

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome (PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
- PSO2. Assimilate complex mathematical ideas and arguments.
- PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.
- PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.
- PSO5. Demonstrate basic mathematical understanding and computational skills.
- PSO6. Apply soft computing techniques.
- PSO7. Implement various algorithms using advanced Object Oriented Programming languages.
- PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.
- PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.
- PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.
- PSO11. Use appropriate software to solve practical problems.
- PSO12. Employ advanced statistical and optimisation techniques.
- PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.
- PSO14. Formulation of mathematical models and simulation of the problems in real world.
- PSO15. Inculcate their skills to deal with industrial problems.
- PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.
- PSO17. Electives in the final year which elaborate prerequisite of the research field.
- PSO18. Hands-on practice for self preparation and developing presentation skills through project and seminar.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT2110: APPLIED ANALYSIS-I	Credits / Hours per week					05		
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2110 CO1 Understand the limitations of functions of real variables and importance of studying functions of complex variables and its applications in physical phenomenon. CO2 Learn about the exploration of the algebraic operations on the complex number along with geometry in argand diagram. CO3 Able to apply continuity, differentiability, analyticity of $f(z)$ in particular domain. CO4 Learn about the harmonic and harmonic conjugate functions and able to apply potential theory. CO5 Understand the mapping / transformation and able to plot image in w -plane. CO6 Able to evaluate any complex integral using theory of Cauchy's. CO7 Classify different types of singularities and be able to apply residue theory to evaluate integrals. CO8 Able to describe the ideas of Laplace Transforms and their applications to solve initial and boundary value problems.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Releva nce to Local (L)/ Nation al (N)/ Region al(R)/ Global (G)	Relatio n to Gender (G), Environme nt and Sustainabil ity (ES), Human Values (HV)and Professiona l Ethics (PE)

1	Functions of complex variable, Continuity and Differentiability of function of complex variable, necessary and sufficient conditions for differentiability of $f(z)$, Holomorphic and Homomorphic functions, Elementary properties of holomorphic functions, Harmonic functions and its applications to potential theory.	12	20	1,2,4,5	CO2 CO3 CO4	PSO2 PSO4 PSO5 PSO16	EMP	G	PE
2	Mapping and transformations: Linear transformation, Inversion and Linear fractional transformation, Conformal mapping and its applications, Mapping by elementary functions and some special functions.	08	14	2,3,5	CO5	PSO1 PSO5 PSO9 PSO16			
3	Complex Integrals: contour and contour integrals, different theorems due to Cauchy, Consequences of Cauchy's theorems, Morera's theorem. Liouville's Theorem, Maximum modulus theorem, Fundamental theorem of algebra.	12	20	2,3,4,5	CO1 CO6	PSO2 PSO4 PSO9 PSO16			
4	Power series representations of $f(z)$	08	14	1,2,5	CO1	PSO1 PSO5			
5	Singularities and Residues of $f(z)$, Residue theorem. Applications of residue theory.	08	14	1,3,5	CO7	PSO1 PSO4 PSO16			
6	Reorientation of Laplace Transform and Inverse Laplace transforms, Existence theorem of Laplace Transform, Laplace Transform of Heaviside function and its applications, step functions, Unit impulse function, Laplace transform of Dirac's Delta function and Periodic function, Applications of Laplace transform to ODE (involving Heaviside function and Dirac delta function), PDE and Integral equations, Inversion integral.	12	20	1,2,3,5	CO8	PSO1 PSO5 PSO7 PSO10			

Reference Books

1.	R. V. Churchill and James Ward Brown: Complex Variables and Applications, McGraw-Hill, Inc (VI Edition).
2.	John H. Mathews and Russel Howell: Complex Analysis for Mathematics and Engineering, Narosa Publishing house.
3.	Murray R. Spiegel: Theory & problems of Complex Analysis, McGraw-Hill Co. (Metric Editions).
4.	Serge Lang: Complex Analysis, (Third Edition), Springer.
5.	R. V. Churchill : Operational Mathematics.

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT 2124: Implementation of Mathematical Algorithm	Credits / Hours per week							05
Semester	I	Year of Introduction: 2014	Maximum Marks / Grade							100
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2124 CO1 Understand the use of OOPs concepts in C++. CO2 Solve real world problems using OOP techniques using C++. CO3 Understand the use of C++ for numerical methods. CO4 Understand the use of Packages and Interface in C++. CO5 Design real life situational problems and think creatively and provide a program giving solutions. CO6 Apply a solution clearly and accurately in a program using matlab. CO7 Apply the programming skills for the best features of mathematics, engineering and natural sciences dealing real life problems.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Basic features :Variables, Comments, Punctuations, Matlab Workspace, Simple math, Complex numbers, Built-in		05	8.33	1,2	CO1	PSO2 PSO3 PSO5	SD	G	PE

	Functions.								
2	Script / M-files : Files and directory management, File I/O Arrays and array operation, Relational and Logical operations, Set, Bit and Base conversion function, Character strings, String function, Time functions, Cell arrays and structures.	10	16.66	1,2,3	CO2 CO3	PSO2 PSO3 PSO7			
3	Control Structures : For loops, While loops, If-else-end, Switch-case Statements, Function M-files, Command function duality, Inline functions, Debugging tools. Solving system of linear equations, Eigen values and Eigen vectors of a matrix, Sparse and Special matrices, Roots of polynomial equations, Operators on Polynomials, Graphics : 2-D and 3-D Graph plotting	10	16.67	1,2,3,6	CO2 CO3	PSO2 PSO3 PSO7			
4	Mathematical Algorithms through Object oriented programming: Reorientation of Object oriented Programming language and concepts (C++/java). Classes, methods, inheritance, polymorphism, interfaces etc.	10	16.67	3,4,5,6	CO2 CO3 CO4 CO5	PSO2 PSO3 PSO7			
5	Implementing mathematical objects, their operations and methodologies for: Matrices , Polynomials, Complex numbers, - Trigonometric functions	10	16.67	1,2,3,4	CO6 CO7	PSO2 PSO3 PSO5			
6	- Applications using objects and methodology to : - Solution of system of equations - Finding roots (functions of one variables) - Interpolation - Numerical differentiation - Statistical objects and methodologies	15	25	3,4,5,6	CO5 CO6 CO7	PSO5 PSO6 PSO7			

Reference Books	
1.	Saul A. Teukolsky :Numerical Recips in c++, William H. Press... Cambridge University Press
2.	Daoqii Yang : C++ and Object oriented computing for Scientists & Engineers, Spinger-Verlag
3.	Duane Hanselman & Bruce Littlefied : Mastering Matlab, A Comprehensive tutorial and reference
4.	Desmond J. Higham & Nicolas J. Higham : Matlab Guide ,SIAM, 2000
5.	Duane Hanselman & Bruce Littlefield: Mastering Matlab-6: A Comprehensive Tutorial and Reference, , Prentice Hall, 2001.
6.	Stephen Chapman :Matlab programming for Engineers 4/e, ,Cengage Learning, 2008
7.	Rudra Pratap : Getting started with MATLAB 7, ,Oxford Press (Indian edition), 2006.

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M.Sc. (Applied Mathematics): Regular Programme											
Year	I	Core / Elective / Foundation AMT2123: Linear Algebra and Calculus of Variation		Credits / Hours per week			05				
Semester	I	Year of Introduction: 2014		Maximum Marks / Grade			100				
Mode of Transaction		Lectures									
Course Outcome (CO) AMT2123 CO1: Understands and implement the concept of diagonalization to find out solution of system of linear differential equations using exponential of a matrix. CO2: Introduces properties of different types of operators. CO3: Understands the Cayley-Hamilton theorem for operators and Jordan Canonical form for $n \times n$ matrices. CO4: Can analyze the stability of linear systems. CO5: Able to apply the theory of eigenvalues and eigenvectors to Spectral theorem and Quadratic forms. CO6: Understand what functionals are, derive and use the Euler-Lagrange equation to find differential equations for stationary paths CO7: Solve differential equations for stationary paths, subject to boundary conditions, in straightforward cases.											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)
1	Revision of basic concepts of vector spaces Real world problems leading to a linear systems			16	27	1,2,3	CO1 CO2	PSO2 PSO3	Emp	G	PE

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M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT2106: Numerical Analysis	Credits / Hours per week				05			
Semester	I	Year of Introduction: 1974 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2106										
CO1 Understand the basics of computer arithmetic										
CO2 Understand the concepts of numerical differentiation										
CO3 Study numerically eigenvalue problems and different methods for finding eigenvalues and eigenvectors										
CO4 Understand the numerical solution of ODE										
CO5 Understand solution of nonlinear equations										
CO6 Understand the different techniques of interpolation										
CO7 Understand the different techniques of numerical integration										
CO8 Learn about different techniques of matrix inversion and solution of system of linear equations										
CO9 Learn about different techniques of approximating the given function which is given in discrete form										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1	Computer Arithmetic: Floating point numbers and round off errors, Absolute and relative errors. Approximation: Different types of approximations, Least square polynomial approximation, polynomial approximation by use of orthogonal polynomials, approximation with Chebyshev polynomials	09	15	1, 2, 5	CO1 CO9	PSO1 PSO6	EMP	G	PE
2	Numerical differentiation Gaussian quadrature, Romberg integration, adaptive quadrature	09	15	1, 2, 5	CO2 CO7	PSO1, PSO6			
3	Algebraic Eigen value problem: Properties of eigenvalues and eigenvectors, Power method, Inverse power method, Jacobi's method, Given's method, Schur and Gershgorins theorem, Orthogonal factorization, QR algorithm for eigen value problem, Eigen values of complex matrix and complex eigenvectors	09	15	2, 4, 5	CO3	PSO1 PSO5			
4	Numerical Solution of ODE: Single step method-Runge Kutta methods, Multistep method - Milne Simpson's method	06	10	2, 4, 5	CO4	PSO1			
5	Matrix inversion: Matrix inversion , Jordan's method, Escalator method and Cholesky factorizations Solution of system of linear equations: Pivoting and constructing an algorithm based on Gaussian elimination method, solution of equations by iterative methods(Jacobi's method, Gauss-seidel method) LU factorizations System of nonlinear equations: Newton Raphson's method	15	25	2,5	CO5 CO8	PSO1 PSO6			
6	Polynomial Interpolation: Hermite's Interpolation formula with error analysis,Richardson Interpolation,Splines and spline Interpolation, Aitken Extrapolation	12	20	1,2,,5	CO6	PSO1			

Reference Books

1.	Introduction to Numerical Analysis, C.E. Froberg, Addison Wesley Publishing Company, sixth edition (1981)
2.	Introductory Methods of Numerical Analysis, S.S. Sastri, Prentice Hall of India, New Delhi (1997)
3.	Computer based numerical Algorithms, E.V. Krishnamurthy and S.K. Sen, East – West press Pvt. Ltd. (1976)
4.	Elementary Numerical Analysis: an algorithmic approach, Conte S.D and Carl deBoor, Mc Graw Hill company, Third edition (1981)
5.	Numerical analysis for scientists and Engineers, M.K. Jain, New Age International Ltd. Publishing (1992)
6.	Numerical methods, J.D.Faires and R. Burden, Brooks/Cole publishing Co., second edition (1998)

7.	Solving ordinary differential equations I and II, E.Hairer, E.P.Norsett and G.Wanner, Springer series in computational mathematics 8, Springer Berlin (1993)
8.	Introduction to Numerical Analysis, Stoer and Burlisch

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M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT2105: Ordinary Differential Equations	Credits / Hours per week				05			
Semester	I	Year of Introduction: 1974 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2105 CO1 Basic understanding of how any physical phenomena can be modeled by ordinary differential equations and difference equations. CO2 Understand existence and uniqueness of solutions in closed form and power series form. CO3 Gain a thorough understanding of the state transition matrix, its properties, its methods of computing and its role in the study of system dynamics. CO4 Qualitative analysis of a dynamical system using different tools, able to sketch a phase portrait of linear and non-linear one and two dimensional Systems of ODEs, Understand the phase plane analysis of the dynamical systems, Stability analysis of equilibrium solutions of linear systems. CO5 Linearization of non-linear systems, determine the stability of equilibrium solution of the nonlinear dynamical systems, limit cycles and there stability, bifurcation CO6 Sturm-Liouville eigen value problem, series solution of ODE's.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and

									Professional Ethics (PE)
Note: The topics (1-5) will be discussed for both continuous dynamical systems and discrete dynamical systems.									
1	- Mathematical modeling by means of ordinary differential equations and difference equations - Reduction of nth order equation into first order systems - Existence and uniqueness of solution of a nonlinear system of ordinary differential equations, Lipschitz condition, Gronwall's lemma.	16	26.72	1,2,3,4,5	CO1 CO2	PSO2 PSO4 PSO9 PSO15 PSO16 PSO17	EMP	G	PE
2	- Phase plane Analysis - Linearization of nonlinear systems - Autonomous and non-autonomous Linear system Theory: Linear Dependence and independence of solution, Wronskian.	10	16.7	1,2,3,5	CO4 CO5	Except PSO6 PSO12 PSO13 PSO18			
3	- Transition matrix(fundamental matrix) for a linear system, solution of a nonlinear system by variation of parameters method, - computation of transition matrix , eigenvalue method, Peano-Backer series method.	10	16.7	1,2,3,5	CO3	Except PSO6 PSO12 PSO13 PSO18			
4	Stability of dynamical systems, Lyapunov, exponential and asymptotic stability and their characterization.	10	16.7	1,2,3	CO4 CO5	Except PSO6 PSO12 PSO13 PSO18			
5	Sturm -Liouville equations, Eigenvalue problems	06	10.02	1,2,3	CO6	PSO2 PSO4 PSO9 PSO15 PSO16 PSO17			
6	Series solution of non-autonomous continuous systems, Bessel and Legendre series, Frobenius method	08	13.36	1,2,3,5	CO2	PSO2 PSO4			

						PSO9 PSO15 PSO16 PSO17 PSO10			
Reference Books									
1.	S.L. Ross	:	Differential equations, Blaisdell publishing company, First edition, 1964						
2.	Birkhoff G and Rota G.C	:	Ordinary differential equations, Boston, 1962						
3.	Coddington E. A	and N. Levinson :	Theory of ordinary differential equations, McGraw-Hill, New York, 1955.						
4.	Saber N. Elaydi	:	An introduction to Differential Equations, Springer- verlag, Second edition, 1995						
5.	V.I. Arnold	:	Ordinary Differential Equations, Prentice- Hall of India, New Delhi, 1998						
6.	Verhulst	:	Nonlinear Equations and Dynamical systems Walter ordinary Differential Equation.						

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Year	I	Core / Elective / Foundation AMT 2109L : Programming Practicals				Credits / Hours per week		03	
Semester	I	Year of Introduction: 1973 Year of Syllabus Revision: 2014				Maximum Marks / Grade		50	
Mode of Transaction		Term work, Practical and Viva							
No.	Experiment					Course Code	BT Level	CO	PSO
1	Practicals on Matlab programs: - Polynomial and matrix operations - Finding mean, median , mode and frequency distribution - Plotting Graphs					AMT 2124	1,2,3,6	CO6 CO7	PSO2 PSO3 PSO5
2	Operators: - Arithmetic operations on numbers, vectors and matrices - Area of circle, square ,rectangle and triangle - Volume of cube, cylinder ,cone - Simple and compound interest						1,2,3,6	CO6 CO7	PSO2 PSO3 PSO5
3	Control Structures: - Branching Structures: if, if – else, if – elseif – else and switch statements. - Looping Structures: do – while, while, for statements.						1,2,3,6	CO6 CO7	PSO2 PSO3 PSO7
4	To calculate series expansion of function(sin x, cos x, e ^x , etc.)						1,2,3,6	CO6 CO7	PSO2 PSO3 PSO7
5	Implementation of Numerical and Mathematical Algorithms computation : Using function file: To find out square root of the number using an iterative algorithm - Bisection Method, Runge-Kutta Method						1,2,3,6	CO6 CO7	PSO2 PSO3 PSO7
6	Trapezoidal Rule, Simpson’s Rule						1,2,3,6	CO6 CO7	PSO2 PSO3 PSO7
7	Numerical methods implementation using ‘C++’: Using function and class:						3,4,5,6	CO3 CO4	PSO5 PSO6 PSO7

	For obtaining roots of Non – linear equations: - Bisection Method - Regula Falsi Method - Newton Raphson Method					
8	For obtaining the approximate value of numerical integration: - Trapezoidal Rule - Simpson's 1/3rd Rule - Simpson's 3/8th Rule - Weddle's rule			3,4,5,6	CO3 CO4	PSO5 PSO6 PSO7
9	For solving the initial value problem: - Euler's Method			3,4,5,6	CO3 CO4	PSO5 PSO6 PSO7
10	For solving the linear system of equations: - Gauss Elimination - Gauss – Jacobi Method - Gauss – Seidal Method			3,4,5,6	CO3 CO4	PSO5 PSO6 PSO7
11	For obtaining the finite difference table and finding the value of y for an unknown x(not given in the table) using Interpolation - Newton – Forward Interpolation Formula - Newton – Backward Interpolation Formula - Langrange interpolation formula - Newton divided difference formula			3,4,5,6	CO3 CO4	PSO5 PSO6 PSO7
12	Operations on Complex Numbers using structure			1,2,3,4	CO3 CO4	PSO5 PSO6 PSO7
13	Area of circle, square ,rectangle and triangle,Volume of cube, cylinder ,cone,Simple and compound interest,Multiplication Table			1,2,3,4	CO3 CO4	PSO2 PSO3 PSO5
14	To calculate series expansion of function(sin x, cos x, e ^x , etc.)			1,2,3,4	CO3 CO4	PSO2 PSO3 PSO5

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT2204: Applied Analysis -II	Credits / Hours per week					05		
Semester	II	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2204 CO1 To be able to use the concepts of measurable set and measurable functions, concept the outer measure, measure, Lebesgue Measure, Measurable functions and its properties CO2 To be able to understand the integration of a measurable function over a measurable set, To be able to apply the theorems of monotone and dominated convergence and Fatou's lemma; CO3 To be able to understand the properties of LP-spaces, and Approximation theorems CO4 Understand the limitation of discontinuous function into series form and representation of function in Fourier series CO5 To learn about the representation of non periodic function into Fourier transform and to understand the properties of Fourier transform CO5 To learn about the representation of function given in discrete form in terms of discrete Fourier transform(DFT) ,properties of Fourier transform and algorithms of evaluating DFT using Fast Fourier Transform.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional

									Ethics (PE)
1	Measure spaces, Properties of measurable functions and measures, Lebesgue measure on $\mathbb{R}^k$. L^p spaces:	12	20	1,2,3,4,5	CO1	PSO2 PSO4 PSO5 PSO15 PSO16	EMP	G	PE
2	Integration of positive and complex functions, Convergence theorems and completion of a measure	12	20	1,2,3,4,5	CO2	PSO2 PSO4 PSO5 PSO15 PSO16			
3	Convex functions and inequalities, LP-spaces, Jensen, Holder and Minkowski inequalities. Approximation by continuous functions.	12	20	1,2,3,4,5	CO3	PSO2 PSO4 PSO5 PSO15 PSO16			
5	Fourier Series: Orientation of representation theory, Convergence of Fourier Series, Gibb's Phenomenon	6	10	1,2,3,4	CO4	PSO2 PSO4 PSO17 PSO23 PSO24 PSO26			
6	Fourier transform: Fourier integral and Fourier transform in $L^1(\mathbb{R})$, properties of Fourier transform, convolution, Riemann Lebesgue theorem, transforms of derivatives and derivatives of transforms, inversion theorem Fourier transform in $L^2(\mathbb{R})$, Parseval's formula and Plancherel's theorem DFT and FFT: definition and properties of DFT, description of FFT algorithms and examples	18	30	1,2,3,4	CO5 CO6	PSO2 PSO4 PSO17 PSO23 PSO24 PSO26	EMP	G	PE

Reference Books	
1.	Rudin Walter L : Real and Complex analysis, Mc Graw-Hill book company, Third edition
2.	H. L. Royden : Real analysis, The Macmillan company, NewYork, 1963
3.	Rechard Goldberg : Fourier Transform
4.	R. N. Bracewell : The Fourier transform and its applications
5.	G. P. Tolstov : Fourier series, Prentice-Hall, inc.

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.

PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.

PSO5. Demonstrate basic mathematical understanding and computational skills.

PSO6. Apply soft computing techniques.

PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimization techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

PSO14. Formulation of mathematical models and simulation of the problems in the real world.

PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands on practice for self-preparation and developing presentation skills through project and seminar.

PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year		2019-20					
M.Sc. (Applied Mathematics): Regular Programme											
Year	I	Core / Elective / Foundation AMT2201: Applied Statistics		Credits / Hours per week		05					
Semester	II	Year of Introduction: 2001 Year of Syllabus Revision: 2014		Maximum Marks / Grade		100					
Mode of Transaction		Lectures									
Course Outcome (CO) AMT2201 CO1:Implement how to translate uncertainty problems into probability models and will apply it directly in areas such as genetics, finance, telecommunications and biomathematics. CO2:Understand basic probability theory as well as be familiar with discrete and continuous random variables. CO3:Able to compute probabilities using various distributions and Chebisev’s inequality. CO4:Understand moments and moment generating functions of random variable. CO5:Classify Markov chain models and apply it to appropriate models. CO6:Able to analysis, classify and interpret data to answer questions about the real world problem. CO7:Understand data description, statistical inference, hypothesis testing, analysis of association and variance. CO8:Implement a proficiency in collection, organization, design, and drawing inferences from data using appropriate statistical methodology and problem solving skill. CO9:Able to demonstrate the ability to analyze data by appropriately fitting, assessing, and interpreting a variety of statistical models.											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nalEthics (PE)

1	Reorientation of probability, discrete and continuous random variable, cumulative distribution function. Binomial, Poisson and Normal distributions,	12	20	1,2,5	CO1 CO2 CO3	PSO4 PSO12	Emp	G	PE
2	Expectations, moments and moment generating functions.Law of large number,Chebyshev's inequality.	10	17	2,4	CO4	PSO3 PSO12			
3	Stochastic processes: Markov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, continuous Markov process. Hidden Markov chain with applications.	08	13	3,5	CO5	PSO6 PSO12			
4	Correlation, Regression and multiple regression using least square techniques,curve fitting,	08	13	1, 2, 3	CO6 CO9	PSO5 PSO2 PSO12			
5	Central limit theorem, confidence interval for mean , variance, chi-square test of goodness of fit, contingency tables, one population case, two population case, testing of hypotheses, small samples and large samples, sampling techniques, Simple random sampling with and without replacement, stratified sampling.	14	24	1,2,3,4,5	CO7 CO8	PSO5 PSO12			
6	Control charts for variables and attributes, acceptance sampling by attributes, simple, double and sequential sampling plans, Design of experiments.	08	13	1,2,3,5	CO6 CO8	PSO5 PSO12			

REFERENCES

1	Hogg and Tannis: Probability and Statistical inference, sixth edition, Prentice- Hall, Upper Saddle River, New Jersey, 2000
2	Larsen and Marx: An Introduction to Mathematical Statistics and its applications, Third edition, Prentice - Hall, Upper Saddle River, New Jersey, 2001
3	Mendenhall, Wackerly and Scheffer: Mathematical Statistics with applications, Third edition, PWS-KENT, Boston, 1996.
4	S. P. Gordon and F.S. Gordon: Contemporary Statistics, a computer approach, 1994

5	William Feller: An Introduction to Probability Theory and Its Applications, (Vol.I& II) John Wiley inc.
6	K. L. Chung: Elementary Probability Theory With Stochastic Processes, Springer-Verlag New York, Inc, testing of hypotheses, small samples and large samples

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

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PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

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PSO15. Inculcate their skills to deal with industrial problems.

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PSO17. Electives in the final year which elaborate prerequisite of the research field.

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PSO19. Training and Exposure to research literature and thesis writing through dissertation.

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT 2220 : Functional Analysis	Credits / Hours per week					05		
Semester	II	Year of Introduction: 1974 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Have Good knowledge of topics Normed linear space, Banach space and related theory. CO2 Describe bounded and unbounded operators on Banach spaces which can be applied in their application areas. CO3 Have good knowledge of contraction map, fixed point theorem and their application in obtaining solution of various mathematical systems CO4 Good understanding of the subject and are expected to successfully apply in the domain of its applications like existence of CO5 Explain the fundamental concepts of inner product spaces/Hilbert spaces and their role in Applied mathematics CO6 Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from functional analysis. CO 7 Apply problem solving using functional analysis technique applied to diverse situations in physics, engineering and other mathematical context.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Normed linear spaces, definition and examples, completeness, Banach spaces, Continuous linear mappings, Hahn-Banch theorem (for field of real numbers only).		10	16.7	1,2,4	CO1 CO2	PSO2 PSO9	EMP	G	PE
2	Equivalent norms, Riesz-lemma, compact sets in a normed linear space, Open mapping and closed graph theorem		10	16.7	1,2,4	CO1 CO2 CO4	PSO2 PSO9			

3	Banach's fixed point theorem and its application to solution of linear equations, differential equations and integral equations	8	13.6	1,2,3,4	CO3 CO4	PSO2 PSO9			
4	Hilbert spaces, Orthonormal sets, Orthogonal complements	12	19.6	1,2,3,4	CO5 CO6	PSO2 PSO3 PSO9			
5	Projection theorem, Riesz representation theorem, Bounded operators	10	16.7	1,2,3,4	CO5 CO6 CO7	PSO2 PSO3 PSO9			
6	Adjoint of an operator, normal, unitary and self adjoint operators, compact self-adjoint operators. Application to Sturm-Liouville problem and approximations.	10	16.7	1,2,3,4	CO5 CO6 CO7	PSO2 PSO3 PSO9			

Reference Books

1.	B.V. Limaye : Functional Analysis ,Wiley Eastern Ltd.
2.	G.F. Simmons : Introduction to Topology and Modern Analysis, McGraw – Hill
3.	E. Kreyszig : Functional Analysis and its application, John Wiley and sons.
4.	J.N. Sharma & A Vashistha: Functional Analysis.

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)

Programme Specific Outcome (PSO)

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
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- PSO17. Electives in the final year which elaborate prerequisite of the research field.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year				2019-20			
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT 2205: Mechanics	Credits / Hours per week				05			
Semester	II	Year of Introduction: 1974 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT 2205 CO1 Understand the basic concepts of mechanics in plane as well as in space CO2 Understand about the behavior of system of particles CO3 Understand about the generalized coordinates CO4 Study behavior of kinematics and dynamics of particles and rigid bodies CO5 Derive study and apply Lagrange’s equation of motion. CO6 Study Hamilton’s principle CO7 Derive study and apply Hamilton’s equation of motion.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Kinematic Equations of particle motion. Newton’s laws of motion. Basic vector & tensor results. General principles of mechanics. Statics: reductions of force Systems. Equilibrium of a		12	20	2, 3, 4	CO1	PSO3 PSO5	SD	G	PE

	system of particles and of rigid bodies.								
2	Generalized coordinates. Eulerian angles. Work, Potential Energy and the Principle of virtual work.	09	15	2, 3, 5	CO2	PSO3			
3	Kinematics of particles and rigid bodies: moments of inertia, kinetic energy and angular momentum	09	15	2, 5	CO3	PSO3 PSO5			
4	Dynamics of particle and a system of particles, moving frames of reference, Dynamics of a rigid body	06	10	2	CO4	PSO3 PSO5			
5	Euler's equation of motion, simple pendulum, spinning top, rigid body with a fixed point moving under no external forces. Work and energy methods applied to the motion of particles & rigid bodies. Impulsive motion and mechanical vibrations. Lagrange and Hamiltonian dynamics: Lagrange's equations for a particle in a plane.	14	23.33	1,2,3,5	CO5 CO6	PSO3 PSO5			
6	Hamilton's principle and principles of least action. Hamilton – Jacobi theory, action – angle variables. Maps & Chaos : Poincare map, logistic map and Poincare- Birkhoff theorem.	10	16.67	1,2,3,5	CO6 CO7	PSO3 PSO5			

Reference Books

1.	A textbook of Quantum Mechanics, P. M. Mathews and K. Venkatesan, Tata McGraw Hill (2007)
2.	Introduction to quantum mechanics, D. J. Griffiths, Pearson Education International (2005)
3.	Feynman Lecture Series: R P Feynman, R B Leighton and M. Sands (2005)
4.	Quantum mechanics (2nd edition), E. Merzbacher, J. Wiley (1970)
5.	Thermodynamics, Kinetic theory and statistical thermodynamics, Sears and Salinger, Narosa Publishing House, 1989.
6.	Statistical Mechanics & Properties of matter: E. R. Gopal.
7.	Fundamentals of Statistical and thermal Physics : F. Reif.
8.	Classical Mechanics, Addison-Wesley Publishing Co., 1980: Herbert Goldstein

AMT 2205. MECHANICS

Dynamics of a rigid body, Euler's equation of motion, simple pendulum, spinning top, rigid body with a fixed point moving under no external forces.

Work and energy methods applied to the motion of particles & rigid bodies.

Impulsive motion and mechanical vibrations.

Lagrange and Hamiltonian dynamics: Lagrange's equations for a particle in a plane.

Hamilton's principle and principles of least action.

Hamilton – Jacobi theory, action – angle variables

Maps & Chaos : Poincare map, logistic map and Poincare- Birkhoff theorem.

Reference Books:

1. John L. Synge,
: Byron A.Griffith
Herbert Goldstein
: “Principles of Mechanics”, McGraw-Hill Book Co., 1960.
2. R. G. Takwale,
: “Classical Mechanics”, Addison-Wesley Publishing Co.,1980
3. P. S. Puranik,
: “Introduction to Classical Mechanics”,Tata McGraw-Hill Publishing Co., 1979
4. Marion and Thornton
: “Classical Dynamics of Particles and Systems”, Harcourt; 4th edition (January 17, 1995).
5. Robert C. Hilborn,
: “Chaos and Nonlinear Dynamics : An Introduction for Scientists and Engineers”, Oxford University Press, USA (January 1, 1994)

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year					2019-20			
M.Sc. (Applied Mathematics): Regular Programme										
Year	I	Core / Elective / Foundation AMT 2203 : PARTIAL DIFFERENTIAL EQUATIONS	Credits / Hours per week					05		
Semester	II	Year of Introduction: 1974 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Able to use knowledge of partial differential equations (PDEs), modelling, and analytic methods for solutions. CO2 Able to formulate physical problems as PDEs using conservation laws. CO3 Able to understand analogies between mathematical descriptions of wave phenomena in physics and engineering. CO4 Able classify PDEs, apply analytical methods, and physically interpret the solutions. CO5 Able interpret solutions in a physical context, such as identifying travelling waves, standing waves, and shock waves. CO6 Understanding existence, Uniqueness and other properties of a solution of differential equations CO7 Know and be able to use fundamental solutions and Greens’s function for various types of equations CO8 Know how to use the maximum principle for Elliptic and Parabolic Partial differential equations and be familiar with distributions, sobolov spaces and Embedding theorems CO9 Know variation formulations of Elliptic problems and existence theorems for general problems; Lax-Miligram theorem and Energy Estimate, Fredholm alternatives, poincare’s inequility and error estimate(FEM); CO10 Be familiar with existence theorems for general Parabolic and Hyperbolic PDE and related solutions methods CO11 Be able to understand the method of characteristics to find the solution of partial differential equations CO12 Be able to understand weak solution, Shock solution and rarefaction solution of Burger equation and first order scaler Hyperbolic PDE										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1.	Introduction to PDE: - Modelling Problems related to PDE. - General II order PDE, Classification of PDE -hyperbolic, elliptic and parabolic PDE - Canonical form	8	13.6	1,2,3	CO1 CO4	PSO1 PSO2 PSO4 PSO14 PSO15 PSO16 PSO18	Emp	G	PE
2	Hyperbolic PDE - Boundary conditions, well-posed problem, - The Cauchy-Kowalewski theorem for existence and uniqueness of solutions to PDE - Scalar first order Partial differential equations - Method of Characteristics, - Compatible system of I order PDE, - Charpits method, - Weak Solutions.	10	16.7	2,4,5	CO2 CO3 CO10 CO11 CO12	PSO1 PSO2 PSO3 PSO4 PSO9 PSO10 PSO15			
3	Hyperbolic PDE - Quasi-linear first order equations and quasi-Linear systems of partial differential equations, - weak solutions, shocks and rerefactions - Burgers equation, - Non-uniqueness and entropy conditions, - Wave equation	10	16.7	2,4,5	CO2 CO3 CO5 CO11 CO12	PSO1 PSO2 PSO3 PSO4 PSO9 PSO10 PSO12 PSO15 PSO16 PSO17			
4	Elliptic PDE Solution of Laplace equation using	10	16.7	2,4,5	CO7 CO8 CO9	PSO1 PSO2 PSO3 PSO4			

[illegible]

9.	M.Junk: Analytical and Numerical Methods for Partial differential equations,
10.	Lecturer notes, University of Kaiserslautern, 1999
11.	D.Gilbarg and N.S. Trudinger: Elliptic Partial differential equations of second order.

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome (PSO)**

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics			Academic Year	2019-20	
M.Sc. (Applied Mathematics): Regular Programme						
Year	I	Core / Elective / Foundation AMT 2224L : Practicals on Numerical Analysis and Statistical methods	Credits / Hours per week		03	
Semester	I	Year of Introduction: 1973 Year of Syllabus Revision: 2014	Maximum Marks / Grade		50	
Mode of Transaction		Term work, Practical and viva				
Course outcome (CO) AMT2224L CO1 Study numerically eigenvalues problems and different methods for finding eigenvalues and eigenvectors CO2 Understand the numerical solution of ODE CO3 Understand the different techniques of interpolation CO4 Understand the different techniques of numerical integration CO5 Learn about different techniques of matrix inversion and solution of system of linear equations CO6 Learn about different techniques of approximating the given function which is given in discrete form CO7 Able to compute probabilities using various distributions CO8 Able to analysis, classify and interpret data to answer questions about the real world problem CO9 Understand data description, statistical inference, hypothesis testing, analysis of association and variance CO10 Implement a proficiency in collection, organization, design and drawing inferences from data using appropriate statistical methodology and problem solving skill CO11 Able to demonstrate the ability to analyze data by appropriately fitting, assessing, and interpreting a variety of statistical models						
No.	Practical		Course Code	BT Level	CO	PSO
	<u>NUMERICAL ANALYSIS: (BY USING OBJECT ORIENTED PROGRAMMING)</u>		AMT2224L	1,2,3,5		
1	Interpolation				CO3	PSO1
2	Integration with Newton cote's, Gauss quadrature				CO4	PSO1,PSO6
3	Definition of a class for a matrix with the following members: Number of rows, number of columns and a two dimensional array of numbers as attributes with methods for transpose of the matrix, determinant of the matrix, for finding largest eigen value (power method),etc.				CO1	PSO1,PSO5
4	Implementing matrix inversion by Jordan & Escalator methods in the matrix class.				CO5	PSO1,PSO6
5	Romberg Integration				CO4	PSO1,PSO6
6	Least Square method: fitting a straight line, and second degree curve				CO6	PSO6
7	Solution of ODE through Euler, modified Euler, Runge-kutta and Milne-Simpson's method.				CO2	PSO1

	<u>STATISTICAL METHODS : (BY USING OCTAVE / MATLAB)</u>				
8	Given a set of data, set up various graphical representation of data, Bar diagram, Histogram, Pie charts, frequency polygon etc			CO8	PSO5, PSO12
9	Given a set of data, calculate the various features of central tendency, measures of dispersion			CO8	PSO6, PSO12
10	Given a large population, take samples from it, using various sampling technique			CO9 CO10	PSO5, PSO12
11	Calculate Correlation Coefficient between two sets of data points, plot regression lines			CO8 CO11	PSO5, PSO12
12	Fitting of curves, Multiple regression techniques to linear and nonlinear problems			CO8 CO11	PSO5, PSO12
13	Testing of Hypothesis: Practical examples			CO9 CO10	PSO5, PSO12
14	Confidence interval for mean, proportions			CO9 CO10	PSO5, PSO12
15	Simulation of Poisson, Binomial and Normal distribution			CO7	PSO5, PSO12
16	Examples with small samples and large samples			CO9	PSO4, PSO12

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1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics))

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PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimisation techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

PSO14. Formulation of mathematical models and simulation of the problems in real world.

PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands-on practice for self preparation and developing presentation skills through project and seminar.

PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core/ Elective / Foundation AMT2308: Applied Fourier Analysis	Credits / Hours per week					05		
Semester	I	Year of Introduction:2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2308 CO1 Understanding the limitations of expansion of discontinuous function into series and introduction to basic concepts and techniques concerning trigonometric sums. CO2 To learn about the concepts like orthogonality, orthonormality, completeness of system of functions in L^2 space and minimum property of Fourier coefficients with respect to general orthonormal system. CO3 To learn about the behavior of Fourier coefficients depending on nature of a function. Basic properties of Fourier coefficients, uniqueness of Fourier coefficients, convergence test for Fourier series, Cesaro summability and related theorems, absolute and uniform convergence. CO4 Understanding the concept of completeness of Orthogonal system with reference to system of Walsh functions, techniques of deriving Walsh functions. CO5 Introduction to other orthogonal functions like block pulse functions, Haar functions. CO6 Extending the idea of Fourier transform to transforms using orthogonal functions like Walsh and Haar.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	Trigonometric series and Fourier series, Wave forms trigonometric polynomials, Sine and Cosine series with monotone coefficients, Evaluation of Fourier Coefficients when function is given in the form of a discrete data.	07	11.7	1,2	CO1	PSO3	Emp	G	PE
2	L^p - spaces, Orthonormal systems, Complete orthonormal system, Riesz-Fischer Theorem, Bessel's inequality, Parseval's inequality.	07	11.7	1,2	CO2	PSO1, PSO5			
3	Functions of bounded variation, Order of Fourier coefficients, Basic properties of Fourier coefficients, Riemann-Lebesgue lemma, Uniqueness of Fourier coefficients, Completeness of trigonometric systems. Partial sums of Fourier series and their rate of growth, Riemann's Principle of Localization, Convergence tests for Fourier series, Dini's and Jordan's test.	20	33.3	2, 3, 4	CO3	PSO1 PSO2 PSO4 PSO5 PSO9			
4	Cesaro summability of Fourier series, Fejer's Theorem, Fejer-Lebesgue theorems, Estimates of partial sums. Uniform convergence, Absolute convergence, Lusin-Denjoy Theorem.	10	16.6	1,2, 3, 4	CO4	PSO3			
5	Walsh function series: Definition of Walsh series, Relation between Fourier and Walsh series, Function ordering, Walsh function derivation, Wave form synthesis using Walsh & Fourier series.	07	11.7	1,2,3,4	CO4	PSO3			
6	The Haar Function: Definition, Relation between Walsh and Haar functions, The Fast Haar Transforms, Two dimensional Haar transformation, The Haar Power Spectrum. Walsh transformation: Definition, Comparison with Discrete Fourier Transform, Conversion between Discrete Walsh and Fourier transformation, The Fast Walsh Transform, The generalized transform. Applications in Communications and Signal Processing.	09	15	1,2,3	CO6	PSO1 PSO3			

Reference Books		
1.	Charles Sparks Rees, S.M.Shah, C. V. Stanojevic	: Theory and applications of Fourier Analysis, Marcel Dekkar, Inc. New York.
2.	Rajendra Bhatia	: Fourier Series, Hindustan Book Agency, Delhi.
3.	N. K. Bary	: A Treatise on Trigonometric Series, Pergamon Press.
4.	A. Zygmund	: Trigonometric Series, Cambridge Press.
5.	Hwei P. Hsu, Haroourt Brace Jovanovich:	: Applied Fourier Analysis, New York
6.	K. G. Beauchhamp,	: Walsh Functions and their applications Academic Press..
7.	E. Oran Brigham,	The Fast Fourier Transform Prentice Hall of India

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.

PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.

PSO5. Demonstrate basic mathematical understanding and computational skills.

PSO6. Apply soft computing techniques.

PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimization techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

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PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands on practice for self-preparation and developing presentation skills through project and seminar.

PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT2303: Fluid Dynamics	Credits / Hours per week					05		
Semester	I	Year of Introduction: 2001 Year of Revision of Syllabus: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2303 CO1 To be able to understand the basics for Fluid Dynamics. To be able to Classify and exploit fluids based on the physical of a fluid, To be able to compute the Kinematical properties of a fluid element. CO2 To be able to apply the conservation principles of mass, linear momentum, and energy to fluid flow systems. To be able to understand flow equations with applications. CO3 To be able to understand the Navier-Stokes’ equation, and Demonstrate the ability to model inviscid, steady fluid flow. CO4 To be able to understand the complex Potential flow and related applications CO5 To be able to understand the viscous incrompressible flow using Navier- Stokes equation. CO6 To be able to understand the Boundary layer and its application CO7 To be able to solve Industry related flow problems.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal

									Ethics (PE)
1	Review of vector notation and vector operators in various coordinate systems. Brief outline of Cartesian Tensor Analysis. Properties of second order tensors. Fundamental equation of fluid statics and derivation of Hydrostatic equation and Torricelli's Principle.	08	13.36	1, 2	CO1	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16	EMP	G	PE
2	Fluid kinematics: Flow description using Lagrangian and Eulerian methods. Stream lines and path lines. Material derivative and fluid acceleration, vorticity. Equation of continuity in cartesian and general vector form. Expression in cylindrical and spherical coordinates, stream tube flow. Boundary conditions. Euler's equation of motion in general vector form and derivation of Bernoulli's equation. Application to flow through orifices, Pitot's tube and Venturi meter.	10	16.7	1, 2, 3	CO2	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
3	Navier Stokes equations : General theory of stress and rate of strain in fluid flow. Nature of stresses. Transformation of stress components. Nature of strains. Transformation of rates of strain. Derivation of the Navier-stokes equations. Derivation of Euler's equations as a special case of Navier – Stokes equation. potential, the harmonic oscillator, multiple potential wells, splitting of energy levels, energy bands	10	16.7	1, 2, 3, 5	CO3	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
4	Potential flow of ideal fluids : - Velocity potential and irrotational flow, circulation and Kelvin's theorem, flows with axial symmetry - Three dimensional singularities. Image systems. Stoke's stream function. Singularities in two-dimensional flow. Stream function in two dimensions.	10	16.7	1, 2, 3, 4, 5	CO5	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
5	- Complex velocity potential. - Flow net. Superposition of simple flows. Rankine's method	08	13.36	1, 2, 3, 4, 5	CO4	PSO2 PSO3			

	- for construction of stream lines. - Indication of the use of complex analysis and conformal transformations in flow problems.					PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
6	- Laminar flow of viscous incompressible fluids. Similarity of flows – Reynold's and Froude number. - Flow between parallel plates – Couette flow and plane Poiseuille flow. - Hagen – Poiseuille flow through pipes.	10	16.7	1, 2, 3, 4, 5	CO5	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
7	Laminar boundary layer : - Definition of boundary layer - Boundary layer equations in two- dimensional flow. - Blasius solution for the boundary layer along a flat plate.	04	6.68	1, 2, 3, 4, 5	CO6 CO7	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			

Reference Books

1.	Foundations of fluid Mechanics, S. W. Yuan, Prentice – Hall International (1970)
2.	Ideal and Incompressible fluid dynamics, M. E. O'Neill and F. Chorlton John Wiley & Sons (1986)
3.	An Introduction to Fluid Dynamics, Batchelor G. K, Cambridge University Press (1999)
4.	Analytical Fluid Dynamics, Emanuel G, CRC Press, Boca Raton, Second edition, FL (1999)
5.	Incompressible Flows, Panton R. L., Wiley Interscience (1984)
6.	Fundamental Mechanics of Fluids, Currie I. G, McGraw-Hill, New-york (1993)
7.	Mathematical introduction to Fluid Mechanics, Chorin, Springer Verlag, Fourth edition
8.	Textbook of Fluid Dynamics, F. Chorlton, Van Nostrand (1967)

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics))

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core/ Elective / Foundation AMT2308: Applied Fourier Analysis	Credits / Hours per week					05		
Semester	I	Year of Introduction:2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2308										
CO1 Understanding the limitations of expansion of discontinuous function into series and introduction to basic concepts and techniques concerning trigonometric sums.										
CO2 To learn about the concepts like orthogonality, orthonormality, completeness of system of functions in L^2 space and minimum property of Fourier coefficients with respect to general orthonormal system.										
CO3 To learn about the behavior of Fourier coefficients depending on nature of a function. Basic properties of Fourier coefficients, uniqueness of Fourier coefficients, convergence test for Fourier series, Cesaro summability and related theorems, absolute and uniform convergence.										
CO4 Understanding the concept of completeness of Orthogonal system with reference to system of Walsh functions, techniques of deriving Walsh functions.										
CO5 Introduction to other orthogonal functions like block pulse functions, Haar functions.										
CO6 Extending the idea of Fourier transform to transforms using orthogonal functions like Walsh and Haar.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	Trigonometric series and Fourier series, Wave forms trigonometric polynomials, Sine and Cosine series with monotone coefficients, Evaluation of Fourier Coefficients when function is given in the form of a discrete data.	07	11.7	1,2	CO1	PSO3	Emp	G	PE
2	L^p - spaces, Orthonormal systems, Complete orthonormal system, Riesz-Fischer Theorem, Bessel's inequality, Parseval's inequality.	07	11.7	1,2	CO2	PSO1, PSO\$			
3	Functions of bounded variation, Order of Fourier coefficients, Basic properties of Fourier coefficients, Riemann-Lebesgue lemma, Uniqueness of Fourier coefficients, Completeness of trigonometric systems. Partial sums of Fourier series and their rate of growth, Riemann's Principle of Localization, Convergence tests for Fourier series, Dini's and Jordan's test.	20	33.3	2, 3, 4	CO3	PSO1 PSO2 PSO4 PSO5 PSO9			
4	Cesaro summability of Fourier series, Fejer's Theorem, Fejer-Lebesgue theorems, Estimates of partial sums. Uniform convergence, Absolute convergence, Lusin-Denjoy Theorem.	10	16.6	1,2, 3, 4	CO4	PSO3			
5	Walsh function series: Definition of Walsh series, Relation between Fourier and Walsh series, Function ordering, Walsh function derivation, Wave form synthesis using Walsh & Fourier series.	07	11.7	1,2,3,4	CO4	PSO3			
6	The Haar Function: Definition, Relation between Walsh and Haar functions, The Fast Haar Transforms, Two dimensional Haar transformation, The Haar Power Spectrum. Walsh transformation: Definition, Comparison with Discrete Fourier Transform, Conversion between Discrete Walsh and Fourier transformation, The Fast Walsh Transform, The generalized transform. Applications in Communications and Signal Processing.	09	15	1,2,3	CO6	PSO1 PSO3			

Reference Books		
1.	Charles Sparks Rees, S.M.Shah, C. V. Stanojevic	: Theory and applications of Fourier Analysis, Marcel Dekkar, Inc. New York.
2.	Rajendra Bhatia	: Fourier Series, Hindustan Book Agency, Delhi.
3.	N. K. Bary	: A Treatise on Trigonometric Series, Pergamon Press.
4.	A. Zygmund	: Trigonometric Series, Cambridge Press.
5.	Hwei P. Hsu, Haroourt Brace Jovanovich:	: Applied Fourier Analysis, New York
6.	K. G. Beauchhamp,	: Walsh Functions and their applications Academic Press..
7.	E. Oran Brigham,	The Fast Fourier Transform Prentice Hall of India

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

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PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

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PSO17. Electives in the final year which elaborate prerequisite of the research field.

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT2303: Fluid Dynamics	Credits / Hours per week					05		
Semester	I	Year of Introduction: 2001 Year of Revision of Syllabus: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2303 CO1 To be able to understand the basics for Fluid Dynamics. To be able to Classify and exploit fluids based on the physical of a fluid, To be able to compute the Kinematical properties of a fluid element. CO2 To be able to apply the conservation principles of mass, linear momentum, and energy to fluid flow systems. To be able to understand flow equations with applications. CO3 To be able to understand the Navier-Stokes’ equation, and Demonstrate the ability to model inviscid, steady fluid flow. CO4 To be able to understand the complex Potential flow and related applications CO5 To be able to understand the viscous incrompressible flow using Navier- Stokes equation. CO6 To be able to understand the Boundary layer and its application CO7 To be able to solve Industry related flow problems.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal

									Ethics (PE)
1	Review of vector notation and vector operators in various coordinate systems. Brief outline of Cartesian Tensor Analysis. Properties of second order tensors. Fundamental equation of fluid statics and derivation of Hydrostatic equation and Torricelli's Principle.	08	13.36	1, 2	CO1	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16	EMP	G	PE
2	Fluid kinematics: Flow description using Lagrangian and Eulerian methods. Stream lines and path lines. Material derivative and fluid acceleration, vorticity. Equation of continuity in cartesian and general vector form. Expression in cylindrical and spherical coordinates, stream tube flow. Boundary conditions. Euler's equation of motion in general vector form and derivation of Bernoulli's equation. Application to flow through orifices, Pitot's tube and Venturi meter.	10	16.7	1, 2, 3	CO2	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
3	Navier Stokes equations : General theory of stress and rate of strain in fluid flow. Nature of stresses. Transformation of stress components. Nature of strains. Transformation of rates of strain. Derivation of the Navier-stokes equations. Derivation of Euler's equations as a special case of Navier – Stokes equation. potential, the harmonic oscillator, multiple potential wells, splitting of energy levels, energy bands	10	16.7	1, 2, 3, 5	CO3	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
4	Potential flow of ideal fluids : - Velocity potential and irrotational flow, circulation and Kelvin's theorem, flows with axial symmetry - Three dimensional singularities. Image systems. Stoke's stream function. Singularities in two-dimensional flow. Stream function in two dimensions.	10	16.7	1, 2, 3, 4, 5	CO5	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
5	- Complex velocity potential. - Flow net. Superposition of simple flows. Rankine's method	08	13.36	1, 2, 3, 4, 5	CO4	PSO2 PSO3			

	- for construction of stream lines. - Indication of the use of complex analysis and conformal transformations in flow problems.					PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
6	- Laminar flow of viscous incompressible fluids. Similarity of flows – Reynold's and Froude number. - Flow between parallel plates – Couette flow and plane Poiseuille flow. - Hagen – Poiseuille flow through pipes.	10	16.7	1, 2, 3, 4, 5	CO5	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			
7	Laminar boundary layer : - Definition of boundary layer - Boundary layer equations in two- dimensional flow. - Blasius solution for the boundary layer along a flat plate.	04	6.68	1, 2, 3, 4, 5	CO6 CO7	PSO2 PSO3 PSO4 PSO5 PSO6 PSO9 PSO14 PSO15 PSO16			

Reference Books

1.	Foundations of fluid Mechanics, S. W. Yuan, Prentice – Hall International (1970)
2.	Ideal and Incompressible fluid dynamics, M. E. O'Neill and F. Chorlton John Wiley & Sons (1986)
3.	An Introduction to Fluid Dynamics, Batchelor G. K, Cambridge University Press (1999)
4.	Analytical Fluid Dynamics, Emanuel G, CRC Press, Boca Raton, Second edition, FL (1999)
5.	Incompressible Flows, Panton R. L., Wiley Interscience (1984)
6.	Fundamental Mechanics of Fluids, Currie I. G, McGraw-Hill, New-york (1993)
7.	Mathematical introduction to Fluid Mechanics, Chorin, Springer Verlag, Fourth edition
8.	Textbook of Fluid Dynamics, F. Chorlton, Van Nostrand (1967)

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year		2019-20					
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT2309 : MATHEMATICAL CONTROL THEORY –I	Credits / Hours per week				05			
Semester	I	Year of Introduction: 2007 Year of Syllabus Revision: 2019	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2309										
CO1 Use advanced mathematical techniques to formulate and solve control problems										
CO2 Identify practical challenges in posing control problems										
CO3 The student will demonstrate an understanding of the characteristics of feedback control systems and how to apply them										
CO4 The student will demonstrate an understanding of stability of linear feedback systems										
CO5 Understand and discuss Controllability and Observability.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Mathematical Description of Control Theory and - Basic Definition - Mathematical Modeling of control system - State space approach and Frequency Domain Approach - Linearization of Nonlinear systems		8 hrs	13.6%	1,2,3	CO1	PSO9 PSO14	EMP	G	PE

2	Solution of Control systems using Transitions Matrix - Fundamental matrix solution and Transition matrix for linear homogeneous systems - Properties of Transition matrix - Computation of transition matrix for Time invariant systems - Solution of non-homogeneous system	10 hrs	16.6%	1,2,4,5	CO2	PSO1 PSO9			
2	Controllability and Reachability of Linear systems - Solution of non-homogeneous system - Definition and particular cases of controllability - Complete characterization of controllability - Characterization using the theory of Linear operators	10 hrs	16.6%	1,2,4,5	CO2 CO3	PSO1 PSO9			
3	Controllability of time invariant system - Kalman's Rank condition for controllability of Time invariant systems - Algebraic characterization for controllability - Kalman controllability Decomposition of linear systems - Controllability of Jordon Form Systems	10 hrs	16.6%	1,2,4,5	CO2 CO3	PSO1 PSO9 PSO10			
4	Observability - Definition of Observability of Linear Systems - Characterization of observability using operator theory - Reconstruction of initial state from observations - Kalman's Rank condition for observability - Duality between Observability and	10 hrs	16.6%	1,2,4,5	CO5	PSO1 PSO9 PSO10			

	controllability								
6.	Stability and Stabilization - Stability of Dynamical Systems - Definition of Laypunov Stability, Asymptotic Stability and Exponential Stability and Examples - Lyapunvo Theorems of Stability - Stability Analysis of Linear Time invariant systems using spectrum of system matrix - Stability of systems - Feedback control and stabilizability conditions - LMI Tools in MATLAB for Stability Analysis	12 hrs	20%	1,2,4	CO4	PSO1 PSO9			
Reference Books									
1.	Sontag E D : Mathematical control theory – Deterministic Finite Dimensional Systems, Springer, NY 2002.								
2.	Russell D L : Mathematics of Finite Dimensional Control Systems, Marcel Dekker, NY, 1979.								
3.	Brockett R W : Linear systems, John Wiley, 1985.								
4.	Joshi M C : Differential Equations, A modern Perspective, Narosa Publ. 2004								
5.	Chen, C T Chen: Linear System Theory and Design, Henry Holt, 1995								
6.	William J. Terrell: Stability and Stabilizability, Princeton University Press, 2009.								
7.	Balachandran K: and Dauer J P: Elements of Control Theory, Narosa Publ. House, 2001								

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
- PSO2. Assimilate complex mathematical ideas and arguments.
- PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.
- PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.
- PSO5. Demonstrate basic mathematical understanding and computational skills.
- PSO6. Apply soft computing techniques.
- PSO7. Implement various algorithms using advanced Object Oriented Programming languages.
- PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.
- PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.
- PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.
- PSO11. Use appropriate software to solve practical problems.
- PSO12. Employ advanced statistical and optimisation techniques.
- PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.
- PSO14. Formulation of mathematical models and simulation of the problems in real world.
- PSO15. Inculcate their skills to deal with industrial problems.
- PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.
- PSO17. Electives in the final year which elaborate prerequisite of the research field.
- PSO18. Hands-on practice for self preparation and developing presentation skills through project and seminar.
- PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics) Regular Programme										
Year	II	Core / Elective / Foundation AMT 2301: Numerical Methods for Partial Differential Equations	Credits / Hours per week					05		
Semester	I	Year of Introduction:2001 Year of Revision of Syllabus: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT 2301 CO1: To learn about finite difference approximation to partial derivatives and the solution of Partial Differential Equation (PDE) using different algorithms using Finite difference of parabolic PDE. CO2 :To learn about the Solution of hyperbolic and elliptic PDE using finite difference algorithms and their convergence and stability CO3 : To be able to Understand the general steps of finite element methods, To be able to understand the Engineering aspects for FEM CO4 : To be able to Understand the basic finite element formulation techniques. To be able to understand the mathematical methods for FEM in one and dimension and three dimension, be able to formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics. CO5 : Understanding of FEM Open source software/License software CO6 : Understanding of application of FEM software to industrial problems related to BVP and IVP-BVP CO7 : Advantages of FEM over other Methods										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics

									(PE)
1	<u>FINITE DIFFERENCE METHOD</u> Numerical methods for parabolic PDE - Finite difference method: Explicit methods, implicit methods and Crank- - Nicolson implicit method, Stability, Convergence and error of these methods, Predictor -Corrector methods	14	23.3	1,2,5	CO1	PSO1 PSO6	Emp	G	PE
2	Numerical methods for hyperbolic PDE - Explicit methods, implicit methods, stability, convergence and error of these methods, - Method of characteristics, Lax-Wendroff method, method of artificial viscosity, Courant – Friedrichs - Lewy condition. Numerical Methods for elliptic PDE : - Numerical solutions of Laplace and Poisson equation using forward difference scheme and its error.	10	16.7	1,2,5	CO2	PSO1, PSO6			
3	<u>FINITE ELEMENT METHOD</u> - Introduction, Advantages of FEM over other methods, Basic steps in FEM, Springs in series analogy, Understanding about weak solution, Relay Ritz Method - Different approaches in FEM formulation, Variational and Galerkin's approach. Descretization of problem, Descretization of geometry - Element types, Shape functions, Element equations, Assembly procedure, Imposition of Essential boundary conditions, Properties of assembled matrix, Methodology for solving system of equations. - Formulation of the FEM for elliptic problems	16	26.72	1,2,3,4,5	CO3 CO4 CO5 CO6 CO7	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			

	Variational and Galerkin formulation <u>Finite element discretizations in 1D</u> - Variational approach - Galerkin approach								
4	<u>Finite element discretization in 2D</u> - A FEM for Poisson's equation, steady state heat equation, General second order pde - Galerkin approach Second order pde in different domain with physical parameter's description.	10	16.7	1,2,3,4,5	CO3 CO4 CO5 CO6	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			
5	Formulation of the FEM for elliptic problems Variational and Galerkin Formulation	06	10.02	1,2,3,4,5	CO3 CO4 CO5 CO6	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			
6	FEM as a tool for solving boundary value problems	04	06.68	1,2,3,4,5		PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16			

						PSO17			
Reference Books									
1.	G.D Smith	:	Numerical solution of Partial Differential Equations: FiniteDiffernce Methods, Third edition, Oxford University Press, 1986.						
2.	K. W. Morton and D. F. Mayers	:	Numerical solution of Partial Differential Equations, Cambridge University Press, New York, 1993						
3.	A. R. Mitchell and D. F. Griffiths	:	The Finite Difference Methods in Partial Differential Equations, Wiley, April, 2001						
4.	A. Quarteroni and A. Valli	:	Numerical Approximation of Partial Differential Equations, Springer, 1994						
5.	S. Brenner and L.R.Scott	:	The Mathematical theory of Finite element methods, Springer-Verlag, 1994						
6.	C.Johnson	:	Numerical solution of partial differential equations by the FEM, Cambridge University Press, 1994.						
7.	Cook, Malkus and Plesha	:	Concepts and Applications of finite element analysis, Third edition , John Wiley and sons, 1989.						
8.	B. Szabo and I. Babuska	:	Finite element analysis, Wiley and Sons,1991.						
9.	K.H. Huebner	:	The Finite element Method for Engineers, John Wile and Sons, 1975.						
10.	J.N Reddy	:	An introduction to Finite Element Method, , MacGrawHill						

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.

PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.

PSO5. Demonstrate basic mathematical understanding and computational skills.

PSO6. Apply soft computing techniques.

PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimization techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

PSO14. Formulation of mathematical models and simulation of the problems in the real world.

PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands on practice for self-preparation and developing presentation skills through project and seminar.

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year		2019-20					
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT 2304:OPTIMIZATION I	Credits / Hours per week				05			
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) : AMT 2304 CO1: Able to formulate and choose appropriate methodology to solve an optimization problem according the classification in terms of Linear/Non-Linear, Single Variable/Multi-Variable, With Constraint/Without Constraint. CO2: Understand and can successfully apply the classical theory of optimization, to solve various problems which belongs to classes; viz. single/multivariate problems without constraints, Lagrange method for problems having equality constraints and theory of Kuhn-Tucker for problems having inequality constraints. CO3: Able to choose and apply an appropriate method from various methods designed for single variable optimization problems. CO4: Develops an ability to choose appropriately from various available methods designed for solving Multivariable optimization problems (Unconstrained and Constrained) and apply them successfully for desired solution. CO5: Apply optimization methods to various real life areas, engineering problems , industrial problems CO6: Interpreting results and effects of change in the structure or parameters of Optimization problems. CO7:Understand and apply constrained optimization theory for continuous problems, involving integer solutions or including the Kuhn-Tucker conditions for quadratic programming.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

									Professional Ethics (PE)
1	Optimization problems in engineering and industries Optimization problem formulation Classification of optimization problem Classical optimization techniques Single variable optimization, Multivariable optimization, Constrained optimization: Lagrangian multiplier method, Kuhn-Tucker conditions.	16	26	1,3,4	CO1 CO2	PSO2 PSO4 PSO5	Emp SD	G	PE
2	Single variable optimization techniques Bracketing method - Exhaust search Region elimination method - Interval halving method, Golden section method, Interpolation method - Quadratic interpolation method, Gradient based methods – Newton's method, bisection method.	10	17	2,3,5	CO3	PSO5 PSO9 PSO12			
3	Multivariable optimization techniques (Unconstrained and Constrained) Univariate method, Direct Search method - Simplex search method, Powell's conjugate direction method, Gradient based methods - steepest descent (Cauchy) method, conjugate gradient (Fletcher-Reeves) method, Box complex method, Sequential linear programming method, Interior and Exterior Penalty function methods	10	17	3,4,5	CO4	PSO9 PSO15 PSO12			
4	Constraint linear optimization problem Overview of linear optimization problem Sensitivity analysis	10	17	2,4,5	CO5	PSO12 PSO14			
5	Quadratic programming Wolf's modified simplex method Broyden's methods	08	13	1,2,5	CO6	PSO12			
6	Integer programming problem Gomory's cutting plane method branch and bound techniques	06	10	1,2,3,5	CO7	PSO12			
Reference Books									
1.	Rangrajan K. Sundaram: A first Course in Optimization Theory, Cambridge University Press, First edition, 1996.								
2.	S. S. Rao: Engineering Optimization (Theory and Practice), New Age International Publishers, New Delhi, Third edition, 2001.								
3.	Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Wiley-India publishers, Second edition, 2001.								

4.	Mohan C. Joshi, Kannan M. Moudgalya: Optimization (Theory and Practice), Narosa Publishing House, First edition, 2004.
5.	Kalyanmoy Deb: Optimization for Engineering Design (Algorithms and Examples), Prentice-Hall of India Private Limited, New Delhi, 1995.
6.	Kantiswarup, P.K. Gupta and Manmohan: Operations Research, Sultan Chand and Sons.
7.	S.D. Sharma: Operations Research (Theory, Methods and Applications), Kedar Nath, Ram Nath & Co., Fifteenth edition, 2005.
8	H.A. Taha : Operation research an Introduction, Prentice-Hall of India Private Limited, New Delhi, Sixth edition, 2001.
9	B.E. Gillet : Introduction to Operations Research-Computer Oriented Algorithm.
10	K. V. Mittal, Chandra Mohan: Optimization Methods in Operations Research and System Analysis, New-Age international Publishers, 2008.
11	J. C. Pant: Introduction to Optimization: Operations Research, Jain Brothers, New Delhi, 2010.
12	Wayne L. Wilson: Operations Research: Applications and Algorithms, Cengage Learning India Pvt. Ltd., 2011.

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Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome (PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year					2019-20				
M.Sc. (Applied Mathematics): Regular Programme											
Year	II	Core / Elective / Foundation AMT2313: Simulation and Mathematical Modelling			Credits / Hours per week			05			
Semester	I	Year of Introduction: 2007 Year of Syllabus Revision: 2014			Maximum Marks / Grade			100			
Mode of Transaction		Lectures									
Course Outcome (CO) AMT2313 CO1 Understand different methods for random number generation. CO2 Have a clear understanding of the need for the development process to initiate the real problem. CO3 Have a clear understanding of principle and techniques of mathematical and simulation methods CO4 Be able to describe the components of continuous and discrete systems and simulate them. CO5 Be able to model any system from different fields . CO6 Be able to implement numerical algorithm to solve the mathematical model that meet the real life requirements. CO7 Be able to discuss the simulation methods and select the suitable technique to apply on the several problems. CO8 Know how to simulate any system. CO9 Have a clear understanding of the system to be studied.											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)

1	Random numbers: Generating uniform random variables: Pseudo – random numbers, congruential generators and their properties, alternative approaches. Testing random numbers: empirical and theoretical tests or sequences of uniform random numbers, General methods: Inversion method, acceptance-rejection, composition methods. Particular methods for non-uniform random variables, Box–Muller methods to generate normal variates. Exponential, Binomial and Poisson variates.	10	16.66	1,2,3,6	CO1	PSO2 PSO4 PSO8 PSO11	SD	G	PE
2	Discrete Event simulation modeling: Introduction to simulation modeling, Queuing models, Simulation of queueing systems, Output analysis of short and long term performance, Verification and validation, Statistical simulations: Monte-Carlo simulation, Variance reduction technique: Arithmetic variables, conditioning, control variates, importance sampling and common random numbers, Simulation inference.	10	16.66	1,3,4,5	CO3 CO4 CO8	PSO3 PSO5 PSO10 PSO11			
3	Needs and Techniques of mathematical modeling: Idea of mathematical modeling, need for mathematical modeling, steps in mathematical modeling, Characteristics of mathematical modeling, Interpretation. Models in mechanical vibration :Spring mass system, pendulum problems. Models in population dynamics:One species model, logistic model, growth model in time delays, Predator-Prey models, Volterra-Lotka models.	10	16.66	1,2,3,4,5,6	CO2 CO5 CO6 CO9	PSO1 PSO3 PSO5 PSO10			
4	Models of chemical processes, Electrical network and Diffusion processes, Partial Differential Equations models, Traffic flow models and different pde models pertaining to human physiology. Models of chemical processes, Electrical network and Diffusion processes	10	16.66	3,4,5,6	CO5 CO6 CO9	PSO1 PSO3 PSO5 PSO10			
5	Modeling dynamical systems: differential equations and their numerical solution, linear and non-linear dynamics, stability, convergence, attractors. Physical systems: System types and characteristics behaviour, Continuous-time,discrete – time and discrete -event systems, linear and non linear systems.	10	16.66	2,4,5	CO7 CO8 CO9	PSO3 PSO5 PSO9 PSO10			
6	Exploration of behaviour through simulation: developing	10	16.7	3,4,5,6	CO7	PSO5			

	simulations of dynamical systems using Matlab : representation and visualization of simulation experiments, analyzing behavioural characteristics for a range of classes of physical and computational systems eg. Predictor- prey models, evolutionary systems and cellular systems				CO8 CO9	PSO6 PSO8 PSO11			
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Reference Books

1.	J.N.Kapur: Mathematical modelling ,Wiley eastern Ltd.,1994.
2.	M.M. Gibbons: A concrete approach to Mathematical modeling , John Wiley and sons, 1995.
3.	H. Neunzert and A.H. Siddiqu: Topics in Industrial Mathematics, Kluwer Academic Publishers, London, 2000
4.	P. E. Wellstead: Introduction to Physical system modeling, Academic Press, 1979.
5.	Richard Haberman: Mathematical Models, Practice- Hall Inc., NJ, 1979.
6.	Jery Banks, John S., Carson II, Barry Nelson and David M.Nicol: Discrete – Event system simulation , Prentice hall, 2001
7.	J.N.Kapoor: Mathematical modeling in biology & medicine, Eastwest press

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome (PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics)Industrial Mathematics: Regular Programme										
Year	II	Core / Elective / Foundation AMT2305: Wavelets and Image Processing	Credits / Hours per week					05		
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2305 CO1 A deeper understanding of limitations of Fourier analysis in signal processing and why wavelets are better for digital signal processing. CO2 Understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform. CO3 Importance of Multi Resolution Analysis(MRA) and construction of wavelets from MRA. CO4 Implement decomposition and reconstruction of signal using detailed wavelet coefficient and justify the basis of the application of wavelet transforms to different fields. CO5 Understand Wavelet packets. CO6 Describe basic image related concepts. CO7 Explain various image enhancement and restoration techniques. CO8 Describe colour image processing, image compression, image segmentation and representation.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environm ent and Sustainabi lity (ES), Human Values (HV)and Professio nal Ethics (PE)

1	Fourier theory, sampling, signal processing, time-frequency representations. Short time Fourier transform and Continuous wavelet transform, admissibility condition, some well-known wavelets.	12	20	1,2	CO1 CO2	PSO4 PSO5	SD	G	PE
2	Multiresolution Analysis Process, Analysis of Haar expansion of discrete -time signals, Wavelet transform and filter banks, Multichannel Filter Banks, Decomposition and Reconstruction scheme,	14	23	1,2,3	CO3 CO4	PSO4 PSO9			
3	Othonormal Wavelets, Biorthogonal Wavelets. Construction by lifting scheme: "next-generation wavlets", Mallat's MRA and Wavlet-Packets, Multidimentional Wavelets.	10	17	1,2,3,6	CO1 CO5	PSO5 PSO6			
4	Introduction to image processing: Fundamental steps in image processing, Digital image modelling, Image sampling and quantization-spatial and grey level resolution, zooming and shrinking digital images, relationship between pixels, Labelling connected components. Image enhancement in special domains: Basic grey level transformations, Image negatives, Histogram processing, Enhancement using arithmetic logic operations, Image averaging, Basics of special filtering, smoothing and sharpening filters, combining spatial enhancement methods.	9	15	1,2,3	CO7	PSO2 PSO3			
5	Image enhancement in frequency domain: 1-D and 2-D Fourier transforms and its inverse, 1-D and 2-D DFT and its inverse, Filtering in frequency domain, smoothing and sharpening frequency domain filters. Colour image image processing: Colour fundamentals, colour image models, pseudo colour image processing, colour transformations, colour complements, colour slicing.	9	15	3,4,5	CO6 CO7 CO8	PSO3 PSO8			
6	Image segmentation: Detection of discontinuities, Edge linking and boundary detection, global processing via Hough transform. Segmentation by Morphological water shades.	06	10	3,4,5,6	CO5 CO6 CO7	PSO2 PSO3 PSO8			
Reference Books									

1.	C.K. Chui: An Introduction to wavelets, Academic Press.
2.	S. Malat: An Introduction to wavelets, Academic Press.
3.	S. Malat: A Wavelet Tour of Signal Processing, Academic Press, 1998.
4.	Adhemar Bultheel: Learning to swim in a sea of wavelets.
5.	Ingrid Daubechies: Ten Lectures on Wavelets, Soc. For Industrial and Applied Mathematics, Philadelphia, 1992
6.	Rafael C. Gonzalez and Richard E. Woods: Digital Image Processing, Pearson Education (Asia) 2002.

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics))

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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Syllabus of Course:

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics				Academic Year		2019-20	
M.Sc. (Applied Mathematics): Regular Programme									
Year	II	Core / Elective / Foundation AMT2328L : Practicals on Numerical methods for PDE, and Optimization				Credits / Hours per week		03	
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014				Maximum Marks / Grade		50	
Mode of Transaction		Term Work, Practical & Viva							
No.	Experiment					Course Code	BT Level	CO	PSO
1	Programs for Solution of Heat equation using Explicit scheme and implicit scheme					AMT2326	1, 2, 3, 5	CO1	PSO1, PSO6
2	Introduction to symbolic toolbox, Optimization toolbox of MATLAB useful for Optimization					AMT2304	1, 2	CO3	PSO6
3	Programs for Solution of Heat equation using Fully implicit scheme and Crank- Nicolson scheme					AMT2326	1, 2, 3, 5	CO1	PSO1, PSO6
4	Programs for finding maxima or minima of function of one/two variables using Necessary and sufficient condition					AMT2304	1, 2, 4, 5	CO1, CO2	PSO2, PSO4, PSO5
5	Programs for Solution of wave equation from Finite difference method using Explicit method (by taking forward difference / central difference for the initial condition with derivatives)					AMT2326	1, 2, 3, 4, 5	CO2	PSO1, PSO6
6	Programs for finding maxima or minima with constraint using Lagrangian multiplier method					AMT2304	1, 2, 4, 5	CO1, CO2	PSO2, PSO4, PSO5
7	Programs for Solution of PDE using Lax – Wendroff scheme					AMT2326	1, 2, 3, 5	CO1, CO2	PSO1, PSO6
8	Programs for finding minimum of function of one variable using Exhaustive search method, Interval Halving method, Golden Section method					AMT2304	1, 2, 4, 5	CO3	PSO5, PSO9, PSO12
9	Programs for Solution of Elliptic partial differential equation (Laplace equation) using Standard 5 point formula					AMT2326	1, 2, 3, 5	CO2	PSO1, PSO6
10	Programs for finding minimum of function of one variable using Bisection method, Newton’s method, Fibonacci method					AMT2304	1, 2, 4, 5	CO3	PSO5, PSO9, PSO12
11	Programs for Solution of Elliptic partial differential equation (Poisson equation) using Standard 5 point formula					AMT2326	1, 2, 3, 5	CO2	PSO1, PSO6
12	Programs for finding minimum of function of two variables using Univariate method, Steepest Descent method, Powell’s method					AMT2304	1, 2, 4, 5	CO4	PSO9, PSO12, PSO15

Programme Name: MSc. (Applied Mathematics)

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Course:

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics				Academic Year		2019-20		
M.Sc. (Applied Mathematics)Industrial Mathematics: Regular Programme										
Year		II	Core / Elective / Foundation AMT2329L : Practicals on Numerical methods for PDE, Wavelets and Image Processing and Optimization				Credits / Hours per week		03	
Semester		I	Year of Introduction: 2001 Year of Syllabus Revision: 2014				Maximum Marks / Grade		50	
Mode of Transaction			Term Work, Practical & Viva							
No.	Experiment						Course Code	BT Level	CO	PSO
1	Programs for Solution of Heat equation using Explicit scheme and implicit scheme						AMT2326	1, 2, 3, 5	CO1	PSO1,PSO6
2	Introduction to symbolic toolbox, Optimization toolbox of MATLAB useful for Optimization						AMT2304	1, 2	CO3	PSO6
3	Programs for Solution of Heat equation using Fully implicit scheme and Crank- Nicolson scheme						AMT2326	1, 2, 3, 5	CO1	PSO1,PSO6
4	Programs for finding maxima or minima of function of one/two variables using Necessary and sufficient condition						AMT2304	1, 2, 4, 5	CO1 CO2	PSO2,PO4, PSO5
5	Programs for Solution of wave equation from Finite difference method using Explicit method (by taking forward difference / central difference for the initial condition with derivatives)						AMT2326	1, 2, 3, 4, 5	CO2	PSO1,PSO6
6	Programs for finding maxima or minima with constraint using Lagrangian multiplier method						AMT2304	1, 2, 4, 5	CO1 CO2	PSO2,PO4, PSO5
7	Programs for Solution of PDE using Lax – Wendroff scheme						AMT2326	1, 2, 3, 5	CO1 CO2	PSO1,PSO6
8	Programs for finding minimum of function of one variable using Exhaustive search method, Interval Halving method, Golden Section method						AMT2304	1, 2, 4, 5	CO3	PSO5,PO9, PSO12
9	Programs for Solution of Elliptic partial differential equation (Laplace equation) using Standard 5 point formula						AMT2326	1, 2, 3, 5	CO2	PSO1,PSO6
10	Programs for finding minimum of function of one variable using Bisection method, Newton’s method, Fibonacci method						AMT2304	1, 2, 4, 5	CO3	PSO5,PO9, PSO12
11	Programs for Solution of Elliptic partial differential equation (Poisson equation) using Standard 5 point formula						AMT2326	1, 2, 3, 5	CO2	PSO1,PSO6
12	Programs for finding minimum of function of two variables using Univariate method, Steepest Descent method, Powell’s method						AMT2304	1, 2, 4, 5	CO4	PSO9,PO12, PSO15
13	Basic Inbuilt commands of Image Processing, Programs on Image Processing						AMT2305	1,2,3	CO6 CO7 CO8	PSO4,PSO5, PSO6,PSO9
14	Basic Inbuilt commands of Wavelets, Programs on Wavelet Transforms and its application on signals.						AMT2305	1,2,3,4	CO4	PSO2,PSO3, PSO8

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.

PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.

PSO5. Demonstrate basic mathematical understanding and computational skills.

PSO6. Apply soft computing techniques.

PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimization techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

PSO14. Formulation of mathematical models and simulation of the problems in the real world.

PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands on practice for self-preparation and developing presentation skills through project and seminar.

PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year		2019-20					
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT2309 : MATHEMATICAL CONTROL THEORY –I	Credits / Hours per week				05			
Semester	I	Year of Introduction: 2007 Year of Syllabus Revision: 2019	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2309										
CO1 Use advanced mathematical techniques to formulate and solve control problems										
CO2 Identify practical challenges in posing control problems										
CO3 The student will demonstrate an understanding of the characteristics of feedback control systems and how to apply them										
CO4 The student will demonstrate an understanding of stability of linear feedback systems										
CO5 Understand and discuss Controllability and Observability.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Mathematical Description of Control Theory and - Basic Definition - Mathematical Modeling of control system - State space approach and Frequency Domain Approach - Linearization of Nonlinear systems		8 hrs	13.6%	1,2,3	CO1	PSO9 PSO14	EMP	G	PE

2	Solution of Control systems using Transitions Matrix - Fundamental matrix solution and Transition matrix for linear homogeneous systems - Properties of Transition matrix - Computation of transition matrix for Time invariant systems - Solution of non-homogeneous system	10 hrs	16.6%	1,2,4,5	CO2	PSO1 PSO9
2	Controllability and Reachability of Linear systems - Solution of non-homogeneous system - Definition and particular cases of controllability - Complete characterization of controllability - Characterization using the theory of Linear operators	10 hrs	16.6%	1,2,4,5	CO2 CO3	PSO1 PSO9
3	Controllability of time invariant system - Kalman's Rank condition for controllability of Time invariant systems - Algebraic characterization for controllability - Kalman controllability Decomposition of linear systems - Controllability of Jordon Form Systems	10 hrs	16.6%	1,2,4,5	CO2 CO3	PSO1 PSO9 PSO10
4	Observability - Definition of Observability of Linear Systems - Characterization of observability using operator theory - Reconstruction of initial state from observations - Kalman's Rank condition for observability - Duality between Observability and	10 hrs	16.6%	1,2,4,5	CO5	PSO1 PSO9 PSO10

	controllability								
6.	Stability and Stabilization • Stability of Dynamical Systems • Definition of Laypunov Stability, Asymptotic Stability and Exponential Stability and Examples • Lyapunvo Theorems of Stability • Stability Analysis of Linear Time invariant systems using spectrum of system matrix • Stability of systems • Feedback control and stabilizability conditions • LMI Tools in MATLAB for Stability Analysis	12 hrs	20%	1,2,4	CO4	PSO1 PSO9			
Reference Books									
1.	Sontag E D : Mathematical control theory – Deterministic Finite Dimensional Systems, Springer, NY 2002.								
2.	Russell D L : Mathematics of Finite Dimensional Control Systems, Marcel Dekker, NY, 1979.								
3.	Brockett R W : Linear systems, John Wiley, 1985.								
4.	Joshi M C : Differential Equations, A modern Perspective, Narosa Publ. 2004								
5.	Chen, C T Chen: Linear System Theory and Design, Henry Holt, 1995								
6.	William J. Terrell: Stability and Stabilizability, Princeton University Press, 2009.								
7.	Balachandran K: and Dauer J P: Elements of Control Theory, Narosa Publ. House, 2001								

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
- PSO2. Assimilate complex mathematical ideas and arguments.
- PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.
- PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.
- PSO5. Demonstrate basic mathematical understanding and computational skills.
- PSO6. Apply soft computing techniques.
- PSO7. Implement various algorithms using advanced Object Oriented Programming languages.
- PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.
- PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.
- PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.
- PSO11. Use appropriate software to solve practical problems.
- PSO12. Employ advanced statistical and optimisation techniques.
- PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.
- PSO14. Formulation of mathematical models and simulation of the problems in real world.
- PSO15. Inculcate their skills to deal with industrial problems.
- PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.
- PSO17. Electives in the final year which elaborate prerequisite of the research field.
- PSO18. Hands-on practice for self preparation and developing presentation skills through project and seminar.
- PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics) Regular Programme										
Year	II	Core / Elective / Foundation AMT 2301: Numerical Methods for Partial Differential Equations	Credits / Hours per week					05		
Semester	I	Year of Introduction:2001 Year of Revision of Syllabus: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT 2301 CO1: To learn about finite difference approximation to partial derivatives and the solution of Partial Differential Equation (PDE) using different algorithms using Finite difference of parabolic PDE. CO2 :To learn about the Solution of hyperbolic and elliptic PDE using finite difference algorithms and their convergence and stability CO3 : To be able to Understand the general steps of finite element methods, To be able to understand the Engineering aspects for FEM CO4 : To be able to Understand the basic finite element formulation techniques. To be able to understand the mathematical methods for FEM in one and dimension and three dimension, be able to formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics. CO5 : Understanding of FEM Open source software/License software CO6 : Understanding of application of FEM software to industrial problems related to BVP and IVP-BVP CO7 : Advantages of FEM over other Methods										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics

									(PE)
1	<u>FINITE DIFFERENCE METHOD</u> Numerical methods for parabolic PDE - Finite difference method: Explicit methods, implicit methods and Crank- - Nicolson implicit method, Stability, Convergence and error of these methods, Predictor -Corrector methods	14	23.3	1,2,5	CO1	PSO1 PSO6	Emp	G	PE
2	Numerical methods for hyperbolic PDE - Explicit methods, implicit methods, stability, convergence and error of these methods, - Method of characteristics, Lax-Wendroff method, method of artificial viscosity, Courant – Friedrichs - Lewy condition. Numerical Methods for elliptic PDE : - Numerical solutions of Laplace and Poisson equation using forward difference scheme and its error.	10	16.7	1,2,5	CO2	PSO1, PSO6			
3	<u>FINITE ELEMENT METHOD</u> - Introduction, Advantages of FEM over other methods, Basic steps in FEM, Springs in series analogy, Understanding about weak solution, Relay Ritz Method - Different approaches in FEM formulation, Variational and Galerkin's approach. Descretization of problem, Descretization of geometry - Element types, Shape functions, Element equations, Assembly procedure, Imposition of Essential boundary conditions, Properties of assembled matrix, Methodology for solving system of equations. - Formulation of the FEM for elliptic problems	16	26.72	1,2,3,4,5	CO3 CO4 CO5 CO6 CO7	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			

	Variational and Galerkin formulation <u>Finite element discretizations in 1D</u> - Variational approach - Galerkin approach								
4	<u>Finite element discretization in 2D</u> - A FEM for Poisson's equation, steady state heat equation, General second order pde - Galerkin approach Second order pde in different domain with physical parameter's description.	10	16.7	1,2,3,4,5	CO3 CO4 CO5 CO6	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			
5	Formulation of the FEM for elliptic problems Variational and Galerkin Formulation	06	10.02	1,2,3,4,5	CO3 CO4 CO5 CO6	PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16 PSO17			
6	FEM as a tool for solving boundary value problems	04	06.68	1,2,3,4,5		PSO1 PSO2 PSO4 PSO5 PSO6 PSO9 PSO11 PSO14 PSO15 PSO16			

						PSO17			
Reference Books									
1.	G.D Smith	:	Numerical solution of Partial Differential Equations: FiniteDiffernce Methods, Third edition, Oxford University Press, 1986.						
2.	K. W. Morton and D. F. Mayers	:	Numerical solution of Partial Differential Equations, Cambridge University Press, New York, 1993						
3.	A. R. Mitchell and D. F. Griffiths	:	The Finite Difference Methods in Partial Differential Equations, Wiley, April, 2001						
4.	A. Quarteroni and A. Valli	:	Numerical Approximation of Partial Differential Equations, Springer, 1994						
5.	S. Brenner and L.R.Scott	:	The Mathematical theory of Finite element methods, Springer-Verlag, 1994						
6.	C.Johnson	:	Numerical solution of partial differential equations by the FEM, Cambridge University Press, 1994.						
7.	Cook, Malkus and Plesha	:	Concepts and Applications of finite element analysis, Third edition , John Wiley and sons, 1989.						
8.	B. Szabo and I. Babuska	:	Finite element analysis, Wiley and Sons,1991.						
9.	K.H. Huebner	:	The Finite element Method for Engineers, John Wile and Sons, 1975.						
10.	J.N Reddy	:	An introduction to Finite Element Method, , MacGrawHill						

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT 2304:OPTIMIZATION I	Credits / Hours per week					05		
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) : AMT 2304 CO1: Able to formulate and choose appropriate methodology to solve an optimization problem according the classification in terms of Linear/Non-Linear, Single Variable/Multi-Variable, With Constraint/Without Constraint. CO2: Understand and can successfully apply the classical theory of optimization, to solve various problems which belongs to classes; viz. single/multivariate problems without constraints, Lagrange method for problems having equality constraints and theory of Kuhn-Tucker for problems having inequality constraints. CO3: Able to choose and apply an appropriate method from various methods designed for single variable optimization problems. CO4: Develops an ability to choose appropriately from various available methods designed for solving Multivariable optimization problems (Unconstrained and Constrained) and apply them successfully for desired solution. CO5: Apply optimization methods to various real life areas, engineering problems , industrial problems CO6: Interpreting results and effects of change in the structure or parameters of Optimization problems. CO7: Understand and apply constrained optimization theory for continuous problems, involving integer solutions or including the Kuhn-Tucker conditions for quadratic programming.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and

									Professional Ethics (PE)
1	Optimization problems in engineering and industries Optimization problem formulation Classification of optimization problem Classical optimization techniques Single variable optimization, Multivariable optimization, Constrained optimization: Lagrangian multiplier method, Kuhn-Tucker conditions.	16	26	1,3,4	CO1 CO2	PSO2 PSO4 PSO5	Emp SD	G	PE
2	Single variable optimization techniques Bracketing method - Exhaust search Region elimination method - Interval halving method, Golden section method, Interpolation method - Quadratic interpolation method, Gradient based methods – Newton's method, bisection method.	10	17	2,3,5	CO3	PSO5 PSO9 PSO12			
3	Multivariable optimization techniques (Unconstrained and Constrained) Univariate method, Direct Search method - Simplex search method, Powell's conjugate direction method, Gradient based methods - steepest descent (Cauchy) method, conjugate gradient (Fletcher-Reeves) method, Box complex method, Sequential linear programming method, Interior and Exterior Penalty function methods	10	17	3,4,5	CO4	PSO9 PSO15 PSO12			
4	Constraint linear optimization problem Overview of linear optimization problem Sensitivity analysis	10	17	2,4,5	CO5	PSO12 PSO14			
5	Quadratic programming Wolf's modified simplex method Broyden's methods	08	13	1,2,5	CO6	PSO12			
6	Integer programming problem Gomory's cutting plane method branch and bound techniques	06	10	1,2,3,5	CO7	PSO12			
Reference Books									
1.	Rangrajan K. Sundaram: A first Course in Optimization Theory, Cambridge University Press, First edition, 1996.								
2.	S. S. Rao: Engineering Optimization (Theory and Practice), New Age International Publishers, New Delhi, Third edition, 2001.								
3.	Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Wiley-India publishers, Second edition, 2001.								

4.	Mohan C. Joshi, Kannan M. Moudgalya: Optimization (Theory and Practice), Narosa Publishing House, First edition, 2004.
5.	Kalyanmoy Deb: Optimization for Engineering Design (Algorithms and Examples), Prentice-Hall of India Private Limited, New Delhi, 1995.
6.	Kantiswarup, P.K. Gupta and Manmohan: Operations Research, Sultan Chand and Sons.
7.	S.D. Sharma: Operations Research (Theory, Methods and Applications), Kedar Nath, Ram Nath & Co., Fifteenth edition, 2005.
8	H.A. Taha : Operation research an Introduction, Prentice-Hall of India Private Limited, New Delhi, Sixth edition, 2001.
9	B.E. Gillet : Introduction to Operations Research-Computer Oriented Algorithm.
10	K. V. Mittal, Chandra Mohan: Optimization Methods in Operations Research and System Analysis, New-Age international Publishers, 2008.
11	J. C. Pant: Introduction to Optimization: Operations Research, Jain Brothers, New Delhi, 2010.
12	Wayne L. Wilson: Operations Research: Applications and Algorithms, Cengage Learning India Pvt. Ltd., 2011.

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics))

Programme Specific Outcome(PSO)

PSO1. Solve mathematical problems using analytical as well as numerical methods.

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Syllabus of Course:

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics				Academic Year		2019-20	
M.Sc. (Applied Mathematics): Regular Programme									
Year	II	Core / Elective / Foundation AMT2328L : Practicals on Numerical methods for PDE, and Optimization				Credits / Hours per week		03	
Semester	I	Year of Introduction: 2001 Year of Syllabus Revision: 2014				Maximum Marks / Grade		50	
Mode of Transaction		Term Work, Practical & Viva							
No.	Experiment					Course Code	BT Level	CO	PSO
1	Programs for Solution of Heat equation using Explicit scheme and implicit scheme					AMT2326	1, 2, 3, 5	CO1	PSO1, PSO6
2	Introduction to symbolic toolbox, Optimization toolbox of MATLAB useful for Optimization					AMT2304	1, 2	CO3	PSO6
3	Programs for Solution of Heat equation using Fully implicit scheme and Crank- Nicolson scheme					AMT2326	1, 2, 3, 5	CO1	PSO1, PSO6
4	Programs for finding maxima or minima of function of one/two variables using Necessary and sufficient condition					AMT2304	1, 2, 4, 5	CO1, CO2	PSO2, PSO4, PSO5
5	Programs for Solution of wave equation from Finite difference method using Explicit method (by taking forward difference / central difference for the initial condition with derivatives)					AMT2326	1, 2, 3, 4, 5	CO2	PSO1, PSO6
6	Programs for finding maxima or minima with constraint using Lagrangian multiplier method					AMT2304	1, 2, 4, 5	CO1, CO2	PSO2, PSO4, PSO5
7	Programs for Solution of PDE using Lax – Wendroff scheme					AMT2326	1, 2, 3, 5	CO1, CO2	PSO1, PSO6
8	Programs for finding minimum of function of one variable using Exhaustive search method, Interval Halving method, Golden Section method					AMT2304	1, 2, 4, 5	CO3	PSO5, PSO9, PSO12
9	Programs for Solution of Elliptic partial differential equation (Laplace equation) using Standard 5 point formula					AMT2326	1, 2, 3, 5	CO2	PSO1, PSO6
10	Programs for finding minimum of function of one variable using Bisection method, Newton’s method, Fibonacci method					AMT2304	1, 2, 4, 5	CO3	PSO5, PSO9, PSO12
11	Programs for Solution of Elliptic partial differential equation (Poisson equation) using Standard 5 point formula					AMT2326	1, 2, 3, 5	CO2	PSO1, PSO6
12	Programs for finding minimum of function of two variables using Univariate method, Steepest Descent method, Powell’s method					AMT2304	1, 2, 4, 5	CO4	PSO9, PSO12, PSO15

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1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome (PSO)**

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
- PSO2. Assimilate complex mathematical ideas and arguments.
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- PSO14. Formulation of mathematical models and simulation of the problems in real world.
- PSO15. Inculcate their skills to deal with industrial problems.
- PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year				2019-20			
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT2313: Simulation and Mathematical Modelling	Credits / Hours per week				05			
Semester	I	Year of Introduction: 2007 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2313 CO1 Understand different methods for random number generation. CO2 Have a clear understanding of the need for the development process to initiate the real problem. CO3 Have a clear understanding of principle and techniques of mathematical and simulation methods CO4 Be able to describe the components of continuous and discrete systems and simulate them. CO5 Be able to model any system from different fields . CO6 Be able to implement numerical algorithm to solve the mathematical model that meet the real life requirements. CO7 Be able to discuss the simulation methods and select the suitable technique to apply on the several problems. CO8 Know how to simulate any system. CO9 Have a clear understanding of the system to be studied.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustainab ility (ES), Human Values (HV)and Professio nal Ethics (PE)

1	Random numbers: Generating uniform random variables: Pseudo – random numbers, congruential generators and their properties, alternative approaches. Testing random numbers: empirical and theoretical tests or sequences of uniform random numbers, General methods: Inversion method, acceptance-rejection, composition methods. Particular methods for non-uniform random variables, Box–Muller methods to generate normal variates. Exponential, Binomial and Poisson variates.	10	16.66	1,2,3,6	CO1	PSO2 PSO4 PSO8 PSO11	SD	G	PE
2	Discrete Event simulation modeling: Introduction to simulation modeling, Queuing models, Simulation of queueing systems, Output analysis of short and long term performance, Verification and validation, Statistical simulations: Monte-Carlo simulation, Variance reduction technique: Arithmetic variables, conditioning, control variates, importance sampling and common random numbers, Simulation inference.	10	16.66	1,3,4,5	CO3 CO4 CO8	PSO3 PSO5 PSO10 PSO11			
3	Needs and Techniques of mathematical modeling: Idea of mathematical modeling, need for mathematical modeling, steps in mathematical modeling, Characteristics of mathematical modeling, Interpretation. Models in mechanical vibration :Spring mass system, pendulum problems. Models in population dynamics:One species model, logistic model, growth model in time delays, Predator-Prey models, Volterra-Lotka models.	10	16.66	1,2,3,4,5,6	CO2 CO5 CO6 CO9	PSO1 PSO3 PSO5 PSO10			
4	Models of chemical processes, Electrical network and Diffusion processes, Partial Differential Equations models, Traffic flow models and different pde models pertaining to human physiology. Models of chemical processes, Electrical network and Diffusion processes	10	16.66	3,4,5,6	CO5 CO6 CO9	PSO1 PSO3 PSO5 PSO10			
5	Modeling dynamical systems: differential equations and their numerical solution, linear and non-linear dynamics, stability, convergence, attractors. Physical systems: System types and characteristics behaviour, Continuous-time,discrete – time and discrete -event systems, linear and non linear systems.	10	16.66	2,4,5	CO7 CO8 CO9	PSO3 PSO5 PSO9 PSO10			
6	Exploration of behaviour through simulation: developing	10	16.7	3,4,5,6	CO7	PSO5			

	simulations of dynamical systems using Matlab : representation and visualization of simulation experiments, analyzing behavioural characteristics for a range of classes of physical and computational systems eg. Predictor- prey models, evolutionary systems and cellular systems				CO8 CO9	PSO6 PSO8 PSO11			
Reference Books									
1.	J.N.Kapur: Mathematical modelling ,Wiley eastern Ltd.,1994.								
2.	M.M. Gibbons: A concrete approach to Mathematical modeling , John Wiley and sons, 1995.								
3.	H. Neunzert and A.H. Siddiqu: Topics in Industrial Mathematics, Kluwer Academic Publishers, London, 2000								
4.	P. E. Wellstead: Introduction to Physical system modeling, Academic Press, 1979.								
5.	Richard Haberman: Mathematical Models, Practice- Hall Inc., NJ, 1979.								
6.	Jery Banks, John S., Carson II, Barry Nelson and David M.Nicol: Discrete – Event system simulation , Prentice hall, 2001								
7.	J.N.Kapoor: Mathematical modeling in biology & medicine, Eastwest press								

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

- PSO1 Solve mathematical problems using analytical as well as numerical methods.
- PSO2 Assimilate complex mathematical ideas and arguments.
- PSO3 Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.
- PSO4 Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.
- PSO5. Demonstrate basic mathematical understanding and computational skills.
- PSO6 Apply soft computing techniques.
- PSO7 Implement various algorithms using advanced Object Oriented Programming languages.
- PSO8 Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.
- PSO9 Describe the study of fundamental and advanced concepts in Mathematical Analysis.
- PSO10 Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.
- PSO11 Use appropriate software to solve practical problems.
- PSO12 Employ advanced statistical and optimization techniques.
- PSO13 Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.
- PSO14 Formulation of mathematical models and simulation of the problems in real world.
- PSO15 Inculcate their skills to deal with industrial problems.
- PSO16 Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.
- PSO17 Electives in the final year which elaborate prerequisite of the research field.
- PSO18 Hands-on practice for self preparation and developing presentation skills through project and seminar.
- PSO19 Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year		2019-20					
M.Sc. (Applied Mathematics): Regular Programme											
Year	II	Core / Elective / Foundation AMT2403: Advance Analysis		Credits / Hours per week		05					
Semester	II	Year of Introduction: 2001 Year of Syllabus Revision: 2014		Maximum Marks / Grade		100					
Mode of Transaction		Lectures									
Course Outcome (CO) AMT2123											
CO1 Explain the fundamental concepts of real analysis, and their role in modern mathematics and applied contexts											
CO2 An application of distribution to develop the classical notion of non-smooth functions in mathematical analysis											
CO3 Understand the concept of Sobolev space and usefulness of these spaces as the natural development of monotone and absolutely continuous functions											
CO4 Solve the Variational problems and learn about the existence and uniqueness of elliptic boundary value problems											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)
1	Distribution: Introduction to weak, weak* topologies, locally convex topological spaces. Test Functions and distributions Some operations with Distributions Supports of Distributions Convolution of Functions Convolution of Distributions Fundamental Solutions			20	33	1, 2, 3, 4	CO1	PSO1 PSO2 PSO4 PSO9	EMP	G	PE

							EMP	G	PE
2	The Fourier Transform, The Schwartz Space and the Fourier Inversion Formula Tempered Distributions	07	12	3, 4, 5	CO2	PSO1 PSO9			
3	Sobolev Spaces: Definition and basic Properties Approximation by smooth Functions, Extension Theorems, Imbedding Theorems Compactness Theorems, Dual Spaces, Fractional Order spaces and Trace Spaces Trace Theory	23	38	2, 4, 5	CO3	PSO2 PSO4 PSO9			
4	Weak solutions of Elliptic Boundary value problems: Some Abstract Variational Problems Examples of Elliptic Boundary Value Problems Regularity of Weak Solutions	10	17	3, 5, 6	CO4	PSO1 PSO4 PSO9			
Reference Books									
1	S. Kesavan : Topics in Functional analysis and Applications, Wiley Eastern Ltd.1989.								
2	Adams R.A. ,Sobolev Spaces ,Academic Press, 1975.								
3	J. T. Oden and J. N. Reddy: An introduction to the Mathematical Theory of Finite Elements, John Wiley,NY,1976								

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)**Programme Specific Outcome(PSO)**

PSO1. Solve mathematical problems using analytical as well as numerical methods.

PSO2. Assimilate complex mathematical ideas and arguments.

PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.

PSO4. Give organized written and verbal explanations of mathematical reasoning in a precise and articulate manner.

PSO5. Demonstrate basic mathematical understanding and computational skills.

PSO6. Apply soft computing techniques.

PSO7. Implement various algorithms using advanced Object Oriented Programming languages.

PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.

PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.

PSO10. Select appropriate methods for solving ordinary and partial differential equations which is arising in Mathematical modelling of problem.

PSO11. Use appropriate software to solve practical problems.

PSO12. Employ advanced statistical and optimization techniques.

PSO13. Build, Manage and Lead a team to successfully complete an industrial project and communicate across teams and organizations to achieve professional objectives.

PSO14. Formulation of mathematical models and simulation of the problems in the real world.

PSO15. Inculcate their skills to deal with industrial problems.

PSO16. Advanced understanding to qualify for various competitive exams to build their academic as well as industrial career.

PSO17. Electives in the final year which elaborate prerequisite of the research field.

PSO18. Hands on practice for self-preparation and developing presentation skills through project and seminar.

PSO19. Training and Exposure to research literature and thesis writing through dissertation.

Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year				2019-20				
M.Sc. (Applied Mathematics): Regular Programme											
Year	II	Core / Elective / Foundation AMT2402: Differential Geometry and Integral Equations		Credits / Hours per week				05			
Semester	II	Year of Introduction: 2001 Year of Syllabus Revision: 2014		Maximum Marks / Grade				100			
Mode of Transaction		Lectures and Tutorials									
Course Outcome (CO) AMT2402 CO1: Understand geometric quantities such as Regular curves, arc length, and natural parameterization of curves. CO2: The theory of surfaces introduces the fundamental quadratic forms of a surface and intrinsic geometry of surfaces. CO3: Able to apply curvature and torsion of the curve and calculate the Frenet frame of a spatial curve. CO4: Apply the concept of involute, evolute and Bertrand curves. CO5: To acquaint ‘Applied Mathematician’ with the knowledge of various type of Integral equations and their solution techniques, which often are not treated in courses at graduate level. CO6: Various exact and approximate methods for obtaining solutions of Integral Equations are incorporated. CO7: Able to Convert Boundary Value Problems and Initial Value Problems into Fredholm and Volterra Type Integral equations and vice-versa. CO8: Able to solve certain class of Integral Equations using Green’s Functions.											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)

1	Concept of a curve, regular curve, arc length as a parameter, order of contact, orthogonal triad $\vec{t}, \vec{n}, \vec{b}$. Curvature, Torsion and Frenet-Serret formulae.	10	17	1,2	CO1 CO3	PSO4 PSO5 PSO16	Emp	G	PE
2	The fundamental existence and Uniqueness theorem, Curves of constant slope or cylindrical Helices, circle of curvature, locus of center of curvature, sphere of curvature. Osculating curves & Surfaces.	08	13	2,3,5	CO2	PSO1 PSO9 PSO16			
3	Involutes and Evolutes, Bertrand curves. Surfaces, Envelopes, Edge of regression, developable surface, general equation to developable surface.	06	10	1, 3, 5	CO4	PSO2 PSO9 PSO16			
4	Linear Integral equations, Definition, relation between differential & integral equations, Green's function.	12	20	1, 2, 3	CO5 CO7 CO8	PSO2 PSO5 PSO16			
5	Fredholm and Volterra equations, Method of successive approximations, equations with separable kernels.	14	23	2, 3, 5	CO6	PSO1 PSO2 PSO16			
6	Hilbert-schmidt theory, Fredholm theory. Singular Integral equations.	10	17	2, 3, 4	CO6	PSO5 PSO9 PSO16			

REFERENCES

- 1 T.J. Willmore: An Introduction to Differential Geometry, Oxford University Press(India).
- 2 Martin Lipschultz : Differential Geometry (Schaum's Outlines), Tata McGraw-Hill publishing Co. Ltd(India)
- 3 D.J, Struik : Classical Differential Geometry.
- 4 Francis B. Hildebrand: Methods of Applied Mathematics, Prentice-Hall, Inc., Second Edition, 1965.
- 5 R.V. Churchill : Operational Mathematics
- 6 B.P. Parashar: Differential and Integral equations, CBS Publishers, Second edition, 1992.
- 7 M. Krasnov, A. Kiselev, G. Makarenko: Problems and Exercises in Integral Equations, Mir Publishers, Moscow, 1971.

Bloom's Taxonomy Levels:

1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: MSc. (Applied Mathematics)

Programme Specific Outcome (PSO)

- PSO1. Solve mathematical problems using analytical as well as numerical methods.
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- PSO3. Recognize the relationships between different areas of Mathematics and the connections between Mathematics and other disciplines.
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- PSO8. Demonstrate facility in computer programming, data processing, numerical simulation, scientific visualization, and virtual experimentation.
- PSO9. Describe the study of fundamental and advanced concepts in Mathematical Analysis.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year				2019-20			
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core / Elective / Foundation AMT 2401: Discrete Mathematics	Credits / Hours per week				05			
Semester	II	Year of Introduction: 2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2401 CO1 Apply an argument using logical notation and determine if the argument is or is not valid. CO2 Apply rules of inference, tests for validity, and methods of proof and write proofs using symbolic logic. CO3 Use finite-state machines to model computer operations. CO4 Know asymptotic notations and check time/space complexity of an algorithm CO5 Know shortest path algorithms and apply to data structures/real world applications.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1	Logic Propositional and predicate logic Propositions Predicates and		14	23.33	1,2,3	CO1	PSO2, PSO5	SD	G	PE

	quantifiers Quantifier and logical operators								
2	Theory of inference Rules of inference Methods of proof and logical verification of computer programs	10	16.67	1,2,3,4	CO2	PSO2, PSO5			
3	Theory of algorithms Problems and instances algorithms, characteristics of algorithms Concepts of test data, efficiency of algorithms	07	11.67	1,2,3	CO4	PSO2, PSO5			
4	Theoretical, empirical and hybrid approaches to measure efficiency Complexity, space complexity, asymptotic notations solving recurrences using characteristics equations, examples of simple algorithm and their analysis	07	11.67	1,2,3	CO4	PSO2, PSO5			
5	Graph theoretic algorithms and computer programs Recap the concepts and definitions of graph and trees as data structure some basic algorithms, representation of graphs breadth first search, topological search heap sort algorithm connectedness and assumptions, Lattice theory, Boolean algebra	10	16.66	1,2,3,4	CO5	PSO2, PSO5			
6	Theory of Computation Models in computer science finite state automata their use and properties, Deterministic finite automata Deterministic finite automata non deterministic finite automata regular languages and their unions finite state transducers Push down automata context free languages	12	20	1,2,3,4	CO3	PSO2, PSO5			

	turning machine and computing by turing machines								
Reference Books									
1.	Harry R. Lewis and Christosh H. Papadimitriou. Elements of the theory of computation, Prentice Hall of India.1996								
2.	V.Aho,J.E.Hopcroft and J.D. Ullman The design and analysis of Computer algorithms. 1974								
3.	Thomas H. Cormen Leiserson and Rivest Introduction to algorithm, Prentice Hall of India,1998								
4.	Dino Mandrioli, Carlo Ghezzi : Theoretical foundations of computer science, John-Wiley and sons,1987								
5.	Kenneth A. Ross, Charles R. B. Wright: Discrete Mathematics, Pearson 2012, 5th Edition.								
6.	Seymour Lipschutz, Marc Lipson: Discrete Mathematics (Schaum's Outlines), Tata McGraw Hill.								

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Physics				Academic Year		2019-20		
M.Sc. (Applied Physics): Regular Programme										
Year		I	Core / Elective / Foundation APH2105 : Laboratory Practical				Credits / Hours per week		09	
Semester		I	Year of Introduction: 2007 Year of Syllabus Revision: 2016				Maximum Marks / Grade		150	
Mode of Transaction			Laboratory Experiments, discussion and viva				PSO7 is common for all experiments			
No.	Experiment					Course Code	BT Level	CO	PSO	
1	Franck Hertz experiment					APH2102	1,2	CO1	PSO1	
2	Laser Divergence and Gaussian intensity profile					APH2203	2		PSO2	
3	Dissociation energy of Iodine molecules					APH2102	2,3		PSO1, PSO2	
4	Spectral Response of photo detector					APH2102	3,4		PSO4	
5	Determination of Planck’s constant					APH2102	2,3	CO1	PSO1, PSO4	
6	Determination of Lande g factor from Electron Spin Resonance					APH2201	2,3		PSO1	
7	Fourier Analysis					APH2101	3,4		PSO2	
8	LCR Damped Harmonic Oscillator					APH2103	2		PSO4	
9	Diode Characteristics					APH2202	2		PSO4	
10	Electromagnetic Induction					APH2103	2,3		PSO2, PSO4	
11	Solar Cell					APH2202	2,3,4		PSO2, PSO4	
12	High pass – low pass filter					APH2202	2		PSO4	
13	Statistical Board and its simulation					APH2102	2,3,4	CO6	PSO1, PSO3	
14	GM counter					APH2102	2,3		PSO1, PSO6	
15	Verification of Fresnel’s equations					APH2103	2,3,4		PSO2	

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Programme Name: MSc. (Applied Mathematics))

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Syllabus of Courses

		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics		Academic Year				2019-20			
M.Sc. (Applied Mathematics): Regular Programme											
Year	II	Core/ Elective / Foundation AMT2406: MATHEMATICAL CONTROL THEORY –II		Credits / Hours per week				05			
Semester	II	Year of Introduction:2007 Year of Syllabus Revision:2019		Maximum Marks / Grade				100			
Mode of Transaction		Lectures									
Course Outcome (CO) AMT2406 CO1 Analyze and synthesize optimal open loop control signals using the Maximum principle. CO2 Analyze and synthesize optimal feedback laws using the Hamilton-Jacobi-Bellman equation. CO3 Describe the connections between optimal control and other optimization approaches. CO4 Identify the various representations of discrete-time control systems and determine their solutions CO5 The ability to carry out the stability analysis of non-linear control systems CO6 Conversance with controllability, observability and stabilizabilty theory in a linear and non-linear, finite-dimensional context. CO7 Determine feedback control and optimal control of discrete-time control systems											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)

1	Optimal Control Problems of continuous-time control systems • Dynamic Programming • Linear Systems with Quadratic Cost • Tracking and Kalman Filtering • Infinite-Time (Steady-State) Problem • Nonlinear Stabilizing Optimal Controls • Optimality: Multipliers	12	20.04	1,2,4	CO3	PSO9	EMP SD	G	PE
2	Unconstrained Controls of continuous-time control systems • Constrained Controls: Minimum Principle • Optimality: Minimum-Time for Linear Systems • Existence Results • Maximum Principle for Time-Optimality • Applications of the Maximum Principle	12	20.04	1,2,4	CO1 CO2	PSO9			
3	Introduction to Discrete-time control systems • Linear and nonlinear systems with examples • Time variant and Time invariant systems • State-Space and frequency domain representation of control systems. • The Z-transform : definition, properties, Inverse Z- transform , Solution of discrete-time control system using Z-transform	10	16.67	2,3,4,5	CO4	PSO2 PSO9 PS017			
4	Controllability , observability of discrete-time control systems • Basic notions of controllability and Reachability • Controllability canonical forms • Controllability matrix and Condition of	10	16.67	2,3,4,5	CO6	PSO9 PSO17			

5.	Kwakernak and Sivan, "Linear optimal control systems , Wiley Inter, NY,1972
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Programme Name: MSc. (Applied Mathematics)

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- PSO1. Solve mathematical problems using analytical as well as numerical methods.
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- PSO17. Electives in the final year which elaborate prerequisite of the research field.
- PSO18. Hands-on practice for self preparation and developing presentation skills through project and seminar.
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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Applied Mathematics	Academic Year	2019-20							
M.Sc. (Applied Mathematics): Regular Programme										
Year	II	Core/ Elective / Foundation AMT2404: Wavelet Analysis	Credits / Hours per week					05		
Semester	II	Year of Introduction:2001 Year of Syllabus Revision: 2014	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) AMT2404 CO1 To understand the limitation of Fourier analysis and need for wavelet. CO2 To learn about removing the deficiency of Fourier transform in time – frequency analysis using Gabor transform, Short time Fourier transform and see the adjustment in the time frequency window with continuous wavelet transform. CO3 Discrete Wavelet transforms, Frames, Tight frames and see the relationship between orthonormal basis and tight frames. CO4 To learn about Multi Resolution Analysis (MRA) for construction of wavelets and understand the structure of the spaces V_j and W_j . CO5 To learn the construction of compactly supported wavelets. CO6 To learn the regularity of orthonormal wavelets.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

1	From Fourier Analysis to Wavelet analysis. To understand the limitations of Fourier transform and to know about what and why wavelets.	08	13.3	1,2	CO1	PSO1	EMP	G	PE
2	Time Frequency Analysis and Continuous Wavelet Transform. Gabor Transform, Short Time Fourier Transform, Uncertainty principle , Continuous wavelet transform.	14	23.3	1,2	CO2	PSO2, PSO3			
3	Discrete the Wavelet Transform ,Frames , Generality about Frames , A necessary condition (Admissibility of the mother wavelet) , The dual frame, Examples of Tight frames, The Mexican hat function, a modulated Gaussian function, Frames for the Windowed Fourier transform	12	20	2, 3, 4	CO3	PSO2 PSO3 PSO5 PSO8			
4	Time-Frequency Density , Orthonormal Wavelet bases , Multi Resolution Analysis & Construction of Wavelets from MRA	12	20	2, 3, 4	CO4	PSO9			
5	Construction of compactly supported wavelets, Riesz bases of scaling function , The Battle-Lemaire wavelets.	07	11.7	1,2,3,4	CO4	PSO5			
6	Regularity of Orthonormal wavelet bases , Orthonormal Bases of Compactly Supported Wavelets with Examples , Regularity of Compactly Supported Wavelets.	07	11.7	1,2,3	CO5, CO6	PSO2			
Reference Books									
1.	Ingrid Daubechies	:	Ten Lectures on Wavelets, OBMS-NSF SIAM, Philadelphia,1992.						
2.	Charles K. Chui	:	An introduction to wavelets, Academic Press ,1992						
3.	G. Kaiser	:	Friendly Guide to wavelets , Birkhauser Boston 1994.						
4.	E. Hernandez and Guido Weiss	:	A first course on wavelets, CRC Press, 1996.						