd, 2009.					
4	S. S. Sastry, Introductory methods of Numerical Analysis, Prentice-Hall of India, 2006.					

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M. Sc. (Mathematics): Regular Programme							
Year	I	Core: MAT2202 – Functions of Real variable and Fourier Transforms				Credits	04
Semester	II						
Unit No.	Topics					Contact Hours	
1	Functions of bounded variation, Differentiation of an integral, Absolute continuity, Jensen inequality.					15	
2	The Lebesgue spaces L^p ($1 \leq p \leq \infty$), Minkowski and Hölder inequalities. Convergence of sequences and series in L^p -spaces, Completeness of L^p -spaces, Dense subsets of L^p -spaces (without proof), Approximation in L^p -spaces (without proof).					15	
3	Bounded linear functionals on L^p -spaces, Riesz representation theorem. Measure space, completion of measure, Lebesgue measure on $\mathbb{R}^n$, Product measures on $\mathbb{R}^n$, Fubini theorem, Tonelli theorem (without proof).					15	
4	Fourier Transforms in $L^1(\mathbb{R})$ and its properties, Riemann-Lebesgue Lemma, Inversion Formula, Uniqueness of a Fourier transform (without proof).					15	
References							
1.	G. D. De Barra, Measure and Integration, Wiely Eastern Limited, 1981.						
2.	Richard Goldberg, Fourier Transforms, Cambridge University Press, 2009.						
3.	P. R. Halmos, Measure Theory, Van Nostrand Publishers, 1979.						
4.	I. P. Natanson, Theory of Functions of a Real Variable, Vol.I, Frederick Ungar Publishing Co., 1964.						
5.	I. K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, 2004.						
6.	H. L. Royden, Real Analysis, Macmaillan Publishing Company, 1995.						
7.	Walter Rudin, Real and complex Analysis, Tata-Mc Graw-Hill Publishing Co. Ltd., 1987.						
8.	J. H. Williamson, Lebesgue Integration, Holt, Rienhart and Winston Inc., 1962.						

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M.Sc. (Mathematics): Regular Programme							
Year		I	Core: MAT2203 – Complex Analysis – II			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Singularities of a complex function, Residue theorems, Residue at poles, Zeros and poles of order m.					15	
2	Evaluation of (i) Real Improper, and (ii) Real Definite integrals using residues, Indented path technique, Integration through branch cut, Argument principle, Rouche's theorem.					15	
3	Linear Transformations, Transformation $w = 1/z$, Linear fractional transformation, Exponential Transformation.					15	
4	Logarithmic transformations, Mapping by branches of $z^{1/2}$. Conformal mapping: preservation of angle, other properties.					15	
References							
1.	J. W. Brown and R. V. Churchill, Complex variables and Applications, McGraw-Hill, Inc. 1996.						
2.	John B. Conway, Functions of One Complex Variable, Narosa Publishing house, 2002.						
3.	S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing house, 2005.						
4.	H. S. Kasana, Complex Variables (Theory and applications), Prentice-Hall of India Pvt. Ltd., 2006.						

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M.Sc. (Mathematics): Regular Programme							
Year		I	Core: MAT2204 – Partial Differential Equations			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Origin of second order partial differential equations (PDE), Second order linear PDE with constant coefficients, Second order linear PDE with variable coefficients, Canonical forms and solutions.					15	
2	Separation of variables, Sturm-Liouville problem, Eigen values and eigen functions, Orthogonality and uniqueness of eigen functions.					15	
3	Transverse vibration in a string and longitudinal vibration of bars, Solution of wave equation, heat equation and Laplace equation using method of separation of variables.					15	
4	Non-linear second order equations and Monge’s method for solving equations of the type $Rr + Ss + Tt = V$.					15	
References							
1.	T. Amaranath, Partial Differential Equations, Narosa Publishing House, 2000.						
2.	R. V. Churchill, Fourier Series and Boundary Value Problems, McGraw Hill Book Co., 1963.						
3.	Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill Book Co., 1988.						

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M.Sc. (Mathematics): Regular Programme					
Year	I	Core: MAT2205 – Topology – II		Credits	04
Semester	II				
Unit No.	Topics			Contact Hours	
1	Separable, First countable and Second countable spaces, The separation axioms, Urysohn's lemma, Tietze's extension theorem .			15	
2	Urysohn's metrization theorem, Local finiteness of collection of subsets of X , Paracompact spaces and Metrization theorem.			15	
3	Complete metric spaces and completion of a metric space, Baire's category theorem, Partition of unity and its existence, m – manifold, Compact m – manifolds.			15	
4	Homotopy, Path homotopy, Fundamental group, Covering spaces, The fundamental group of the circle and fundamental group of S^n , $n \geq 2$.			15	
References					
1.	J. Dugundji, Topology, Prentice-Hall of India, 1966.				
2.	A. Hatcher, Algebraic Topology, Cambridge University Press, 2005.				
3.	J. R. Munkres, Topology - A First course, Prentice-Hall of India, 2000.				
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2004.				
5.	S. Willard, General Topology, Addison-Wesley, 2004.				

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2207 – Module Theory			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Module: left and right module over a ring. Sub module, direct product and direct sum of modules, Free module, module over a division ring, Pathologies between free modules and vector space.				15	
2	Quotient module, Homomorphism of modules, $\text{Hom}_R(M, N)$ as R -module, Epimorphism theorem, Theorem on quotient of a quotient, Theorem on quotient of a sum.				15	
3	Maximal and minimal modules, simple module, Schur's lemma, module over PID, Artinian module, Noetherian module, Length of a module, composition series, Jordan-Holder theorem.				15	
4	Artinian ring, Noetherian ring, Hilbert basis theorem, Cohen's theorem, Exact sequence, split sequence, Projective module, characterization of projective module, Injective module, Tensor product of R -modules.				15	
References						
1.	D. S. Dummit and R. M. Foote, Abstract Algebra, John Wiley & Sons, 2004.					
2.	C. Musili, Introduction to Rings and Modules, Narosa Publishing House, 2010.					
3.	Ramji Lal , Algebra, Volume II, Shail Publications.					

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M.Sc. (Mathematics): Regular Programme							
Year		I	Core: MAT2208 – Computing Techniques in Mathematics using C++ : II			Credits	02
Semester		II					
Unit No.	Topics					Contact Hours	
1	Templates: class templates, class templates with multiple parameters, function template, function template with multiple parameters, overloading of template function. Inheritance: Defining derived classes, inheritance hierarchies, public, private and protected members under derivation, single inheritance. File I/O.					15	
2	Polymorphism: Early binding and late binding, Virtual function, Normal member function and virtual member function accessed with pointers, pure virtual function. Numerical Solution of an Initial Value problem using Milne-Simpson’s and Adam Bashforth Moulton predictor-corrector methods. Finite difference methods for solving boundary value problems.					15	
References							
1.	E. Balagurusamy, Object-Oriented Programming with C++, Mc Graw-Hill Publishing Company, 2008.						
2.	Robert Lafore, Object-Oriented Programming with C++, Galgotia Publications Pvt. Ltd, 2009.						
3.	Stephen Prata, C++ Primar Plus, Galgotia Publications Pvt. Ltd, 2001.						
4.	S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India, 2006.						

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M.Sc. (Mathematics): Regular Programme						
Year	I	Core: MAT2209 – C++ Programming Practicals – II			Credits	02
Semester	II					
	Object Oriented Programming In C++ on					
1	Templates : Sorting techniques					
2	Inheritance					
3	Polymorphism					
4	Numerical methods for Milne-Simpson’s and Adam Bashforth Moulton predictor-corrector methods for solving Initial value problem.					
5	File I/O					
6	Finite difference method					
References						
1.	E. Balagurusamy, Object-Oriented programming with C++, Mc Graw-Hill Publishing Company, 2008.					
2.	John R. Hubbard, Schaum’s Outline of Theory and Problems of Programming with C++, Tata McGraw-Hill.					
3.	Robert Lafore, Object-Oriented programming in C++, Galgotia Publications Pvt. Ltd, 2009.					
4.	S. S. Sastry, Introductory methods of Numerical Analysis, Prentice-Hall of India, 2006.					

Syllabus for M. Sc. Final

Sr. No.	Course Code	Course Title	Page No.
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M.Sc. (Mathematics): Regular Programme							
Year		II	Core: MAT2302 – Functional Analysis – I			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Normed linear spaces. Banach spaces and examples, Quotient space of normed linear spaces and its completeness, Bounded linear transformations.					15	
2	Hahn Banach theorem, dual spaces with examples, second conjugate space. Open mapping theorem and closed graph theorems.					15	
3	Uniform boundedness theorem. Conjugate of an operator, Hilbert spaces, Orthogonal complements, Orthonormal sets in a Hilbert space, Bessel's inequality.					15	
4	Conjugate space H^* and Riesz representation theorem, Operators on Hilbert space, Adjoint of an operator, Self-adjoint operator, Normal and unitary operators.					15	
References							
1.	Ronald Larsen, Functional Analysis an Introduction, Marcel Dekker, 1973.						
2.	B. V. Limaye, Functional Analysis, Newage International Ltd, 1996.						
3.	Erwin Kreyszig, Introductory Functional Analysis with its applications, John Wiley and Sons, 2007.						
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2004.						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Core: MAT2303 – Advanced Calculus and Curve Theory			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	The Euclidean space R^n , The space $L(R^n, R^m)$, Differential or Frechet derivative of a function on R^n , Properties of the differential, Chain rule, Mean value theorem,					15	
2	Partial and directional derivatives of functions defined on R^n , Inverse Function Theorem, Implicit Function Theorem.					15	
3	Curves in R^3 , Curvature and Torsion, Frenet – Serret formulae, Representation of a curve by its curvature, Spherical Images, Sphere Curves.					15	
4	Fundamental, Existence and Uniqueness theorem for space curves, The Rotation Index simple closed plane curve, Convex curves, The Four-Vertex Theorem (without proof).					15	
References							
1.	Casper Goffman, Calculus of Several Variables, Harper and Row Publication, New York. 1965.						
2.	R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice – Hall Inc., 1977.						
3.	A. Pressley, Elementary Differential Geometry, Springer, 2010.						
4.	Walter Rudin, Principle of Mathematical Analysis, McGraw Hill Book Co, 1976.						
5.	J. A. Thorpe, Introduction to Differential Geometry, Springer, 1979.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Core: MAT2304 – Complex Analysis – III			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	The extended plane and its spherical representation, The space $C(G, \Omega)$ of continuous functions, Arzela-Ascoli theorem.				15	
2	Spaces of analytic functions, Hurwitz's theorem, Montel's theorem, Spaces of meromorphic functions, Schwartz's lemma and characterization of Conformal mappings of the open unit disk onto itself, Riemann mapping theorem.				15	
3	Infinite Products, The Weierstrass Factorization Theorem, The Gamma function, Gauss's formula, Functional equation.				15	
4	Bohr-Mollerup theorem, Euler's integral, The Riemann Zeta function, Riemann's functional equation, The Riemann hypothesis, Euler's theorem.				15	
References						
1.	John B. Conway, Functions of One Complex Variable, Narosa Publishing house, 2002.					
2.	S. Ponnusamy Foundations of Complex Analysis, Narosa Publishing house, 2005.					
3.	H. S. Kasana, Complex Variables (Theory and applications), Prentice-Hall of India Pvt. Ltd., 2006.					
4.	J. W. Brown and Ruel V. Churchill, Complex variables and Applications, McGraw-Hill, Inc. 1996.					

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M.Sc. (Mathematics): Regular Programme							
Year	II	Core: MAT2315 – MATLAB				Credits	02
Semester	I						
Unit No.	Topics					Contact Hours	
1	Basic features: Simple math, the MATLAB workspace, Variables, Comments, punctuation and aborting execution, complex numbers, floating point arithmetic, built-in functions. Arrays and Array operations: Simple array, array indexing, construction and orientation, Scalar-Array and Array-array mathematics, Standard arrays, sorting techniques. Inline functions and user defined Functions. Script M-files Control flow: For loops, While loops, If-else-end, Switch-case Statements, Function M-files: M-files constructions rules, input and output arguments, function workspaces, debugging tools. Two-dimensional Graphics: plot function, Line styles, markers and colors, plot grids, Axes box, labels, customizing plot axes, multiple plots, multiple figures, subplots. Symbolic computation.					30	
2	Numerical Linear Algebra: System of linear equations, Matrix functions, Special matrices, eigen values and eigen vectors of a square matrix. Polynomials: Roots, addition, multiplication, division, evaluation, derivatives and integrals, curve fitting by interpolation and least square. Numerical Integration and differentiation. Ordinary Differential Equations. Three-Dimensional Graphics: Line plot, scalar functions of two variables, mesh plots, surface plots, Statistical methods: Given a set of data, set up various graphical representation of data, Bar diagram, Histogram, Pie charts, frequency polygon, Maximum, minimum, mean and median of data.					30	
References							
1.	Brian R. Hunt, Ronald L. Lipsman, Jonathan M Rosenberg etc, A Guide to MATLAB for beginners and Experienced Users, Cambdridge University press, 2008.						
2.	Duane Hanselman and Bruce Littlefield, Mastering Matlab-7, Pearson Education, 2005.						
3.	E. V. Krishnamurthy and S K Sen, Programming in MATLAB, East-West Press, 2003.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Core: MAT2318 – Advanced Linear Algebra			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Algebra of linear transformations, Minimal polynomial, Regular and Singular linear transformations, Characteristic roots and Characteristic vectors.				15	
2	Algebra of matrices, Canonical forms of matrices: Triangular form, Nilpotent transformations, Jordan form.				15	
3	Rational canonical form, Trace, Transpose and Determinant function on a matrix ring.				15	
4	Cayley – Hamilton theorem, Hermitian, Unitary and Normal transformations, Real Quadratic forms.				15	
References						
1.	D. S. Dummit and R. M. Foote, Abstract Algebra, John Wiley & Sons, 2004.					
2.	I. N. Herstein, Topics in Algebra, John Wiley and Sons, 2006.					
3.	N. Jacobson, Lectures in Abstract Algebra Vol. I(1951) ,II(1952), Van Nostrand Co., New York.					

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2305 – Algebraic Number Theory			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Algebraic numbers, Number fields, Conjugates and discriminants, Algebraic integers, Integral bases, Norms and traces, Rings of integers.					15	
2	Quadratic fields, Cyclotomic fields, Trivial factorizations, Factorizations into irreducible, Examples of non-unique factorization into irreducible, Prime factorization.					15	
3	Euclidean domain and Euclidean quadratic fields. Prime factorization of ideals, Norm of an ideal, Non-unique factorization in cyclotomic fields.					15	
4	Lattices, Minkowski`s Theorem, Geometric Representation of Algebraic Numbers, Class Groups and Class Number.					15	
References							
1.	K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer, 2010.						
2.	S. Lang, Algebraic Number Theory, Addison – Wesley, 1994.						
3.	Ian Stewart and D. O. Tall, Algebraic Number Theory, Chapman and Hall, 2001.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Elective: MAT2306 – Classical Mechanics – I			Credits	04
Semester	I					
Unit No.	Topics				Contact Hours	
1	Mechanics of a system of particles, Constraints, D' Alemberts principle and Lagrange's equations, Velocity dependent potentials and the dissipation function.				15	
2	Simple application of the Lagrangian formulation, Hamilton's principle, Conservation theorem and symmetry property.				15	
3	The two-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The differential equation for the orbits and integrable power law potentials, Condition for closed orbits, The Kepler problem, The motion in time in the Kepler problem				15	
4	The independent coordinates of a rigid body, Orthogonal transformations, Formal properties of the transformation matrix, The Euler angles, Euler's theorem on the motion of a rigid body, Finite rotations, infinitesimal rotations.				15	
References						
1.	Herbert Goldstein, Classical Mechanics, Narosa Publishing House, 1980.					
2.	Louis N. Handa, Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.					
3.	Leonard Meirovitch, Methods of Analytic Mechanics, Dover Publications Inc., 2007.					
4.	Walter Greiner, Classical Mechanics- System of Particles and Hamiltonian Dynamics, Springer, 2004.					

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2307 – Ergodic Theory			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Measure preserving transformations and examples, Recurrence.					15	
2	Poincare’s Recurrence theorem, Ergodicity, two sided shift is ergodic.					15	
3	Ergodic theorems of Birkhoff and Von Neuman, Mixing, Weak-mixing and their characterizations, the isomorphism problem: conjugacy, Spectral equivalence.					15	
4	Transformations with discrete spectrum, Entropy, Kolmogorov-Sinai theorem, calculation of entropy.					15	
References							
1.	P. R. Halmos, Lectures on Ergodic Theory, American Mathematical Society, 2006.						
2.	M. G. Nadkarni, Basic Ergodic Theory, BirkhauserVerlag, 1998.						
3.	Peter Walters, An Introduction to Ergodic Theory, Springer,						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2308 – Fourier Analysis – I			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Trigonometric series and its conjugate series as real and imaginary parts of Taylor series on unit circle, Fourier series, 2π -periodic functions and their relation with functions on unit circle, Fourier series of even and odd functions, elementary properties of Fourier coefficients and Riemann Lebesgue lemma.					15	
2	Orthonormal systems in L^2 , Fourier series with respect to orthonormal systems, completeness of trigonometric system and uniqueness theorem, Dirichlet and Fejer's kernels and their properties.					15	
3	Convolutions in L^p and its properties, Integral expressions for partial sums and (C,1) means of Fourier series, Approximate identities for convolution, Fejer's theorem, Density and uniqueness theorem,					15	
4	Dirichlet problem and its solutions using Poission kernel, Riemann principle of localization theorem and generalized localization principle, Criterion for the convergence of Fourier series, Dini's and Jordan's theorems.					15	
References							
1.	N. K. Bary, A Treatise on Trigonometric series, Vol.I& II, Pergamon Press, 1964.						
2.	R. E. Edwards, Fourier series: A modern introduction, Vol.I, Springer, 1979.						
3.	G. H. Hardy and W. W. Rogosiniski, Fourier series, Dover, 1999.						
4.	W. Korner, Fourier Analysis, Cambridge University Press, 1989.						
5.	E. Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Pvt. Ltd, 2005.						
6.	Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Book Co, 1976.						
7.	Elias M. Stein and Rami Shakarchi, Fourier Analysis: An Introduction, 2003.						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2309 – Homotopy Theory			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Some simple topological problems, Categories and functors, Homotopy lifting property, H spaces, Suspension.					15	
2	Classification of covering spaces, Fundamental group of the punctured plane, P^2 , Figure eight and double torus.					15	
3	Essential and inessential maps, The fundamental theorem of algebra, Vector fields and fixed points, Brouwer fixed point theorem for disc.					15	
4	Homotopy type, Degree of a map, Jordan curve theorem, Higher homotopy groups.					15	
References							
1.	B. Gray, Homotopy Theory: An introduction to algebraic topology, Academic Press, 1975.						
2.	A. Hatcher, Algebraic topology, Cambridge University Press, 2005.						
3.	J. R. Munkres, Topology: A first course, Prentice – Hall of India, 2000.						
4	E. H. Spanier, Algebraic topology, McGraw Hill Book Co, 1994.						
5	J. W. Vick, Homology Theory: An introduction to algebraic topology, Springer, 1994.						

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M.Sc. (Mathematics): Regular Programme					
Year	II	Elective: MAT2310 – Operations Research – I		Credits	04
Semester	I				
Unit No.	Topics			Contact Hours	
1	Dual simplex method, Sensitivity Analysis: Changes in the coefficients of the Objective function, Change in the components of the R.H.S. vector b.			15	
2	Variations in the components a_{ij} of the matrix A, Addition of a new variable, Deletion of a variable, Addition of a new constraint, Deletion of constraint.			15	
3	Quadratic forms, Convex functions, Classical optimization theory, Unconstrained problems, Necessary & Sufficient conditions, Constrained problems with Equality constraints: Lagrangian method.			15	
4	Inequality constraints: Extension of the Lagrangian method, Convex programming problem, Kuhn Tucker necessary & sufficient conditions.			15	
References					
1.	S. I. Gass, Linear Programming: Methods and Applications, Courier Dover Publications, 1985.				
2.	K.V. Mittal, Optimization Methods in Operation Research and System Analysis, Wiley Eastern Limited, 2007.				
3.	D.T. Phillips, A Ravindran, James Solberg, Operations Research Principles and Practice, John Wiley and Sons, 2007.				
4.	Kanti Swaroop, P.K. Gupta and Man Mohan, Operations Research, S. Chand & Sons, 1978.				
5.	H.A. Taha, Operations Research, MacMillan Publishing Company, 2008.				

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2311 – Special Functions – I			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Infinite product: convergence, evaluation through the partial product, connection with infinite series, Weierstrass definition of gamma function, Euler’s integral of gamma function, Euler’s product formula and its consequences, Legendre duplication formula, Euler’s reflection formula, Series for $\Gamma'(z) / \Gamma(z)$. Beta function.					15	
2	General factorial notation, Gauss hypergeometric function: convergence, integral form, differential equation, function value at $z=1$, Gauss summation formula, Contiguous function relatins, Pffaf-Kummer’s transformation, Euler’s transformation, Kummer’s theorem for function value at $z = -1$.					15	
3	Generalized hypergeometric series, its convergence, special cases: exponential function, binomial series, etc., integral form, operator form differential equation, Saalschutz’s theorems, Whipple’s theorem on terminating series and on non-terminating series, Dixon’s theorem.					15	
4	Bessel function as a particular case of generalized hypergeometric function, differential recurrence relation, pure recurrence relation, differential equation, generating function, relations with the sine and cosine functions, Bessel’s integral, modified Bessel function. Inequalities involving Bessel function of real argument.					15	
References							
1.	G. E. Andrews, R. Askey, and Ranjan Roy, Special Functions, Cambridge University Press, 1999.						
2.	E. D. Rainville, Special Functions, Macmillan Co., New York, 1960.						
3.	Z. X. Wang and D. R. Guo, Special Functions, World Scientific Publ., Singapore, 1989.						
4.	L. C. Andrews, Special Functions of Mathematics for Engineers, McGraw-Hill International Edition, 1992.						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2312 – Special Theory of Relativity			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Speed of light and Galilean relativity, Michelson-Morley experiment, Lorentz-Fitzgerald contraction hypothesis, Relative character of space and time.					15	
2	Postulates of special theory of relativity, Lorentz transformation and its geometric interpretation, Group properties of Lorentz transformations, Composition of parallel velocities, Length contraction, Time dilation.					15	
3	Transformation equation for components of velocity and acceleration, The four-dimensional Minkowskian space-time, Four-vectors and tensors in Minkowskian space-time, Variation of mass with velocity.					15	
4	Equivalence of mass and energy, Transformation equations of mass , momentum and energy, energy-momentum four-vector, Relativistic force and transformation equations for its components.					15	
References							
1.	R. Resnik, Introduction to Special Relativity, Wiley Eastern Pvt. Ltd., 1972.						
2.	W. Rindler, Essential Relativity, Van Nostrand Reinhold Company, 1969.						
3.	J. L. Synge, Relativity: Special Theory, North-Holland Publ. Co., 1956.						

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M.Sc. (Mathematics): Regular Programme					
Year	II	Elective: MAT2313 – Topological Dynamics		Credits	04
Semester	I				
Unit No.	Topics			Contact Hours	
1	Dynamical Systems: Definition and examples (including real life examples), Orbits, Types of orbits, Topological conjugacy and orbits, Phase Portrait - Graphical Analysis of orbit, Periodic points and stable sets, Omega and alpha limit sets and their properties,			15	
2	Sarkovskii's Theorem, Dynamics of Logistic Functions, Shift spaces and subshifts, Subshift of finite type and subshift represented by a matrix. Definition and examples of expansive homeomorphisms, Properties of expansive homeomorphisms, Non-existence of expansive homeomorphism on the unit interval and unit circle,			15	
3	Generators and weak generators, Generators and expansive homeomorphisms, Converging semiorbits for expansive homeomorphisms, Definition and examples of shadowing property, properties of shadowing property, Topological Stability, Anosov maps and topological stability.			15	
4	Practicals: Introduction to MATLAB. Sketching of phase portraits. (AIM: To compute orbits of different points for several functions and analyze the behaviour of the orbits its phase portrait.) To determine whether the orbit of a point is periodic or not. Rate of convergence for orbits. (Rate of convergence towards periodic points) Analysis of dynamics of logistic maps. Period – Doubling Bifurcation.			15	
References					
1.	N. Aoki, Topics in General Topology, edited by: K. Morita and J. Nagata, North Holland Publications, pp 625 – 740, 1989.				
2.	N. Aoki and K. Hiraide, Topological theory of Dynamical Systems, Recent Advances, North Holland Publications, 1994.				
3.	Richard Holmgren, A first course in discrete dynamical systems, (2 nd Edition), Universitext, Springer – Verlag New York, 1996				
4.	D. Lind and B. Marcus, Symbolic Dynamics and Coding, Cambridge University Press, 1996.				
5.	Clark Robinson, Dynamical Systems, Stability, Symbolic Dynamics and Chaos, CRC Press, 1998.				

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2314 – Topological Vector Spaces			Credits	04
Semester		I					
Unit No.	Topics					Contact Hours	
1	Definition and examples of topological Vector spaces, Convex, balanced and absorbing sets and their properties. Product spaces, subspaces, direct sums, quotient spaces, Topological vector spaces of finite dimension.					15	
2	Linear manifolds and hyperplanes, Linear transformation and linear functionals and their continuity, Minkowski's functional.					15	
3	Locally convex topological vector spaces, Normable and metrizable Topological vector spaces, Complete topological vector spaces and Frechet spaces.					15	
4	Geometric form of Hahn-Banach theorem, Uniform-boundedness principle, Open mapping theorem and closed graph theorem for Frechet spaces, Banach Alaoglu theorem.					15	
References							
1.	John B Conway, A Course in Functional Analysis, Springer, 1990.						
2.	Walter Rudin , Functional Analysis, Tata McGraw Hill Book Co., 1991.						
3.	H. H. Schaefer, Topological Vector Spaces, Springer, 1999.						
4.	F. Treeves, Topological Vector Spaces, Distributions, and Kernels, Academic Press, 1967.						

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M.Sc. (Mathematics): Regular Programme							
Year		II		Core: MAT2402 – Functional Analysis – II		Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Projections, Eigen values and eigen spaces of an operator on a finite dimensional Hilbert space, the spectrum of an operator and the spectral theorem.					15	
2	Banach algebras, Regular and singular elements, Topological divisors of zero, the spectrum of an element of a Banach algebra and its non-emptiness.					15	
3	The spectral radius formula, The radical and semi-simplicity, Commutative Banach algebras, The Gelfand mapping and the maximal ideal space, Gelfand representation theorem.					15	
4	Involutions in Banach algebras, The Gelfand – Neumark Theroem for commutative B^* - algebras, Maximal Ideal space of $C(X)$ (X compact and Hausdorff) and Banach Stone Theorem.					15	
References							
1.	Ronald Larsen, Functional Analysis an Introduction, Marcel Dekker, 1973.						
2.	B. V. Limaye, Functional Analysis, Newage International Ltd, 1996.						
3.	Erwin Kreyszig, Introductory Functional Analysis with its applications, John Wiley and Sons, 2007.						
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2004.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Core: MAT2403 – Surfaces and Manifolds			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Surfaces, Tangent vectors to surfaces, The first fundamental form and arc length, Normal curvature, Geodesic curvature, Gauss's formulas (without proof), Geodesics, The second fundamental form and the Weingarten map,				15	
2	Principal, Gaussian, Mean and Normal curvatures, Riemannian curvature and Gauss's theorem Egregium, Fundamental theorem of surfaces (without proof).				15	
3	Definition and examples of topological manifolds, Differentiable manifolds, Differentiable functions, Rank of a mapping, Immersions,				15	
4	Submanifolds, Tangent vectors and the Tangent space, Vector fields, Tangent Covectors, The Riemannian Metric, Riemannian Manifold as a metric space.				15	
References						
1.	W. M. Boothby, An Introduction to Differentiable Manifolds and Riemannian Geometry, Academic Press, 1975.					
2.	R. S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice - Hall Inc, 1977.					
3.	A. Pressley, Elementary Differential Geometry, Springer, 2010.					
4.	J. A. Thorpe, Introduction to Differential Geometry, Springer, 1979.					
5.	L. W. Tu, An Introduction to Manifolds, Springer, 2010.					

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M.Sc. (Mathematics): Regular Programme							
Year		II	Core: MAT2418 – Calculus of Variations and Integral Equations			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Basic concepts of calculus of variations, Variation and its properties, Euler’s equation, Fundamental lemma of calculus of variation, Functionals dependent on higher order derivatives and on several independent variables					15	
2	Variational problem in parametric form, applications, Variational problem with moving boundaries, Sufficient condition for an extremum.					15	
3	Introduction and basic examples, Classifications of integral equations, Volterra integral equations, Relationship between linear differential equation and Volterra equations, Solutions with separable kernels, Resolvent kernels , Method of successive approximations.					15	
4	Fredholm integral equations, Method of Fredholm determinants, iterated kernels, Degenerate kernels, eigen values and eigen functions of a Fredholm alternatives.					15	
References							
1.	Courant, R. and Hilber D., Methods of Mathematical Physics, Vol. I, Interscience Press, 1953.						
2.	Elsgolc, L.D., Calculus of Variations, Pergamon Press Ltd., 1962.						
3.	Robert Weinstock, Calculus of Variations, with Applications to Physics and Engineering, Dover, 1974.						
4.	A. S. Gupta, Calculus of Variation with Applications, Prentice Hall of India, 1999.						
5.	Cordumenau, C., Integral Equations and Applications, Cambridge University Press, 1991.						
6.	Kanwal, R. P., Linear Integral Equations, Theory and Techniques, Birkhauser, 1997.						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2404 – Matrix Groups			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	The general linear groups, The orthogonal groups, The isomorphism question, Reflection in $\mathbb{R}^n$, Curves in a vector space, Smooth homeomorphisms, The special orthogonal groups.					15	
2	Orthogonal matrices and isometries, Exponential and Logarithm of a matrix, one parameter subgroups, Lie Algebras, $SO(3)$ and $Sp(1)$.					15	
3	Maximal tori, Covering by maximal tori, Reflections in R^n , Monogenic groups.					15	
4	Conjugacy of maximal tori, Clifford algebras, $Pin(k)$, $Spin(k)$ and isomorphisms.					15	
References							
1.	Morton L. Curtis, Matrix Groups, Springer, 1984.						
2.	Kristopher Tapp, Matrix Groups for Undergraduates, American Mathematical Society, 2005.						

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M.Sc. (Mathematics): Regular Programme							
Year		II		Elective: MAT2405 – Banach Algebras		Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Normed Algebra, regular ideals, Theorem of Gelfand, regularity and quasiregularity, Topologically nilpotent elements, Gelfand Mazur theorem. Topological zero divisors of $C(X)$ (X compact + T_2), Basic properties of spectra in Banach algebra, Polynomial spectral mapping theorem.					15	
2	Maximal regular ideals and complex homomorphisms, Maximal ideal space of commutative Banach algebra without identity, Beurling-Gelfand theorem, Semisimple Banach algebras, Gelfand representation of $C(X)$ (X locally compact + T_2) and the disc algebra $A(D)$.					15	
3	Algebra of complex holomorphic function on an open set in the complex plane C . Symbolic calculus and its applications, multiplicative group of all invertible elements of a Banach algebra, Involution on Banach algebras, B^* - algebras.					15	
4	Square roots of hermitian elements, Study of spectra of hermitian, Normal and positive elements in a B^* - algebra, Positive functionals and their properties, Spectral theorem for Normal operators.					15	
References							
1.	R. G. Douglas, Banach Algebra Techniques in Operator Theory, Academic Press, 1972.						
2.	Ronald Larsen, Banach Algebras: An Introduction, M. Dekker, 1973.						
3.	Walter Rudin, Functional Analysis, McGraw Hill International Publishers, 2006.						
4.	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2004.						
5.	M. Takesaki, Theory of Operator Algebras, Springer, 2003.						

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M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2406 – Chaos Theory			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Topological transitivity: Examples and properties, Topological mixing: Examples and Properties, Transitivity and limit sets for maps on I , Characterizing topological mixing in terms of topological transitivity for maps on I ,					15	
2	Sensitive dependence on initial conditions, Devaney's definition of chaos, Logistic maps and shift maps as chaotic maps, Period three implies chaos, Relation between transitivity and chaos on I .Topological Entropy: Definitions, Entropy of interval maps,					15	
3	Horseshoes, Entropy of cycles, Continuity properties of the Entropy, Entropy of shift spaces, Entropy for circle maps, Various other definitions of Chaos and their interrelationships.					15	
4	Practicals: Analysis of Sensitive dependence on initial conditions through phase portraits. From regularity to chaos. Programs using symbolic math tool box. Numerical-symbolic Matlab program for the analysis of chaotic systems. Using Algorithms to calculate Entropy. Programs related to algorithms for minimal right-resolving.					15	
References							
1.	Richard Holmgren, A first course in discrete dynamical systems, (2 nd Edition), Universitext, Springer – Verlag New York, 1996.						
2.	D. Lind and B. Marcus, Symbolic Dynamics and Coding, Cambridge University Press, 1996.						
3.	Clark Robinson, Dynamical Systems, Stability, Symbolic Dynamics and Chaos, CRC Press, 1998.						
4.	S. Ruelle, Chaos for continuous interval maps, University Lecture Series Volume 67, AMS, 2017.						
5.	Peter Walters, An introduction to Ergodic Theory, Springer – Verlag New York, 1982.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Elective: MAT2407 – Classical Mechanics – II			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Rate of change of a vector, The Coriolis force, Angular momentum and kinetic energy of motion about a point, The moment of inertia, Principal axis, The Euler equations of motion.				15	
2	Torque free motion of a rigid body, The heavy symmetrical top with one point fixed, Legendre transformation and Hamilton's equation of motion, Cyclic coordinates and conservation theorems.				15	
3	Derivation of Hamilton's equations from variational principle, The principle of least action, The equations of canonical transformations, The symplectic approach to canonical transformations.				15	
4	Poisson brackets and other canonical invariants, Equations of motion, Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The Angular momentum Poisson bracket relations.				15	
References						
1.	Herbert Goldstein, Classical Mechanics, Narosa Publishing House, 1980.					
2.	Louis N. Handa, Janet D. Finch, Analytical Mechanics, Cambridge University Press, 1998.					
3.	Leonard Meirovitch, Methods of Analytic Mechanics, Dover Publications Inc., 2007.					
4.	Walter Greiner, Classical Mechanics- System of Particles and Hamiltonian Dynamics, Springer, 2004.					

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Mathematics Sayajigunj, Vadodara 390002, Phone: 0265-2795329 head-math@msubaroda.ac.in			Academic Year	2020-21	
M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2408 – Cryptology			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Finite fields, Legendre symbol and quadratic reciprocity, Jacobi symbol, Cryptosystems, diagraph transformations and enciphering matrices.					15	
2	RSA Cryptosystem, Primality and Factoring, Pseudoprimes, Carmichael numbers, Primality tests, Strong Pseudoprimes.					15	
3	Monte Carlo method, Fermat factorization, Factor base, Implication for RSA, Elliptic curves - basic facts, Elliptic curves over $\mathbb{R}$, $\mathbb{C}$, $\mathbb{Q}$, finite fields.					15	
4	Hasse's theorem (without proof), Weil's conjectures (without proof), Elliptic curve cryptosystems, Elliptic curve factorization - Lenstra's method.					15	
References							
1.	David Bressoud, Factorization and Primality Testing, Springer, 1989.						
2.	Abhijit Das and C. E. Veni Madhavan, Public – key cryptography: Theory and Practice, Pearson Education, 2009.						
3.	Neal Koblitz, A Course in Number Theory and Cryptography, Springer, 1994.						
4.	M. Rosen and K. Ireland, A Classical Introduction to Number Theory, Springer, 1990.						

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Mathematics Sayajigunj, Vadodara 390002, Phone: 0265-2795329 head-math@msubaroda.ac.in			Academic Year	2020-21	
M.Sc. (Mathematics): Regular Programme							
Year		II		Elective: MAT2409 – Fourier Analysis – II		Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Fourier series in L^2 , Minimal property of partial sums of Fourier series. Bessel's inequality and convergence of Fourier series in L^2 , Parseval's equality, Riesz-Fischer theorem, Subsequences of partial sums of Fourier series and Kolmogorov's theorem, Integration of Fourier series.					15	
2	Convex and quasi-convex sequences, Sequences of bounded variation, Properties of convex sequences, Modified Dirichlet kernel and Conjugate Dirichlet kernel, Sine and cosine series with monotonically decreasing coefficients.					15	
3	Fourier series of a continuous function divergent at a point, Absolute convergence of Fourier series, Bernstein, Szasz, Stechkin and Zygmund's theorems for the absolute convergence of Fourier series, Riemann's method of summation and its application to Fourier series					15	
4	Cantor's and Du Bois Reymond's theorems for uniqueness, Linear and regular methods of summability, Summability (C, α) , Hardy's Theorem, Fejer's and Lebesgue's Theorem for $(C, 1)$ summability and Riesz's Theorem for summability (C, α) .					15	
References							
1.	N. K. Bary. A Treatise on Trigonometric Series, Volume I & II, Pergamon Press, 1964.						
2.	R. E. Edwards, Fourier Series: A Modern Introduction, Volume I, Springer, 1979.						
3.	G. H. Hardy and W. W. Rogosinski, Fourier Series, Dover, 1999.						
4.	Henry Helson, Harmonic Analysis, Hindustan Book Agency, 2010.						
5.	W. Korner, Fourier Analysis, Cambridge University Press, 1989.						
6.	Mark. A. Pinsky, Introduction to Fourier Analysis and Wavelets, Thomson Brooks Cole, 2008.						
7.	Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Book Co, 1976.						
8.	Elias M Stein and Rami Shakarchi, Fourier Analysis: An Introduction, Princeton University press, 2003.						
9.	A. Zygmund, Trigonometric Series, Vol. I & II, Cambridge University Press, 2002.						

 THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty of Science Department of Mathematics Sayajigunj, Vadodara 390002, Phone: 0265-2795329 head-math@msubaroda.ac.in			Academic Year	2020-21	
M.Sc. (Mathematics): Regular Programme						
Year	II	Elective: MAT2410 – General Theory of Relativity			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Transformation of coordinates, Tensors, Algebra of Tensors, Symmetric and skew-symmetric tensors, Contraction of tensors and quotient law, Parallel transport, Christoffel symbols, Covariant derivative, Intrinsic derivatives and geodesics.				15	
2	Riemann Christoffel curvature tensor and its symmetry properties, Bianchi identities and Einstein tensor, Principle of equivalence and general covariance, Geodesic principle, Newtonian approximation of relativistic equations of motion, Einstein's field equations and its Newtonian approximation.				15	
3	Schwarschild external solution and its isotropic form, Planetary orbits and analogues of Kepler's laws in general relativity, Advance of perihelion of a planet.				15	
4	Bending of light rays in a gravitational field, Gravitational red shift of spectral lines, Radar echo delay, Energy-momentum tensor of a perfect fluid, Schwarschild internal solution, Boundary conditions.				15	
References						
1.	R. Adler, M. Bazin, and S. Schiffer, Introduction to General Relativity, McGraw Hill Book Co, 1965.					
2.	J. V. Narlikar, General Relativity and Cosmology, The Macmillan Company of India Ltd, 1979.					
3.	B. F. Shutz, A First Course in General Relativity, Cambridge University Press, 1985.					
4.	C. E. Weatherburn, An Introduction to Riemannian Geometry and Tensor Calculus, Cambridge University Press, 2008.					

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M.Sc. (Mathematics): Regular Programme						
Year	II	Elective: MAT2411 – Homology Theory			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Singular homology theory: singular n - chain, Boundary operator, n - cycle, n - boundary, Singular homology group.				15	
2	Chain complexes, Chain maps and chain homotopies, Exact sequences, Mayer – Vietoris sequence.				15	
3	Jordan Brouwer separation theorem, Brouwer theorem on invariance of domain, Nonexistence of vector fields on even dimensional sphere.				15	
4	Eilenberg steenrod axioms for arbitrary coefficient group, Universal coefficient theorem, Cochain complexes and n^{th} cohomology group.				15	
References						
1.	B. Gray, Homology Theory: An Introduction to Algebraic Topology, Academic Press, 1975.					
2.	A. Hatcher, Algebraic Topology, Cambridge University Press, 2005.					
3.	J. R. Munkres, Topology: A First Course, Prentice – Hall of India, 2000.					
4.	E. H. Spanier, Algebraic Topology, McGraw Hill Book Co, 1966.					
5.	J. W. Vick, Homotopy Theory: An Introduction to Algebraic Topology, Academic Press, 1994.					

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M.Sc. (Mathematics): Regular Programme						
Year		II	Elective: MAT2412 – Operations Research – II		Credits	04
Semester		II				
Unit No.	Topics					Contact Hours
1	Integer programming problem: Gomory’s cutting plane method (fractional cut & λ -cut) for all integer programming problem, Branch and Bound algorithm, Mixed integer programming problem.					15
2	Dynamic Programming Problem (DPP): principle of optimality, Multiple stage decision problem, Characteristic of DPP, Solution of problems with finite number of stages by Dynamic Programming.					15
3	Project scheduling through Project Evaluation and Review Technique (PERT) and Critical path method (CPM): Elements and development of network, Time estimates & time computations.					15
4	Network Analysis, Cost time trade off, Resource leveling, Maximal flow Problem: enumeration of cuts, Maximal flow algorithm. Shortest route problem: examples of the shortest route applications, Dijkstra’s algorithm, Floyd’s algorithm.					15
References						
1.	S. I. Gass, Linear Programming: Methods and Applications, Courier Dover Publications, 1985.					
2.	K. V. Mittal, Optimization Methods in Operation Research and System Analysis, Wiley Eastern Limited, 2007.					
3.	D. T. Phillips, A. Ravindran, James Solberg, Operations Research Principles and Practice, John Wiley and Sons, 1987.					
4.	Kanti Swaroop, P. K. Gupta and Man Mohan, Operations Research, S. Chand & Sons, 2004.					
5.	H. A. Taha, Operations Research, MacMillan Publishing Company, 1978.					

		The Maharaja Sayajirao University of Baroda Faculty of Science Department of Mathematics Sayajigunj, Vadodara 390002, Phone: 0265-2795329 head-math@msubaroda.ac.in			Academic Year	2020-21	
M.Sc. (Mathematics): Regular Programme							
Year		II	Elective: MAT2413 – Special Functions – II			Credits	04
Semester		II					
Unit No.	Topics					Contact Hours	
1	Orthogonal polynomial: Simple set of real orthogonal polynomials, Necessary and sufficient condition of Orthogonality, Zeros, Three term recurrence relation, Christoffel-Darboux formula					15	
2	Generating function relation, General generating functions: $G(2xt-t^2)$, $\exp(t) \psi(xt)$, and $A(t) \exp(-xt/(1-t))$, the differential recurrence relations. Confluent hypergeometric function and its properties, Contiguous functions relations, Kummer's first and second formulas.					15	
3	Laguerre polynomial: Generating functions, Recurrence relations, Differential equation, Rodrigue's formula, Orthogonality, expansion of x^n . Hermite polynomial: Generating function, Recurrence relations, Differential equation, Rodrigue's formula, Orthogonality, expansion of x^n . Relation between Laguerre and Hermite polynomials through integral form.					15	
4	Legendre polynomial: Generating functions, Recurrence relations, Differential equation, Rodrigue's formula, Orthogonality, expansion of x^n ; Laplace first integral, Bounds. Jacobi polynomial: Explicit forms, Generating functions, Recurrence relations, Differential equation, Rodrigue's formula, Orthogonality. Chebyshev polynomials and Gegenbauer polynomial as the special cases.					15	
References							
1.	G. E. Andrews, R. Askey, and Ranjan Roy, Special Functions, Cambridge University Press, 1999.						
2.	E. D. Rainville, Special Functions, Macmillan Co., New York, 1960.						
3.	Z. X. Wang and D. R. Guo, Special Functions, World Scientific Publ., Singapore, 1989.						
4.	L. C. Andrews, Special Functions of Mathematics for Engineers, McGraw-Hill International Edition, 1992.						

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M.Sc. (Mathematics): Regular Programme						
Year	II	Elective: MAT2414 – Symbolic Dynamics			Credits	04
Semester	II					
Unit No.	Topics				Contact Hours	
1	Symbolic dynamics: Full Shift, Shift Spaces, Languages, Higher Block Shifts and Higher Power Shifts, Sliding Block Codes, Shifts of finite type, Graphs and their shifts.				15	
2	Graph representation of shifts of finite type, State splitting, Presentation of Sofic shifts, Characterization of Sofic Shifts, Minimal right-resolving presentation, Constructions and Algorithms.				15	
3	Entropy for shift space, Perron - Frobenius Theorem, Computing Entropy, Irreducible Components.				15	
4	Curtis-Lyndon-Hedlund Theorem for shift dynamical systems, Markov Partitions, The Decomposition Theorem for edge shift, Strong shift equivalence and shift equivalence.				15	
References						
1.	D. Lind and B. Marcus, An Introduction to Symbolic Dynamics and Coding, Cambridge University Press, 1995.					
2.	Clark Robinson, Dynamical Systems, Stability, Symbolic Dynamics and Chaos, CRC Press, 1999.					



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**Academic
Year**

2020-21

M.Sc. (Mathematics): Regular Programme

Year

II

Elective: MAT2422 – Problem Solving Techniques in Mathematics – II

Credits

04

Semester

II

**Unit
No.**

Topics

Contact Hours

1

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations; Algebra of matrices, rank and determinants of matrices, linear equations; Eigenvalues and eigenvectors, Cayley-Hamilton theorem; Matrix representation of linear transformations, change of basis, canonical forms, diagonal forms, Jordan forms; Inner product spaces, orthonormal basis; Quadratic forms, reduction and classification of quadratic forms.

15

2

Analysis: Elementary set theory, finite countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum; Sequences and series, convergence, limsup, liminf; Bolzano Weierstrass theorem, Heine Borel theorem; Continuity, uniform continuity, differentiability, mean value theorem; Sequences and series of functions, uniform convergence; Riemann sums and Riemann integral, Improper Integrals; Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral; Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation; Metric spaces, compactness, connectedness, Normed Linear Spaces, Spaces of Continuous functions as examples.

15

3

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions such as exponential, trigonometric and hyperbolic functions; Analytic functions, Cauchy-Riemann equations; Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem; Taylor series, Laurent series, calculus of residues; Conformal mappings, Mobius transformations.

15

4

Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements; Fundamental theorem of arithmetic, divisibility in $\mathbb{Z}$, congruences, Chinese Remainder Theorem, Euler's ϕ -function, primitive roots; Groups, subgroups, normal subgroups, quotient groups, homomorphisms; cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain; Polynomial rings and irreducibility criteria; Fields, finite fields, field extensions.

15

References

1. I. N. Herstein, Topics in Algebra, Vikas Publishing House Pvt. Ltd., 2004.
2. I. H. Sheth, Abstract Algebra, Prentice-Hall of India, 2009.
3. Richard Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd., 1970.
4. Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill book Co, 1976.
5. V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.
6. John B. Conway, Functions of One Complex Variable, Narosa Publishing house, 2002.
7. J. W. Brown and Ruel V. Churchill, Complex variables and Applications, McGraw-Hill, Inc. 1996.