DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR-431004.

SUB- CAMPUS DHARASHIV.

NAAC Re- Accredited 'A+' Grade

FACULTY OF SCIENCE & TECHNOLOGY

2 Years P.G. Programme

As Per National Education Policy-2020

SUBJECT: MATHEMATICS

(Out Come Based Credit System)

Effective from Academic Year 2023-24

DEPARTMENT OF MATHEMATICS

(Autonomous)

Dr. Babasaheb Ambedkar Marathwada University, Sub- Campus, Dharashiv.

M.Sc. IInd Year Syllabus

Head
Department of Mathematics
Dr.Babasaheb Ambedkar Marathwada
University Sub-Campus, Dharashiv.

Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/ Sci./Deptt./NEP-2020/85/2024

It is hereby inform to all concerned that, the syllabus prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted the Syllabus of M.Sc. Mathematics IIIrd and IVth semester under the Faculty of Science & Technology as per Norms of National Education Policy – 2020 run at Department of Mathematics , Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar** as appended herewith.

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Chhatrapati Sambhajinagar
-431 004.
REF.NO. SU/SCI./2024/26060-68
Date:- 03.05.2024.

*****

Deputy Registrar,
Academic Section.

Copy forwarded with compliments to :-

1] **Head of the Department, Department of Mathematics, Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.**
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation, Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.
2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

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PREAMBLE

As Per the decision and directives of UGC and Government of Maharashtra (NEP-2020) the Post Graduate program in Mathematics that is 2 year/1 Year Post Graduate program is designed which will be implemented in the department of Mathematics Dr. Babasaheb Ambedkar Marathwada University ,Chhatrapati Sambhajinagar, sub-camp Dharashiv. from the academic year 2025-26. While Preparing this program the discussion with all the stake holders, resource persons and experts is taken into account. The program is aimed to develop knowledgeable and skilful human resources for local, national and international needs. The program caters the abstractness as the applicability of Mathematics to the learners.

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After Successful completion of this post graduate programme in Mathematics of 88 credits

Programme Outcomes (Pos):

The student will:

PO 1:- enter in the areas of current and advanced fields of Mathematics

PO 2:- develop analytical, scientific and critical thinking.

PO 3:-be able to apply Mathematical techniques to solve real life problems

PO 4:-be able to undertake research in mathematics and allied disciplines.

PO 5:-be employable in government, Scientific & Academic Institutions

Private sector autonomous bodies and industries.

Programme Educational Objectives (PEO):-

PEO 1:- To introduce a core and advanced branches of Mathematics

PEO 2:-To inculcate computational and numerical skills.

PEO 3:-To undertake advance research.

PEO 4:-To develop soft skills related to the subject

Programme Specific Objectives (PSO):-

PSO 1:- To understand and develop the skills in various mathematical analysis techniques.

PSO 2:-To develop mathematical modelling skill

PSO 3:- To equip students with latest mathematical software's.

PSO 4:-To develop problem solving and numerical skills.

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Two Year Post- Graduate Program
Course and Credit Distribution of Two years/PG/Master's Degree Program With Entry & Exit Option
Faculty of Science & Technology

Year/ level	Sem.	Major Subject		RM	OJT/FP	RP	Credit	Degree
		DSC Mandatory	DSE (Elective)					
First Year 6.0	I	3(4) + 2 = 14	4	4			22	PG Diploma (after 3 years Degree)
	II	3(4) + 2 = 14	4		4		22	
Cum. Cr. For PG Diploma		28	08	4	4		44	
Exit option with Post-graduate Diploma (44 credits) after first year or two semester with completion of courses equivalent to 44 credits								
Second year 6.5	III	3(4) + 2 = 14	4			4	22	PG Degree after 3 years UG or PG Degree after 4 years UG
	IV	3(4) = 12	4			6	22	
Cum. Cr. For 1 year PG Degree		26	08			10	44	
Cum. Cr. For 2 year PG Degree		54	16	4	4	10	88	
2 Year – 4 sem. PG Degree(88 credits) after three year UG Degree or 1 year- 2 sem. PG Degree(44 Credits) after four year UG degree								
8.0			Course work Min.12 credits 3(4)		Training in teaching/ Education/ pedagogy:4	16+Ph.D. Work		Ph.D. in Mathematics

Note- DSC (Discipline Specific Core) is based on specialization in Mathematics

ABBREVIATION:

Major : Comprising Mandatory- is based on specialization

DSE : Discipline Specific Elective

OJT : On –the- Job Training

FP : Field Project (Corresponding to the Major(Core) Subject

RP : Research Project (Corresponding to the Major (Core) Subject

Intership/ Apprenticeship – (Corresponding to the Major(Core) Subject

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AS PER NEP 2020

Illustrative Credit distribution structure for Two Years P. G. Programme with Multiple Entry and Exit options

(Discipline Specific Core)

Class :- M.Sc. Second Year

Semester :- III

Subject :- Mathematics

Table I: Scheme of Teaching and Examination for Third Semester M.Sc. Mathematics Programme

Course Type	Course Code	Course Name	Credits			Teaching		
			Theory	Practical	Total	Theory	Practical	Total
Major	SAS476003T	Fuctional Analysis	4	-	4	4	-	4
	SAS476013T	Partial Differential Equation	4	-	4	4	-	4
	SAS476023T	Numerical Analysis	4	-	4	4	-	4
Skill	SAS476033P	Python Programming	-	2	2	-	4	4
Elective	**Select any One**							
	SBS476043T	Fluid Mechanics-I	4	-	4	4	-	4
	SBS476053T	Operation Research –I						
	SBS476063T	Wavelet Analysis						
	SBS476073T	Difference Equations						
	SBS476083T	Ordered Fuzzy Numbers						
		NPTEL/SWAYAM/MOOC						
Research	SRS476093P	Research Project	4	-	4	4	-	4
Total			20	2	22	20	4	24

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Course Type: Major **Contact Hours: 60 (4 per week)**

Course Name: Functional Analysis **Credits: 4**

Course Code: SAS476003T **Marks: 100**

Course Objective: To introduce Banach and Hilbert spaces.

Course Outcome: The students will be able to study various fixed point theorems and spectrum of normal and self-adjoint operators which will be useful to them in proving existence of solutions of various equations.

Content:

Unit-1: Definition of normed linear spaces, Banach spaces, continuity of norm, joint continuity of vector addition and scalar multiplication in nor med linear spaces, quotient spaces, Continuous linear transformations and different criterions of continuity of linear transformations on nor med linear spaces, space of bounded linear transformations, isometric isomorphism.

Unit-II: Conjugate spaces, Hahn-Banach theorem and its consequences, natural imbedding of nor med linear space into its second conjugate, The Open Mapping theorem, the Closed graph theorem, the Uniform Boundedness theorem, conjugate of an operator.

Unit III: Inner product spaces, Schwarz's inequality, joint continuity of an inner product, parallelogram law in inner product spaces, Hilbert spaces, Orthogonal complements.

Unit IV: Orthonormal sets and complete orthonormal sets, conjugate space of a Hilbert space, adjoint of an operator, self-adjoint operators, normal and unitary operators.

Text Book:

Introduction to topology and modern analysis, G. F. Simmons (Tata McGraw-Hill Edition 2004)

Reference Book:

Principles of Functional Analysis, Martin Schechter (American Mathematical Society, 2002)

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Course Type: Major **Contact Hours: 60 (4 per week)**

Course Name: Partial Differentail Equation **Credits: 4**

Course Code: SAS476013T **Marks: 100**

Course Objective: To know: Fundamentals of DE and PDE, General analysis of PDE, Fundamentals Linear and Nonlinear PDE and Fundamentals Jacobi's method, Charpit's Method

Course Outcome: Student will become familiar with DE and PDE to find the solutions, Student will be able to analysis to classify the second order PDE, Student will become familiar with how to find the general solution of PDE by using Jacobi's method, Charpit's Method.

Content:

Unit I: First order partial differential equation, linear equations of the first order, integral surface passing through a curve, surfaces orthogonal to a given system of surfaces.

Unit II: Non-linear partial differential equations of the first order, Cauchy's method of characteristics, compatible system of first order equations (condition of compability), Charpit's method.

Unit – III: Special types of first order equations, solutions satisfying given conditions, Integral surface through a curve, Derivation of one complete integral from another, Integral surfaces circumscribing a given surfaces, Jocobi's method for solving $F(x, y, z,p,q) = 0$.

Unit-IV: The origin of second order equations, linear partial differential equations with constant coefficients, intermediate integrals or first integrals, Monge's method of integrating $Rr + Ss + TtV$, classification of second order partial differential equation (Canonical form).

Text book:

Ian Sneddon: Elements of Partial Differential Equation, Dover Publication, McGraw-Hill Book Company, New York, 1957. (Chapters 2, 3, 5 and 6)

Reference books:

(1) T. Amarnath: An elementary course in partial differential equation (2nd Edition) - Narosa Publishing House 2003.

(2) M.D. Raisighania: Ordinary and Partial Differential Equation, S. Chand & Company Ltd, New Delhi.

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Course Type: Major **Contact Hours: 60 (4 per week)**

Course Name: Numerical Analysis **Credits: 4**

Course Code: SAS476023T **Marks: 100**

Course Objective: To know: the various numerical iterative methods for solving a given equation, the various numerical iterative methods for solving a given system of equations, the various interpolating methods for finding interpolating polynomial, Numerical differentiation and integration of the various interpolating polynomial.

Course Outcome: Student will become capable find solutions of a given equation as well as given system of equations, also to find interpolating polynomials using the various interpolating methods their differentiation and integration.

Content:

Unit I: Solution of algebraic and transcendental equations: Introduction; Bisection method, Iteration methods based on first degree equations: Newton Raphson method; Secant and Regular falsi methods, Rate of convergence for secant method and Newton Raphson method; General iteration methods.

Unit – II: System of Linear Algebraic equations: Introduction; Linear system of Equations: Direct methods; Gauss Elimination method; Gauss Jordan Elimination method: Triangularization method; Iteration methods; Jacobi iteration method; Gauss seidal iteration method; successive over Relaxation (SOR) method.

Unit – III: Interpolation and approximation: Introduction; Langrange and Newton Interpolations, Finite difference operators; Interpolating polynomial using finite difference; Hermite interpolation; piecewise and spline interpolation.

Unit IV: Differentiation and integration: Introduction; Numerical Differentiation, Numerical Integration; Methods based on interpolation; Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.; Composite Integration methods; Gauss quadrature methods; Gauss-Legendre Integration methods, Gauss-Legendre Formulas.

Text Book:

1. Jain, lyengar and Jain: Numerical methods for scientific and engineering computation. (4th Edition) New Age Pub. New Delhi.

Reference Books:

1. S. S. Sastry: Introductory methods of Numerical Analysis (4th edition) Prentice Hall)

2. J. 1. buchaman and P. R. Turner: Numerical method & Analysis (PHI)

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Course Type: Skill **Contact Hours: 30 (4 per week)**

Course Name: Python Programming **Credits: 2**

Course Code: SAS476033T **Marks: 50**

Course Objective: To introduce the Python programming language to tackle mathematiocal problems

Course Outcome: The students will be able to writing of string, list, tuple, Writing Input output functions, Use of looping statements, conditional statements, Matrices in Python Programming language

Content:

Unit 1: Installation of Python, Values and types: int, float and str., The Print Function: Print basics, Variables: assignment statements, printing variable values, types of variables, Operators, operands and precedence:+, -, /,,, PEMDAS(Rules of precedence), String operations:+: Concatenation, Repetition, Boolean operator, Comparison operators: Logical operators: and, or, not, Mathematical functions from math, cmath modules, Keyboard input: input() statement, Calculus: Differentiation, Integration, Limit and Series, Strings: Length (Len function), String traversal: Using while statement, Using for statement, String slice, Comparison operators (>, <, =), Lists: List operations, Use of range function, Accessing list elements, List membership and for loop, List operations, Updating list: addition, removal or updating of elements of a list, Tuples: Defining a tuple, Index operator, Slice operator, Tuple assignment, Tuple as a return value, Dictionary, Boolean, Sets

Unit 2: Conditional and alternative statements, Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else, Looping statements such as while, for etc, Tables using while, Functions: Calling functions: type, id, Type conversion: int, float, str., Composition of functions, User defined functions, Parameters and arguments, Matrix construct, eye(n), zeros(n,m) matrices, Addition, Subtraction, Multiplication of matrices, powers and invers of a matrix, Accessing Rows and Columns, Deleting and Inserting Rows and Columns, Determinant, reduced row echelon form, nullspace, columnspace, Rank, Solving systems of linear equations (Gauss Elimination Method, Gauss Jordan, Method, LU-decomposition Method), Eigenvalues, Eigenvectors, and Diagonalization

Recommended and Reference Books:

1. Dr. KalyanraoTakale, Dr. Amjad Shaikh, Mr. Krishna Ghode, Dr. Shrikisan Gaikwad, Prof. S. R. Patil, Manual for T. Y. B. Sc./T. Y. B. A. Mathematics, MT -3510: Programming in Python -I, Nirali Prakashan, 2021.
2. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015,
3. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
4. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.
5. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle& Associates Inc.
6. Sandro Tosi, Matplotlib for Python Developers, Packt Publishing Ltd. (2009)

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Fluid Mechanics-I **Credits: 4**

Course Code: SAS476043T **Marks: 100**

Course Objective: To know fundamentals of fluids, General Analysis of fluid motions, fluid pressure, Fundamentals of motion, Fundamentals of two dimensional flows

Course Outcome: Student will become familiar with real and ideal fluids, fluid motion and other related properties.

Content:

Unit – I: Review of vector Analysis, Kinematics: Lagrangian and Eulerian methods (Rathy) Real and ideal fluids, velocity at a point, streamlines, path lines, streak lines, velocity potential, irrotational and rotational motions (Rathy), vorticity and circulation, Local and particle rates of change. The equation of continuity.

Unit – II: Acceleration of a Fluid, Conditions at rigid boundary, General analysis of fluid motion. Pressure at a point in a fluid at rest and moving fluid, conditions at a boundary of two inviseid immiscible fluids, Euler's equation of motion, Bernoulli's equation.

Unit III: Steady motion under conservative body forces, Potential Theorems, Axial symmetric flows, some two dimensional flows, Impulsive motion, some aspects of vortex motion, sources, sinks, doublets and their images.

Unit IV: Some two dimensional flows: Meaning of two dimensional flow, use of cylindrical polar coordinates, The stream function, The complex potential for two dimensional irrotational, incompressible flow, complex velocity potentials for standard two dimensional flows.

Text Books:

1. R. K. Rathy, An Introduction to Fluid Dynamics, IBH, New Delhi, 1976
Chapter-III: Article 3.1,3.5,3.6

2.F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers and distributors, Delhi, 1985.
Chapter-2: Article 2.1 to 2.10, Chapter-3 Article 3.1 to 3.12, Chapter-4: Article 4.1 to 4.3, Chapter 5: Article 5.1 to 5.10

Reference Books:

1. M. D. Raisighania, Fluid Dynamics, 11/e, S. Chand Publications.
2. S. W. Yuan Foundations of Fluid Mechanics, Prentic Hall of India Pvt. Ltd, New Deli, 1976.

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Operation Research-I **Credits: 4**

Course Code: SBS476053T **Marks: 100**

Course Objective: Students who take this course can expect to know Fundamentals of Linear Programming Problems and methods of their solutions.

Course Outcome: Student will become familiar with Linear Programming Problems and will able to find solution; Students will be able to handle Industrial Problem like Transportation Problem, and Assignment Problem using various given methods.

Content:

Unit I: Operations research and its scope, Necessity of operations research in industry, Linear programming problems, convex sets, feasible solutions, formulation of L.P.P. method for solution of LPP.

Unit II: Graphical solution of L.P.P, Simplex method; theory and problems. Computational procedure, artificial variables inverse of a matrix using simplex method.

Unit III: Duality in L.P.P., Concept of duality, properties, dual simplex method, its algorithm. parametric linear programming.

Unit-IV: Transportation and assignment problems, various methods.

Text Books:

1.KantiSwarup, P.K. Gupta and Man Mohan: Operations Research, S. Chand; & Sons,

New Delhi. Chapter-0 (Related concepts) Chapter 1, 2,3,4,6,7,9,

2. Mittal, K. V.: Optimization methods, Wiley, New Delhi.

Reference Books:

1. H. A.Taha: Operations Research- An introduction, Macmillan, New York,

2 N. S. Kambo, Mathematical-programming Techniques. Affiliated East-West Press,

New Delhi.

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Course Type: Elective | **Contact Hours: 60 (4 per week)**

Course Name: Wavelet Analysis | **Credits: 4**

Course Code: SBS476063T | **Marks: 100**

Course Objective: To introduce the latest mathematical technique of wavelet analysis.

Course Outcome: The student can use the analysis and synthesis of signal in orthogonal And bi orthogonal wavelet system and construct certain wavelet systems.

Content:

Unit-1:- Preliminary introduction to Fourier series and Fourier Transform with properties. Windowed Fourier Transform (STFT), Continuous Wavelet Transform, admissibility condition, Fourier transform of wavelet transform, Parseval's relation and inversion theorem. Properties wavelet transform.

Unit-II:- Discrete Wavelet Transform:- Harr Scaling Functions, Nested Spaces, Harr Wavelet Function, Orthogonality, Normalization at different Scales, Refinement Relation, Support of a Wavelet System, Daubechies Wavelets. Designing Orthogonal Wavelet System: Refinement relations for orthogonal wavelet systems, Restrictions on filter coefficients.

Unit-III:- Filter Banks: Signal Decomposition, Relation with filter Banks, signal Reconstruction, Upsampling and Filtering. Biorthogonality in Vector Space, Biorthogonal Wavelet Systems and Signal representation, Biorthogonal Analysis, Biorthogonal Synthesis-From Course Scale to Fine Scale, Construction of Biorthogonal Wavelet System.

Unit-IV:- Generating and Plotting of Parametric Wavelets: Orthogonality Conditions and Parameterization, Poly phase Matrix and Recurrence Relation, Wavelet Packet Analysis, Haar wavelet packet. B-splines scaling function, orthogonalization of Causal /B-splines scaling function, Anti Causal B-splines, Symmetric splines, Differentiation of B-splines, Fractional Splines.

Text Book:

1. Lokenath Debnath & Damba Bhatta, Integral Transforms and their application (2nd Ed), Chapman & Hall/CRC (2007). [Unit-1]
ISBN-10-1-58488-575-0, ISBN-13: 978-1-58488-575-7
2. Soman K. P. and Ramachandran K. I. and Resmi N. G., Insight in to Wavelets - Form Theory to Practice, (3th Ed.) P.H.I. Pvt. Ltd, New Delhi, 2010.

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Difference Equations **Credits: 4**

Course Code: SBS476073T **Marks: 100**

Course Objective: To study the Difference equations to solve numerical problems.

Course Outcome: Learns to solve various problems and applications in various fields.

Content:

Unit I: Introduction, Difference Calculus-The Difference Operator summation, Generating functions and approximate summation,

Unit – II: Linear difference Equations- first order equations, General results for linear equations. Equations with constant coefficients

Unit – III: Application, Equations with variable coefficients nonlinear equations, which can be linearized, The 2 transform.

Unit-IV : Stability Theory- Initial value problems for linear systems. Stability of linear systems Stability of nonlinear systems chaotic behaviours.

Text Book:

1. Walter G. Kelley and Allan C. Peterson: difference Equations An Introduction with applications. Academic Press, Harcourt Brace Jouranovich Pub, 1991.

Reference book:

1. Calvin Ahlbrandt and Allan C. Peterson: Discrete Hamiltonian systems Difference equations, continued fractions and riccati Equations, Kulwer, Boston 1996.

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Course Type: Elective | **Contact Hours: 60 (4 per week)**

Course Name: Ordered Fuzzy Numbers | **Credits: 4**

Course Code: SBS476083T | **Marks: 100**

Course Objective: To introduce the theory of Ordered Fuzzy Numbers. Examples and Applications.

Course Outcome: Student will become capable to distinguish between Two Approaches to Fuzzy Implication. Model Based on Ordered Fuzzy Numbers and fuzzy control.

Content:

Unit-I: Background of Fuzzy Set Theory; Basic knowledge to Fuzzy Sets, Basic knowledge to to Fuzzy Systems with their suitable examples.

Unit-II: Theory of Ordered Fuzzy Numbers: Ordered Fuzzy Numbers: Sources and Intuitions, Ordered Fuzzy Numbers: Definitions and Operations, Processing Direction with Ordered Fuzzy Numbers, Comparing Fuzzy Numbers Using Defuzzificators on OFN Shapes, Two Approaches to Fuzzy Implication.

Unit-III: Examples of Applications: OFN Capital Budgeting Under Uncertainty and Risk, Input-Output Model Based on Ordered Fuzzy Numbers, Ordered Fuzzy Candlesticks, Detecting Nasdaq Composite Index Trends with OFNs, OFNAnt Method Based on TSP Ant Colony Optimization, A New OFNBee.

Unit- IV: Examples of Applications (continued): Method as an Example of Fuzzy Observance, Applied for ABC Optimization, Fuzzy Observation of DDoS Attack, Fuzzy Control for Secure TCP Transfer, Fuzzy Numbers Applied to a Heat Furnace Control, Analysis of Temporospatial, OFN-Based Brain Function Modeling.

Text Books:

1. Piotr Prokopowicz Jacek Czerniak, Theory and Applications of Ordered Fuzzy Numbers, Springer International Publishing AG, 2017

Reference books:

1. Kaufmann A and Gupta M. M., Introduction to Fuzzy arithmetic, Van Nostrand, 1989.

2. Klir George J. and Yuan Bo, Fuzzy sets and fuzzy logic. Theory and applications. Prentice Hall of India Pvt. Ltd. New Delhi. 1997.

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Illustrative Credit distribution structure for Two Years P. G. Programme with Multiple Entry and Exit options

(Discipline Specific Core)

Class :- M.Sc. Second Year

Semester :- IV

Subject :- Mathematics

Table II: Scheme of Teaching and Examination for Fourth Semester M.Sc. Mathematics Programme

Course Type	Course Code	Course Name	Credits			Teaching		
			Theory	Practical	Total	Theory	Practical	Total
Major	SAS476504T	Linear Integral Equation	4	-	4	4	-	4
	SAS476514T	Mechanics	4	-	4	4	-	4
	SAS476524T	Fuzzy Mathematics	4	-	4	4	-	4
Elective	**Select any One**							
	SBS476534T	Fluid Mechanics-II	4	-	4	4	-	4
	SBS476544T	Operation Research –II						
	SBS476554T	Fractional Calculus						
	SBS476564T	Machine Learning for Forecasting with Python						
	SBS476574T	Fuzzy Logic And Neural Network						
		NPTEL/SWAYAM/MOOC						
Research	SRS476584P	Research Project	4	-	4	4	-	4
Total			20	2	22	20	4	24

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Course Type: Major **Contact Hours: 60 (4 per week)**

Course Name: Linear Integral Equations **Credits: 4**

Course Code: SAS476504T **Marks: 100**

Course Objective: To know the techniques of solving various integral equations.

Course Outcome: The students will come to know various types of integral equations and techniques to solve them.

Content:

Unit-I: Definition of Integral Equations and Linear Integral Equations, Types of Linear Integral Equations, Special kinds of Kemels: Separable or degenerate kernel, symmetric kernel, convolution-type kernels, Eigenvalues and Eigen functions of kernels, Solution of linear integral equations, Verification of solution of linear integral equations, Conversion of Boundary Value Problem to integral equations and vice-versa, conversion of Initial Value Problems to integral equations and vice-versa.

Unit -II: Methods of obtaining solution for Fredholm integral equations, Fredholm integral equations with separable kernels, Approximating kernels by separable kernels, Method of successive approximation, Iterated kernel method for Fredholm integral equations, Resolvant kernels and their properties, Methods of solutions for Volterra integral equations, Volterra type kernel, Method of differentiation, Method of successive approximations, Method of iterative kernels, Resolvant kernels and its use to solve Volterra integral equations.

Unit- III: Symmetric kernel, trace of a kernel, Fredholm operator, Fundamental properties of symmetric kernels, Eigen values and Eigen functions of symmetric kernel and their properties, normalized Eigen functions, Iterated kernel of symmetric kernels and their properties, Truncated kernel of symmetric kernel and necessary and sufficient condition for symmetric kernel to be separable, The Hilbert-Schmidt theorem, Method of Solution for Integral equations with symmetric kernels.

Unit – IV: Integral Transform Methods, Recall of Laplace and Fourier Transforms, Application of Laplace transform to Volterra integral equations with convolution-type kernel and examples, Application of Fourier transform to some singular integral equations and examples.

Text Book:

Linear Integral Equations Theory and Applications, R. P. Kanwal (Academic Press, 1971)

Reference Books:

(1)Integral Equations, Shanti Swarup (Krishna Publication)
(2) Integral Equations and Boundary Value Problems, M. D. Raisinghania(S. Chand & Company Pvt. Ltd. 2007)

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Course Type: Major **Contact Hours: 60 (4 per week)**

Course Name: Mechanics **Credits: 4**

Course Code: SAS476514T **Marks: 100**

Course Objective: To know Fundamentals of equation of motion, analysis of Lagranges equation, Fundamentals and applications of Hamilton's equation, Fundamentals of calculus of variations.

Course Outcomes: Student will become familiar with equation of motions, Hamilton's equations and principle of least action and to handle to solve to extremals of the functional by using Euler's equation.

Content:

Unit-I: Mechanics of system of particles, generalized coordinates, Holonomic &nonholonimic system, Scleronomic&Rheonomic system, D' Alemberts's principle and Lagrange's equation of motion, different forms of Lagrange's equation, Generalized potential, conservative fields and its energy equation, Application of Lagrange's formulation.

Unit -II: Functional, Linear functional, Fundamental lemma of Calculus of Variations simple variational problems, The variation of functional, the extermum of functional, necessary condition for extreme, Euler's equation, Euler's equation of several variables, invariance of Euler's equation, Motivating problems of calculus of variation, Shortest distance, Minimum surface of revolution, Brachistochrone Problem, Isoperimetric problem, Geodesic.

Unit –III: The fixed end point problem for 'n' unknown functions, variational problems in parametric form, Generalization of Euler's equation to (i) 'n' dependent functions (ii) higher order derivatives. Variational problems with subsidiary conditions,

Unit- IV: Hamilton's principle, Hamilton's canonical equations, Lagrange's equation from Hamilton's principle Extension of Hamilton's Principle to nonholonomic systems, Application of Hamilton's formulation (Hamiltonian) cyclic coordinates & conservation theorems, Routh's procedure, Hamilton's equations from variational principle. The principle of least action. Kepler's law of planetary motion.

Text Books:

(1) 1. H. Goldstein, Charles Poole, John Safko: Classical Mechanics, Pearson 3rd Education, 2002. Ch.-1, Ch.-2(2.1 to 2.4), Ch.. (8.2-8.6) Ch. 4 (4.1 to 4.6) (2) L. M. Gelfand & S. V. Fomin: Calculus of variations, prentice-Hall. Chapter-1 (1,2,3,4,5,6) Chapter-2 (9.10,11,12)

Reference Books:

1. N. Rana and B. Jong: Classical Mechanics, Tata McGraw Hill 1991.

2. F. Gantmacher, Lectures in Analytic Mechanics, NIR Publishing House, New Delhi.

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Course Type: Major | **Contact Hours: 60 (4 per week)**

Course Name: Fuzzy Mathematics | **Credits: 4**

Course Code: SAS476524T | **Marks: 100**

Course Objective: To introduce the theory of fuzzy sets as a measure of uncertainty and a ambiguity. Introduce the various operations on fuzzy sets and fuzzy Arithmetic operations.

Course Outcome: Student will become capable to distinguish between Classical and fuzzy approach of Mathematics.

Content:

Unit-I: From classical (crisp) sets to fuzzy sets; Introduction: crisp sets: An overview; Basic concepts in fuzzy sets, convex fuzzy sets (Theorems and exercises).

Unit-II: Fuzzy sets versus crisp sets: Additional properties of a cuts; Representation of fuzzy sets, Decomposition Theorems. Operations on Fuzzy sets, Types of operations; Fuzzy complement (Axioms and theorems).

Unit -III: Operations on Fuzzy Sets: Types of operations; Fuzzy Complements; Fuzzy intersections: t- norms; fuzzy unions: t-co norms; Combinations of operations; Aggregation of operations.

Unit –IV: Fuzzy Arithmetic: fuzzy numbers; Linguistic Variables; Arithmetic operations on intervals of real numbers; Arithmetic operations on fuzzy numbers. Fuzzy relations: Introduction; fuzzy Relations; operations on fuzzy relations; a cuts of a fuzzy relation; composition of fuzzy Relations; fuzzy relation on a domain.

Text Books:

1. Klir George J. and Yuan Bo, Fuzzy sets and fuzzy logic. Theory and applications.Prentice Hall of India Pvt. Ltd. New Delhi. 1997.

2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, (OHI), New Delhi, 2006.

Reference books:

1. Kaufmann A and Gupta M. M., Introduction to Fuzzy arithmetic, Van Nostrand, 1989.

2. Zimmermann H. J., Fuzzy set theory and its applications, 1997.

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Course Type: Elective **Contact Hours: 60 (4 per week)**
Course Name: Fluid Mechanics-II **Credits: 4**
Course Code: SBS476534T **Marks: 100**

Course Objective: To know: Fundamentals of viscous flow, stress and strain, Basics of viscosity and laminar flow, viscous incompressible fluid. Solvable Problems in viscous flow with heat transfer. Applications of flow.

Course Outcome: Student will become familiar with viscous flow, stress and strain, Navier Stock's equations, the energy equation and other aspects of fluid dynamics.

Content:

Unit-I: Viscous flows, stress components in a real fluid, Relation between Cartesian components of stress, translations motion of a fluid element, rate of strain quadrie and principal stresses, properties of the rate of strain quadric, [1].

Unit-II: Stress Analysis in Fluid Motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier Stock's equations, [1]: The energy equation, [2], [3], Equations in Cartesian, cylindrical or spherical polar coordinates for a viscous incompressible fluid: Statements only without proof, [2] [3], Diffusion of velocity and dissipation of energy due to viscosity, [1].

Unit- III: Some Solvable Problems in viscous flow with heat transfer: Flow between parallel Plates velocity and temperature distribution [2], [3] steady flow through a tube of uniform circular cross section, Velocity and Temperature Distribution, [2], [3], Distribution, [2], steady flow between concentric rotating cylinders, velocity and temperature distribution, [2], [3], Flow in tubes of arbitrary but uniform cross section, equations for velocity and Temperature in a steady flow, [1], [2], [3] Uniqueness Theorem for the velocity and Temperature, [1], Velocity distribution for tubes having equilateral triangular or elliptic cross section, [1] Velocity distribution for the flow through a tube of rectangular cross section [2], [3].

Unit-IV: Flow between two porous Plates, plane Couett of plane poisseuille flow - velocity and temperature distribution, [2], Flow through a convergent or divergent channel, [2], [3], Flow of two immiscible fluids between parallel Plates, [2], Flow due to a Plane wall suddenly set in motion or due to an oscillating plane wall, [3].

Text Books: (1) F. Chorlton: Textbook of Fluid Dynamics, C.B.S. Pub. Delhi, 1976, Ch. 8
(2) R. K. Rathy: An Introduction to Fluid dynamics, I.B.H. Puh. Co, New Delhi
1976, (§ 6.5,6.6a to 6.6c, 8.2 to 8.20, 8.2, 8.3 to 8.5b, 8.10, 11.1, 11.2,11.4,11.6,11.9, 11.9. 1196, 11.10, 11.10a, 12.2, 12.3d.).
(3) J. L. Bansal: Viscous Fluid Dynamics, Oxford and IBH Pub. Co. 1977**.**
(§2.5, 2.6, Tables 2.2, 2.4, 2.6, § 4.2 to 4.7, 4.12, 4.13, 5.1 to 5.3, 5.6, 6.1, 6.2.
(4) G. K. Batchelor: An Introduction to Fluid Mechanics, Foundation book New Delhi, 1994, (§4.2, § 4.8).

Reference Books:

1. M. D. Raisighania, Fluid Dynamics, 11/e, S. Chand Publications.
2. S. W. Yuan: Foundations of Fluid Mechanics Prentice Hall, of India, New Dehli, 1976.
3. W. H. Besaut and A. S. Ramsay: A Treatise on Hydrowecouies part II, CBS Pub. Delhi 1988:

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Operation Research - II **Credits: 4**

Course Code: SBS476544T **Marks: 100**

Course Objective: To know: Fundamentals of Dynamic programming, Nonlinear Programming. Replacement problems Network scheduling and PERT CPM.

Course Outcome: To become familiar with Dynamic Programming, nonlinear Programming and to find out Shortest Path and Critical Path for given problem.

Content:

Unit -I: Dynamic programming, computational procedure, solution of LPP by dynamic programming.

Unit –II: Nonlinear Programming introduction, general nonlinear programming problems, problem of constrained maxima and minima, graphical solution Kuhn-Tucker conditions, Quadratic programming. Integer programming.

Unit-III: Replacement problems, Applications to industrial problems.

Unit-IV: Network scheduling and PERT-CPM.

Text book:

1. Kanti Swarup P.K. Gupta and Manmohan: Operations Research, S. Chand and sons, New Delhi (Fourteenth Edition:2008) Chapter-10,11,12 (sections 12.1 to 12.5), 13 (sections 13.1 to 13.4), 18 (sections 18.1 to 18.5). 25 (sections 25.1 to 25.6 and 25.8),27. (Sections 27.1 to 27.5),28 (Section 28.1 to 28.4)

Reference Books:

1. H. A. Taha: Operations Research- An introduction, Macmillan, New York.
2. S.S. Rao: Optimization Theory and Applications, Wiley, New Delhi.
3. N. S. Kambo, Mathematical-programming Techniques. Affiliated East-West Press, New Delhi.

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Fractional Calculus **Credits: 4**

Course Code: SBS476554T **Marks: 100**

Course Objective: To introduce fractional calculus, fractional differential equations and methods of solutions.

Course Outcome: To become familiar fractional calculus, fractional differential equations and methods of solutions.

Content:

Unit 1:- Fractional Derivatives and Integrals: Grunwald_Letnikov Fractional Derivatives, Riemann-Liouville Fractional Derivatives, Caputo's Fractional Derivatives, Sequential Fractional Derivatives, Left and Right Fractional Derivatives, Properties of Fractional Derivatives.

Unit 2:- Laplace transform of Fractional Derivatives, Fourier Transform of Fractional Derivatives, Mellin Transform of Fractional Derivatives.

Unit 3:- Existence And Uniqueness Theorems: Linear Fractional Differential Equations, General form of Fractional Differential Equations, Method of solutions, Dependence on initial conditions.

Unit 4:- The Laplace Transform Method: Standard Fractional Differential Equations, Sequential Fractional Differential Equations.

References:

1. Oldham, Keith B.; Spanier, Jerome (1974). The Fractional Calculus; Theory and Applications of Differentiation and Integration to Arbitrary Order. Mathematics in Science and Engineering. V. Academic Press. ISBN 978-0-12-525550-9.

2. Miller, Kenneth S.; Ross, Bertram, eds. (1993). An Introduction to the Fractional Calculus and Fractional Differential Equations. John Wiley & Sons. ISBN 978-0-471-58884-9.

3. Samko, S.; Kilbas, A.A.; Marichev, O. (1993). Fractional Integrals and Derivatives: Theory and Applications. Taylor & Francis Books. ISBN

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Machine Learning For

Forecasting with Python **Credits: 4**

Course Code: SBS476564T **Marks: 100**

Course Objective: To know: Fundamentals of Time Series Forecasting.

Course Outcome: To become familiar with Time Series Forecasting with Python.

Content:

Unit-I: Introduction to Time Series Forecasting, Machine learning for Time Series Forecasting, Supervised Learning. Experimental setup for Time Series Forecasting.

Unit-II: Data Ingestion, Data Exploration, Data Preprocessing and Feature Engineering. Model Building, Evaluation, Deployment.

Unit- III: Common Data Preparation Operations for Time Series, Time Stamps vs Periods, Converting to Time Stamps, Indexing, Frequency Conversion, Data Cleaning of Missing Values.

Unit-IV: Auto regression, Moving Average, Autoregressive moving Average,Autoregressive Integrated Moving Average, Automated Machine Learnig.

Text book:

1. Francesca Lazzeri: Machine Learning for Time Series Forecasting with Python, Wiley, 2021

Reference Books:

1. M. P. Deisenroth, A. A. Faisal and C. S. Ong Mathematics for Machine Learning.

Cambridge University Press, 2020

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Course Type: Elective **Contact Hours: 60 (4 per week)**

Course Name: Fuzzy Logic And

Neural Network **Credits: 4**

Course Code: SBS476574T **Marks: 100**

Course Objective: To master the various fundamental concepts of fuzzy logic and artificial neural networks. This will help you to get sufficient knowledge to analyze and design the various intelligent control systems.

Course Outcome: Student will become capable to basic concept of erisp sets and fuzzy sets, basic, competitive neural networks.

Content:

UNIT- I: Fundamentals of fuzzy logic: Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets complements- union-intersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings-morphisms-fuzzy relational equations-fuzzy set and systems.

UNIT-II: Architecture of neural networks:Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions-Basic learning rules-Mcculloch-Pitts neuron- Architecture, algorithm, applications-single layer net for pattern classification- Biases and thresholds, linear separability -Hebb'srule- algorithm-perceptron -Convergence theorem-Delta rule

UNIT- III: Basic Neural Network Techniques:Back propagation neural net: standard back propagation-architecture algorithm- derivation of learning rules-number of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine.

UNIT-IV: Competitive Neural Networks:Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ARTI & RT2 Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

Text books

1. TI. Kliryvan- Fuzzy System & Fuzzy logic Prentice Hall of India, First Edition.
2. Lawrence Fussett-fundamental of Neural network Prentice Hall, First Edition.

Reference Books:

1. Bart Kosko, Neural network and Fuzzy Systeml-Prentice Hall-1994.
2. J.Klin and T.A.Folger, Fuzzy setsl University and information- Prentice Hall-1996. 3. J.M.Zurada, -Introduction to artificial neural systemsl-Jaico Publication house, Delhi 1994.
4. Vallusu Rao and Hayagvna Rao, C++ Neural network and fuzzy logicl-BPB and Publication, New Delhi, 1996.
5. Intelligent Systems and Control-http://nptel.ac.in/courses/108104049/16

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