।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
ACADEMIC (1-BOARD OF STUDIES) SECTION
Phone: (02462) 229542
Fax : (02462) 229574
Website: www.srtmun.ac.in
E-mail: bos.srtmun@gmail.com

संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे **CBCS Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७–२०२०**च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्यात येत आहेत.

1. M.Sc.-II Year-Botany
2. M.Sc.-II Year-Herbal Medicine
3. M.Sc.-II Year-Analytical Chemistry
4. M.Sc.-II Year-Biochemistry
5. M.Sc.-II Year-Organic Chemistry
6. M.Sc.-II Year-Physical Chemistry
7. M.Sc.-II Year-Computer Management
8. M.Sc.-II Year-Computer Science
9. M.Sc.-II Year-Information Technology
10. M.C.A. (Master of Computer Applications)-II Year
11. M.Sc.-II Year-Software Engineering
12. M.Sc.-II Year-System Administration & Networking
13. M.Sc.-II Year-Dairy Science
14. M.Sc.-II Year-Environmental Science
15. M.Sc.-II Year-Applied Mathematics
16. M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.Sc.-II Year-Bioinformatics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक–१/परिपत्रक/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०२०–२१/**३३५**

दिनांक : १६.०७.२०२०.

स्वाक्षरित/–
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

FACULTY OF SCIENCE
M. Sc. (Second Year) (Applied Mathematics)

Syllabus

Effective from June-2020 onwards

M.Sc. Applied Mathematics

Swami Ramanand Teerth Marathwada University, Nanded.

M. Sc. II (Applied Mathematics) (CBCS) Syllabus

Semester	Paper No.	Name of the paper	Hrs./ Week	Credits	Max. Marks		
					IA	EA (ESE)	Total
III	XIII	Functional Analysis	4	4	25	75	100
	XIV	Differential Geometry	4	4	25	75	100
	Elective-III XV(A) XV(B) XV(C)	Choose any one Programming in C Topics in Number Theory Field Theory	4	4	25	75	100
	Elective-IV XVI(A) XVI(B) XVI(C)	Choose any one Data Science Fluid Dynamics -I Difference Equation- I	4	4	25	75	100
	Elective-V XVII(A) XVII(B) XVII(C)	Choose any one Soft Computing. Integral Transforms and their applications. Fractional Calculus	4	4	25	75	100
	XVIII	Tutorial-I/Lab Work (Compulsory)		5		125	125
IV	XIX	Mathematical Modelling	4	4	25	75	100
	XX	Optimization Techniques	4	4	25	75	100
	Elective-VI XXI(A) XXI(B) XXI(C)	Choose any one Computational Fluid Dynamics Computational Geometry Combinatorics	4	4	25	75	100
	Elective-VII XXII(A) XXII(B) XXII(C)	Choose any one Data warehousing and Data Mining Fluid Dynamics - II Difference Equation - II	4	4	25	75	100
	Elective-VIII XXIII(A) XXIII(B) XXIII(C)	Choose any one Machine Learning Integral Equations: Theory and Applications Dynamical System and Applications	4	4	25	75	100
	XXIV	Project work (Compulsory)		5		125	125
		Total		50			1250

Swami Ramanand Teerth Marathwada University, Nanded.

M. Sc. II (Applied Mathematics) (CBCS) Syllabus

Effective from June-2020

Third Semester		**Fourth Semester**	
Paper No.	**Name of the paper**	**Paper No.**	**Name of the paper**
XIII	Functional Analysis	XIX	Mathematical Modelling
XIV	Differential Geometry	XX	Optimization Techniques
One paper to be chosen from following papers which are taught in the department.			
Elective-III XV(A) XV(B) XV(C)	Choose any one Programming in C Topics in Number Theory Field Theory	Elective-VI XXI(A) XXI(B) XXI(C)	Choose any one Computational Fluid Dynamics Computational Geometry Combinatorics
Elective-IV XVI(A) XVI(B) XVI(C)	Choose any one Data Science Fluid Dynamics -I Difference Equations- I	Elective-VII XXII(A) XXII(B) XXII(C)	Choose any one Data warehousing and Data Mining Fluid Dynamics - II Difference Equations - II
Elective-V XVII(A) XVII(B) XVII(C)	Choose any one Soft Computing Integral Transforms and their applications Fractional Calculus	Elective-VIII XXIII(A) XXIII(B) XXIII(C)	Choose any one Machine Learning Integral Equations: Theory and Applications. Dynamical System.
XVIII	Tutorial-I/Lab Work (Compulsory)	XXIV	Project work (Compulsory)

Paper No- XIII

Functional Analysis

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces the concepts and develop working knowledge on Banach Space, Norm of continuous Linear Transformations, continuous Linear functional, Conjugate space, Banach Algebra, Inner Product Space, Hilbert Space, Orthogonal vectors, Orthonormal vectors and sets, conjugate space H*, self adjoint, normal and unitary operators, Projections, Eigen value and Eigen vectors, Eigen space and Spectrum of T.

Course Outcome:

After completing this course, the student will be able to:

CO1: Identify Normed Linear Space, Banach Space, continuous Linear transformations, Conjugate space, Banach Algebra, Graph of L.T., Hahn-Banach Theorem and it's applications, Open Mapping and Closed Graph Theorems.
CO2: Analyze Hilbert space, Orthogonal and Orthonormal vectors and sets, Orthogonal Compliments and conjugate space H*., Schwartz Lemma, Bessel's Inequality and Riesz representation theorem.
CO3: To Identify, Self Adjoint, Normal, Unitary and Positive operators and to analyze the invariant subspace and reducible transformations.
CO4: To Provide information on Eigen Value, Eigen Vectors, Eigen Spaces and Spectrum of T.

Unit - I

Normed linear Space, Banach Space, Some examples, Subspace and Quotient Space Holder's Inequality, Continuous linear transformations, The Hahn-Banach theorem, Applications of Hahn Banach Theorem, The natural embedding of N in N**, The Open Mapping Theorem, Closed Graph Theorem, The conjugate of an operator, Uniform Boundedness Principle Theorem.

Unit- II

Inner product. Inner product space, The definition and some simple properties, Parallelogram law, Polarization identity, Schwarz Inequality, Orthogonal vectors, Orthogonal set, Vector orthogonal to a set, Pythagoras theorem and applications, Orthogonal complements, Pythagoras theorem and applications, Orthonormal vectors, Orthonormal set, Complete orthonormal set, Bessel's Inequality, The conjugate space H*, Riesz Representation Theorem.

Unit- III

Operator, The adjoint of on operator, definition and examples. Properties of adjoint of operator of T, The Self adjoint operators, Positive operators, Normal operators, Real and Imaginary part of an operator. Normal Operator, Unitary operator, Projections on Hilbert space, Orthogonal Projection. Invariant subspace, Reducibility.

Unit-IV

Introduction, Finite dimensional Hilbert, Eigen value, Eigen vector, eigen space, spectrum of an operator, The spectral theorem.

Text Book:

1. S.H. Friedberg, A.J. Insel, L.E. Spence, Introduction to "Topology and Modern Analysis" McGraw-Hill Book Company, International student Edition, New York.

Scope: Unit I - Chapter 9.

Unit II - Chapter 10 - Art 52 to 55.

Unit III - Chapter 10 - Art 56 to 59.

Unit IV - Chapter 11 - Art 62.

Reference Book:

1. B.V. Limaye, "Functional Analysis", Wiley Eastern Ltd.
2. G. Bachman and L. Narici "Functional Analysis" Academic Press 1966.
3. D. Somasundaram , "A First Course in Functional Analysis" Narosa Publication.

Paper-XIV

Differential Geometry

Max. Periods: 60(04 Credits)

Course Objective:

In this course we introduced various fields and curves, directional derivatives, Frenet formulas for unit speed and for arbitrary speed curves, Calculus on surface, Differentiable functions and tangent vectors, various curvatures, computational techniques, special curves, surfaces of revolution and congruence of surfaces.

Course Outcome:

After completing this course, the student will be able to:

CO1: Explain directional derivatives of the functions.
CO2: Analyse unit-speed and arbitrary-speed curves.
CO3: construct the parametrizations of different surfaces.
CO4: formulate different types of curvatures of given surface.

Unit-I

Euclidean space, Tangent vectors and tangent vector fields, frame field, representation of curves, standard curves, directional derivatives, differential forms, speed of curve.

Unit – II

The Frenet formulas for unit speed and for arbitrary speed curves, Isometries in R^3, translation, rotation, orthogonal transformation, Frenet approximation of curves, covariant derivatives,

Unit – III

Calculus on surface, Coordinate patches, surface of revolution, Patch computation, Parametrization of a region X(D) in M, Differentiable functions and tangent vectors.

Unit –IV

Shape operator, normal curvature, Gaussian curvature, mean curvature, computational techniques, special curves, surfaces of revolution. Congruence of surfaces.

Text Book:

1. O'Neill, B., Elementary Differential geometry, Academic Press,
Revised Edition,
Scope: Article 1.1. to 5.7

Reference Books:

1. K. S. Amur, Differential Geometry, Narosa Publishing House, 2010.

2. D. Somasundaram, Differential Geometry- First Course, Narosa Publishing House, New Delhi, 2010.

3. Nirmala Prakash, Differential Geometry, Tata McGraw Hill, 1981.

4. Millman, R. and Parker, G. D. Elements of Differential Geometry, Prentice-Hall of India Pvt. Ltd. 1977.

5. Hicks, N., Notes on Differential Geometry, Princeton University Press (1968)

Paper No – XV(A)

Programming in C

Max. Periods: 60 (04 Credits)

Course Objectives:

This main objective of the course is introduce programming language. The course gives brief idea of constants, operators, conditional expressions, statement, loops, function, data types, storage classes, arrays, pointers, structures, program for sorting numbers and solving problems.

Course Outcomes:

After completion of the course, student will be able to

CO1: Classify constants and operators.
CO2: Analyse appropriate loop and syntax.
CO3: Explain arrays and pointers.
CO4: Write correct C program for particular problem.

Unit-I

Operators and expressions, library function, types of decision control statement, conditional expression, flowchart, comma operator, continue and break statements,

Unit-II:

Conditional compilation, function, calling function, returning values, execution of recursive functions, data types and storage classes, external storage class, static storage class.

Unit-III:

Array definition and declaration, strings, introduction to pointers, 2 dimensional array of characters. Explanation of sorting methods, selection sort, program for sorting numbers.

Unit-IV:

Pointers and arrays, operations on pointers, subtraction of one pointer from another, comparison of two pointer variables, array of pointers, pointer to function, definition structure. Exercises**.**

Text Book

Let us C, Yashwant Kanetkar, BPB publisher, India

Scope: Chapter 1 to 10

Reference Books:

1) The C programming language, Brian W. Kernighan and Dennis M., Prentice Hall
2) Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill Education
3) Head first C, David Griffiths and Dawn Griffiths, O'Reilly media Inc.

Paper No –XV(B)

Topics in Number Theory

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces the concepts of congruence's and their properties, Chinese Remainder theorem, Fermat's and Wilson's theorem, Primitive roots and indices, Euler's criterion, The Legendre symbol and its properties, Gauss Lemma, Quadratic reciprocity law, Pythagorean triple, arithmetical functions and Dirichlet multiplication.

Course Outcome:

After completing this course, the student will be able to:

CO1: Understand the concepts of congruence and their properties, solve systems of linear congruence's with different moduli using the Chinese Remainder Theorem.
CO2: Analyze primitive roots and indices.
CO3: Discuss Legendre symbol and its properties, Quadratic reciprocity law.
CO4: Study arithmetical functions and Dirichlet multiplication.

Unit-I:

Congruence, Basic properties of congruence, Binary and decimal representation of integers, Linear congruence's and Chinese Remainder theorem, Pierre de Fermat theorem, Fermat's little theorem and pseudo-primes, Wilson's theorem.

Unit-II:

The order of an integer modulo n, primitive roots for primes, Lagrange's theorem, Composite numbers having primitive roots, the theory of indices.

Unit-III:

Euler's criterion, The Legendre symbol and its properties, Gauss Lemma, Quadratic reciprocity, Quadratic reciprocity law, Quadratic congruence's with composite moduli, The equation $x^2+y^2=z^2$, Pythagorean triple.

Unit-IV:

The Mobius function $\mu(n)$, The Eular Totient function $\varphi(n)$, A relation connecting μ and φ, The product formula for $\varphi(n)$, Dirichlet product of arithmetic function, Dirichlet inverses and Mobius inversion formula, The Managoldt function $\Lambda(n)$, Multipicative function, Multipicative function and Dirichlet Multiplication, Inverse of Completely multiplicative function, Liouville's function, The divisor function, Generalized convolution, Formal power series, The Bell series of an arithmetic function, bell series and Dirichlet multiplication, derivatives of arithmetic function, The Selberg identity.

Text Book:

1. David M. Burton, "Elementary Number Theory" Tata McGraw-Hill Pub. VI Edition.
2. Tom M. Apostol, "Introduction to Analytic Number Theory" Springer International Student Edition, Narosa, Publishing house 1989.

Scope: Unit I - Chapter 4, Chapter 5- Art 5.1 to 5.3.
Unit II - Chapter 8.
Unit III - Chapter 9, Chapter12 - Art 12.1.
Unit IV - Chapter 2.

Reference Books:

1. J.P. Serre, "A course in arithmetic", GTM Vol.7, Springer Verlage 1973.
2. Niven and H.S. Zuckerman, "An Introduction to the Theory of Numbers", Wile Eastern Limited, New Delhi, 1976.

Paper No – XV(C)

Field Theory

Max. Periods: 60 (04 Credits)

Course Objective:

This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge on field in order to develop a background for studying Commutative algebra and Representation Theory. To introduce the concepts and to develop working knowledge of field extensions, Galois groups and interrelation between group theory and field theory.

Course Outcome:

After completing this course, the student will be able to:

CO1: Understand the main algebraic properties of fields.

CO2: Analyze properties of Finite, Algebraic, Normal, Simple, Cyclic & Separable extension and Splitting Fields.

CO3: Compute Galois groups in simple cases and to apply the group-theoretic information to comprehend results about fields and field extensions.

CO4: Understand the concepts Cyclotomic polynomials, Polynomials solvable by radicals, symmetric functions, ruler and compass construction.

Unit-I:

Irreducible polynomial and Eisenstein criterion, Adjunction of roots, Algebraic extensions, algebraically closed field.

Unit-II:

Splitting field, Normal extension, Multiple Roots, Finite Field, Separable Extensions.

Unit-III:

Automorphism groups and fixed fields, fundamental theorem of Galois theory, fundamental theorem of algebra.

Unit-IV:

Roots of unity and cyclotomic polynomials, Cyclic extension, polynomials solvable by radicals, symmetric functions, Ruler and Compass construction.

Text Book:

P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

Scope: Unit I - Chapter 15, Art 1 to 4.
Unit II - Chapter 16 Art 1 to 5.
Unit III - Chapter 17 Art 1 to 3.
Unit IV - Chapter 18 Art 1 to 5.

Reference Books

1. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999.

2.I. S. Luthar and I. B. S. Passi, "Algebra-Vol. II: Groups", Narosa, New Delhi, 1996.

3. V.K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition).

Paper – XVI(A)

Data Science

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces terminology and types of data, exploring and fixing of data, data storage and management, data encoding, visual encodings, basic machine learning algorithms, Naïve Bayes, types of data visualisation and applications of data science.

Course Outcomes:

After completion of the course, student will be able to

CO1: Explains data science process and its types.
CO2: Identify the sources of data and its management.
CO3: Write the basic machine learning algorithms.
CO4: Visualise data, encode the data and visualise encodings of data.

Unit-I

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications

Unit-II:

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources

Unit-III:

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

Unit-IV:

Data visualisation: Introduction, Types of data visualisation, Data for visualisation: Data types, Data encodings, Retinal variables, mapping variables to encodings, Visual encodings. Applications of Data Science.

Text Book:

Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk from The Frontline. O'Reilly, 2013
Scope: Chapter 1 to 6

Reference Books:

1. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, Mining of Massive Datasets. v2.1, Cambridge University Press, 2014

Paper – XVI(B)

Fluid Dynamics – I

Max. Periods: 60 (04 Credits)

Course Objectives:

The course introduces basic idea of various fluid flow, velocity and acceleration of fluid motion. The main objective of the course is to study Equation of continuity, Euler equation, Bernoulli equation, effect of pressure on fluid flow, stream function, some two dimensional flows and applications to real life.

Course Outcomes:

After completion of the course student will be able to

CO1: To visualize the fluid flow pattern.
CO2: Assimilate the meaning of continuity equation.
CO3: Solve two dimensional flow problems symmetric about an axis.
CO4: Acquire command on stream function and line doublets.

Unit – I

Real fluids and Ideal fluids, Velocity of fluid at a point, Streamlines and Pathlines, steady and unsteady flows, the velocity potential, the vorticity vector, Local and particle rates of change, the equation of continuity, worked examples, acceleration of fluid, Conditions at a rigid boundary, general analysis of fluid motion.

Unit – II

Pressure at a point in a fluid at rest, Pressure at a point in a moving fluid, Conditions at a boundary of two inviscid immiscible fluids, Euler's equation of motion, Bernoulli's equation, Mechanism of Pitot Tube and Venturi meter, worked examples.

Unit - III

Discussion of the case of steady motion under conservative body forces, some potential theorems, some flows involving axial symmetry, some special two dimensional flows, Impulsive motion, some further aspects of vortex motion.

Unit – IV

Meaning of two dimensional flow, use of cylindrical polar coordinates, The Stream function, The complex velocity potentials for standard two-dimensional flows, Uniform stream, line sources and line sinks, line doublets, line vortices, some worked examples.

Text Book:

Text book of Fluid Dynamics, F Charlton, Reprint 1998, C B S Publishers and distributors, Delhi –110 002

Scope :

Unit-I Chapter 2, 2.1-2.11

Unit-II Chapter 3, 3.1-3.6

Unit-III Chapter 3, 3.7-3.12

Unit-IV Chapter 5, 5.1-5.6

Reference Books:

1, G.K. Batchelor- An Introduction to Fluid Mechanics (Foundation Book-New Delhi 1994)

2. W.H. Besaint and A.S. Ramsey – A Treatise on Hydro Mechanics Part II, CBS Publisher-1998.

3. S.W. Yuan – Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd- New Delhi 1976.

Paper No –XVI(C)

Difference Equation – I

Max. Periods: 60(04 Credits)

Course Objectives:

The course introduced the elementary analysis and linear algebra to investigate solution to difference equation. To study linear difference equations, stability theory and asymptotic methods.

Course Outcome:

After completing this course, the student will be able to:

CO1: Understand the role of differential operator in differential calculus.
CO2: Analyze the linear and nonlinear difference equations.
CO3: Study the stability of linear and nonlinear systems.
CO4: Discuss asymptotic methods for solving of linear and nonlinear systems.

Unit-I

The Difference operator, Summation, Generating functions and approximate summation.

Unit – II

First order equations, General results for linear equations, solving linear equations, Applications, Equations with variable coefficients, Nonlinear equations that can be linearized, The Z-Transform.

Unit – III

Initial value problems for linear systems, Stability of linear systems, Stability of nonlinear systems.

Unit – IV

Introduction, Asymptotic analysis of sums, linear equations, non-linear equations.

Text Book:

1. Walter G. Kelley and Allan C. Peterson, “Difference Equations”, Academic Press, Second Edition.

Scope: Unit-I Chapter 2.
Unit-II Chapter 3.
Unit-III Chapter 4 Art 4.1, 4.2, 4.5.
Unit-IV Chapter 5.

Reference Books

1. Calvin Ahlbrandt and Allan C. Peterson, “Discrete Hamiltonian Systems: Difference Equations, Continued Fractions and Riccati Equations, “Kluwer, Boston, 1996.
2. Saber N. Elaydi “An Introduction to Difference Equations” Springer, Second Edition.

Paper No – XVII(A)

Soft Computing

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces soft computing and neural network, fuzzy sets, operation on fuzzy sets, fuzzy interface system, fuzzy decision making, neural networks, Artificial Neural Network and Fuzzy Logic Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm.

Course Outcomes:

After completion of the course, student will be able to

CO1: Explain soft computing and neural networks.

CO2: Define membership function, fuzzy interface system.

CO3: Discuss the adaptive networks, feed forward network and advances of neural networks.

CO4: Enumerate study of neural network toolbox and fuzzy logic toolbox.

Unit-I

Introduction to Soft Computing and Neural Networks: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics

Unit-II:

Fuzzy logic: Fuzzy sets, operations on Fuzzy sets, Fuzzy relations, membership function. Fuzzy rules and fuzzy reasoning, fuzzy inference systems, fuzzy expert system fuzzy decision making.

Unit-III:

Neural Networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks

Unit-IV:

Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.

Text Book:

Shing Roger Jang, Chuen, Tsai Sun, Eiji Mizutani, Neuro: Fuzzy and Soft**.** Computing, Prentice Hall of India, 2003
Scope: Chapter 1 to 7.

Reference Books:

1 George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995

Paper No - XVII(B)

Integral Transforms and Their Applications

Max. Periods: 60(04 Credits)

Course Objective

The objective of this course is to introduce students the different types of integral transforms which are commonly used, their formulation concerned to real world problems, their evaluation and applications to solve ordinary and partial differential equations.

Course Outcomes

After completion of the course student will be able to

CO1: Classify the different types of integral transforms they come across.

CO2: Formulate the physical problem under consideration in terms of different types of ordinary and partial differential equations with initial and boundary conditions.

CO3: Solve the initial value problems and boundary value problems using the appropriate integral transform.

CO4: Analyze the nature of the solution of the initial value problems and boundary value problems.

Unit-I

The Laplace Transform: Introduction, The Laplace Transform of some typical functions, Basic operational properties, Transforms of more complicated functions, The inverse Laplace Transform, Complex Inversion Formula.

Unit-II

Applications involving Laplace Transform: Introduction, Evaluating integrals, Solutions of ODEs, Solutions of PDEs. The Mellin transform, Evaluation of Mellin transform, Complex variable methods, Applications.

Unit-III

Fourier integrals and Fourier Transforms: Introduction, Fourier integral representations, Proof of the Fourier integral theorem, Fourier transform pairs, Properties of the Fourier Transform, The convolution integrals of Fourier.

Unit-IV

Applications involving Fourier transforms: Introduction, Boundary value problems, Heat conduction in solids, The Hankel Transform, Introduction, Evaluation of Hankel Transform, Applications.

Text Books:

1. Larry C. Andrews, Bhimsen K. Shivamoggi, *Integral Transforms for Engineers*, Prentice Hall of India, New Delhi.

Scope: Unit-I: Chapter 4 Sections 4.1 to 4.6

Unit-II: Chapter 5, Sections 5.1 to 5.4, Chapter 6, Sections 6.1 to 6.4

Unit-III: Chapter2, Sections 2.1 to 2.5, 2.7

Unit-IV Chapter 3, Sections 3.1 to 3.3, Chapter 7, Sections 7.1 to 7.3.

Reference Books:

1. J. K. Goyal, K. P. Gupta, *Integral Transforms*, Pragati Prakashan, Meerut.

2. A. R. Vasishtha, Dr. K. L. Gupta, *Integral Transforms*, Krishna Prakashan Mandir, Meerut.

Paper No – XVII(C)

Fractional Calculus

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces some special functions of the fractional calculus, Riemann-Liouville fractional derivative, Caputo's fractional derivative, Laplace, Fourier and Mellin transforms of fractional derivatives, Existence and uniqueness theorem as a method of solution.

Course Outcome:

After completing this course, the student will be able to:

CO1: Understand the Gamma, Mittag-Leffler, Wright functions of the fractional calculus.
CO2: Study Riemann-Liouville and Caputo's fractional derivative.
CO3: Analyze the integral transform methods of solution of fractions differential equations.
CO4: Study existence and uniqueness theorem of fractions differential equations.

Unit-I

Definition of Gamma function and Beta function, Some properties of Gamma and Beta functions, Relation between Gamma and Beta functions, Definition of Mittag-Leffler functions of one and two parameters, Relations of Mittag-Leffler function in two parameters, Wright function, Definition of Wright function, Integral relation and relation to other functions.

Unit-II

Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivative, some other Approaches-Caputo's fractional derivative, generalized functions approach, Sequential fractional derivatives, Left and right fractional derivatives.

Unit-III

Laplace transform of fractional derivatives, Fourier transform of fractional derivative and Mellin transform of fractional derivative.

Unit-IV

Linear Fractional differential equations, fractional differential equations of a general form, Existence and uniqueness theorem as a method of solution, dependence of a solution on initial conditions.

Text Book:

Igor Podlubny, “Fractional Differential Equations”, Academic Press, San Diego, California, 92101-4495, USA

Scope: Unit I - Chapter 1.
Unit II - Chapter 2- Art 2.1 to 2.6.
Unit III - Chapter 2- Art 2.7 to 2.10.
Unit IV - Chapter 3.

Reference Books:

1. Miller K.S. and Ross B., “An Introduction to Fractional Calculus and Fractional Differential Equations”, New York, John Wiley, 1993.

2. Oldham K.B. and Spanier J., “The Fractional Calculus”, New York, Academic Press, 1974.

Paper – XVIII

Tutorial –III 05 Credits

Papers	Marks	Credits
Tutorial on theory paper –XIII	25	1
Tutorial on theory paper –XIV	25	1
Tutorial on theory paper –XV(A/B/C)	25	1
Tutorial on theory paper –XVI (A/B/C)	25	1
Tutorial on theory paper –XVII (A/B/C)	25	1
Total	125	5

The format for scheme of marking for tutorial of 25 marks in each paper is as follows:

Tutorial: ------- Paper No. and Name: ------

Sr.No	Name of Student	Seat No	Seminar	Attendance	Viva	Total
			10 Marks	5 Marks	10 Marks	25 Marks

Signature of Teacher:

The format in which the marks obtained by students in tutorial of 125 marks, to be submitted by HOD through the Principal to BOEE S.R.T.M.U. Nanded is as follows.

Sr. No.	Name of the student	Seat No.	Tutorial					Total
			Paper No.----	Paper No.----	Paper No.----	Paper No.----	Paper No.----	
			Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 125

Head of the Department

Paper – XIX

Mathematical Modelling

Max. Periods: 60 (04 Credits)

Course Objectives:

The course introduces characteristics, classification and techniques of mathematical modelling. Moreover, mathematical modelling though ordinary differential equation of first order, system of ODE of first order, second order ordinary differential equation and partial differential equation.

Course Outcomes:

After completion of the course, student will be able to

CO1: Define mathematical modelling and its classification.
CO2: Gain command over mathematical modelling.
CO3: Prepare model using differential equation.
CO4: Construct model with the help of partial differential equation.

Unit – I

The technique of mathematical modelling, classification and characteristic of mathematical models, Mathematical modelling through geometry, Mathematical modelling through algebra, Mathematical modelling through trigonometry, Mathematical modelling through calculus, limitations of Mathematical modelling**.**

Unit – II

Mathematical modelling through differential equations, linear growth and decay models, compartment models, Mathematical modelling in dynamics through ODE of first order, Mathematical modelling of geometrical problems through ODE of first order.

Unit- III

Mathematical modelling in population dynamics, Mathematical modelling of Epidemics through system of ODE of first order, Compartment models through systems of ODE, Mathematical modelling of in economics through system of ODE of first order, Mathematical modelling in medicine and dynamics.

Unit- IV

Mathematical modelling of planetary motions, Mathematical modelling of circular motion and motion of satellites, Mathematical modelling through differential equation of second order. First method of getting PDE models, equation of continuity for heat flow.

Text Book:

Mathematical Modelling, J N Kapur, New Age International Publishers, New Delhi

Scope: Unit I, Chapter 1 complete
Unit II, Chapter 2 complete
Unit III, Chapter 3 complete
Unit IV, Chapter 4 complete, Chapter 6, 6.1 to 6.3

Reference Books:

1) M. Cross, The art of Mathematical Modelling, Ellis Horwood and John Wiley.

2) C Dyson and E Ivery, Principal of Mathematical Modelling, Academic Press, New York

3) E Kreyszing, Advanced Engineering Mathematics, Wiley International Edition

4) D J White, Dynamic Programming, Addison Wesley, New York

Paper- XX

Optimization Techniques

Max. Periods: 60(04 Credits)

Course Objective:

In this course we introduce the basic concepts of Operations Research such as Linear Programming Problem, Duality in Linear Programming, Transportation Problem, Assignment Problem and Game Theory.

Course Outcome:

After completing this course, the student will be able to:

CO1: Explain Graphical Method, Simplex Method, Big-M method, Two Phase method.
CO2: Apply Duality to solve problems in Linear Programming.
CO3: Analyze the test of optimality for Degeneracy by using Transportation Algorithms.
CO4: Discuss the Assignment Problem and its Applications, game theory.

Unit-I:

Definitions, Graphical method, Simplex Method (Technique or Algorithm), Duel Simplex Method, Big-M method, Two Phase method.

Unit-II:

Introduction to the model, Definition of the Transportation Model, Matrix Terminology, Formulation and solution of transportation models, Variance in transportation problems, Least time transportation Problems, Post Optimality analysis in Transportation, Trans-Shipment Problems.

Unit-III:

Definition of Assignment Model, Mathematical representation of the assignment model, Comparison with the Transportation model, Solution of the Assignment problem, Hungerian method for solution of the assignment problems, Formulation and solution of assignment Models.

Unit-IV:

Variations of the Assignment problem, Sensitivity analysis in Assignment problems, Travelling Salesman problem (Shortest Cyclic Route Models), The theory of games, Characteristics of games, Game Models, Saddle Points, Two by Two and three by three Game Theory, Optimization.

Text Book:

Premkumar Gupta, D. S. Hira, “Operation Research”, S. Chand and Co. Ltd.

Scope: Unit 1: - Art.2, 2.9, 2.16, 2.17, 2.17.1, 2.17.2.

Unit 2: - Art.3.1 to 3.10.

Unit 3: - Art.4.1, 4.6.

Unit 4: - Art. 4.7, 4.10, 9.10 to 9.18.

Reference Books:

1. H.A. Taha , “Operation Research”, Prentice Hall.
2. Kanti Swarup, “Operation Research”, S. Chand Co.

Paper – XXI(A)

Computational fluid dynamics

Max. Periods: 60(04 Credits)

Course Objective:

Computational fluid dynamics constitutes a new third approach in the philosophical study and development of the whole discipline of fluid dynamics. The fundamental aspects is to develop numerical discretization of the governing equations, the discretization of the partial differential equation and some popular numerical techniques.

Course Outcome:

After completing this course, the student will be able to:

CO1: Explain experimental, theoretical and computational approaches.
CO2: Construct forward, backward and central difference formulae**.**
CO3: Analyse stability, convergence & consistency of finite difference schemes.
CO4: Solve problems in CFD using computer software.

Unit-I

Comparison of experimental, theoretical and computational approaches, Finite difference method, overview of programming languages, conservation equations, Reynolds averaged Navier-Stoks equation, Stokes flow, boundary layer, stability equations, classification of conservation equation, boundary conditions.

Unit – II

Model equations, discretization of derivatives with finite differences, explicit method, implicit method for parabolic equations, finite difference methods for elliptic equations using direct method, iterative method and multigrid method.

Unit – III

Numerical method for modelling hyperbolic equations, Explicit method using two step Lax-Wendorff method, Mac Cormack method, Implicit methods, Upwind methods, numerical dissipation and dispersion, artificial viscosity.

Unit – IV

Inviscid flow equations for incompressible fluids, Laplace equation and its fundamental solutions, Finite difference method, Finite difference schemes for Burgers equation, FTCS method, a panel proagram for airfoils, subroutine GAUSS, subroutine VPDIS, subroutine CLCM.

Text Book

Computational Fluid Dynamics: An introduction, J D Anderson, J E Wendt, G Degrez and E Dick, Springer Verlog

Scope: Chapter 1 to 6

Reference Books

1. J D Anderson, Computational Fluid Dynamics: Basics with applications, McGraw Hill

2. C T Shaw, Using computational fluid Dynamics, Prentice Hall

3. G D Smith, Numerical Solution of Partial Differential Equations: Finite Difference Methods, Oxford Applied Mathematics and Computing Science Series, Oxford University Press, 1985.

4. C. A.J. Fletcher, Computational Techniques for Fluid Dynamics Vol. I & II, Springer Verlag Berlin Heidelberg, 1988

5.T J Chung, Computational Fluid Dynamics, Cambridge University Press, 2002.

Paper- XXI(B)

Computational Geometry

Max. Periods: 60(04 Credits)

Course Objective:

To introduce explore the applications of geometry to computer graphics and computer aided design, the manipulation and the representation of geometric objects. To study planner and spatial transformations to construct objects from geometric primitives and to manipulate existing objects.

Course Outcome:

After completing this course, the student will be able to:

CO1: Explain transformations in homogenous coordinates.
CO2: Analyse the concept of concatenation of transformations.
CO3: classify conics, intersections of a conic with a line.
CO4: Describe B-splines and properties of the B-spline curve

Unit-I

Translation, scaling about origin, reflection, rotations, shears, concatenation of transformations, applications, Homogenous coordinates, points at infinity, projective plane, transformations in homogenous coordinates.

Unit- II

Transformations of the space: translations, scaling, reflections, rotations about coordinate axes, rotation about an arbitrary line, reflection in an arbitrary plane, applications to computer aided design, projections.

Unit – III

Curves: curve rendering, parametric curves, arclenght and reparametrization, classification of conics, intersections of a conic with a line, parametrization of an irreducible conic, conics in space, applications of conics.

Unit –IV

Bezier curves of low degree, linear Bezier curves, quadratic Bezier curves, cubic Bezier curves, the general Bezier curve, properties of the Bernstein polynomials, properties of Bezier curves. Introduction to B-splines, properties of the B-spline Curve

Text Book

Duncan Marsh, Applied Geometry for Computer Graphics and CAD (Springer, Second Edition)

Scope:

Unit I Article 1.1 to 2.4
Unit II Article 3.1 to 3.3
Unit – III Article 5.1 to 5.8
Unit – IV Article 6.1 to 6.7 and 8.1

Reference Books

1) Gibson, C G, Elementory Geometry of Algebraic curves, Cambridge University press, 1998

2) Davis P, B – splines and geometric design, SIAM, 1996

3) Hoschek, J and Lasser, Fundamentals of computer Aided Geometric Design, 1993

4) de Berg, van Kreveld Oyermars and Schwarzkopf, Computational Geometry Algorithms and Applications, 2nd edition, Springer Verlag.

Paper – XXI(C)

Combinatorics

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces the basic concepts of counting principles, arrangements and selections permutations and combinations, Generating functions, recurrence relations, inclusion exclusion principle and rook polynomials.

Course Outcomes:

After completion of the course, student will be able to

CO1: Comprehend the rules of sum and product of permutations and combinations.
CO2: Identify the solution techniques of generating function.
CO3: Discuss the recurrence relations, divide and conquer relations.
CO4: Analyze the Inclusion exclusion principle and rook polynomials.

Unit-I

Basic counting principles, Simple arrangements and selections, Arrangements and selection with repetition, Distributions, Binomial Identities.

Unit-II:

Generating function models, Calculation of generating functions, Partitions, Exponential generating functions, a summation method.

Unit-III:

Recurrence relations: Recurrence relation model, Divide and conquer relations, Solution of linear recurrence relations, Solution of inhomogeneous recurrence relations, Solution with generating functions.

Unit-IV:

Counting with Venn diagrams, Inclusion-exclusion formula, Restricted positions and Rook polynomials.

Text Book:

1. **Alan Tucker**, "Applied Combinatorics", (3rd edition), John Wiley & sons, New York (1995)

Scope: Unit I: Chapter 5: Complete
Unit II: Chapter 6: Complete
Unit III: Chapter 7: Complete
Unit IV: Chapter 8: Complete

Reference Books:

1. V. Krishnamurthy, "Combinatorial, Theory and Applications", East West Press, New Delhi (1989) Scientific, (1996).

2. V.K. Balakrishnan, "Theory and Problems of Combinatories", Schaum outline series, Mcgraw Hill, New York

Paper – XXII(A)

Data Warehousing and Data Mining

Max. Periods: 60 (04 Credits)

Course Objectives:

This course gives brief of data warehousing and data mining, mining concepts, data in cluster analysis, transactional patterns and other temporal based frequent patterns, mining time series data, mining data streams, graph mining, automatic classification of web document and web usage mining.

Course Outcomes:

After completion of the course, student will be able to

CO1: Define data mining, mining data stream. Graph mining.
CO2: Identify Transactional Patterns and other temporal based frequent patterns.
CO3: Discuss the Trend analysis and Similarity search in Time-series analysis
CO4: Explain Methodologies for stream data processing and stream data systems.

Unit-I

Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods.

Unit-II:

Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods, Transactional Patterns and other temporal based frequent patterns.

Unit-III:

Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis and Similarity search in Time-series analysis, Mining Data Streams

Unit-IV:

Methodologies for stream data processing and stream data systems, frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis Automatic classification of web documents and web usage mining.

Text Book:

Jiawei Han and M Kamber, Data Mining Concepts and Techniques, 2/e, Elsevier Publishers, 2011
Scope: Article 1 to 13

Reference Books:

1. Vipin Kumar, Pang-Ning Tan, Michael Steinbach, Introduction to Data Mining, Addison Wesley, 2006.
2. G Dong, J Pei, Sequence Data Mining, Springer, 2007.

Paper – XXII(B)

Fluid Dynamics –II

Max. Periods: 60 (04 Credits)

Course Objectives:

The aim of this course is to study two dimensional image system, Milne-Thomson circle theorem, theorem of Blasius, concepts of gas dynamics, stress strain relations, uniqueness theorem, important relations related to Navier-Stokes equations and various applications in all fields.

Course Outcomes:

After completion of the course, student will be able to

CO1: Apply Milne-Thomson circle theorem
CO2: Identify appropriate governing equation for particular flow.
CO3: Explain stress strain relations.
CO4: Evaluate the velocity of fluid flow.

Unit-I

Two dimensional image system, The Milne- Thomson circle theorem, Applications of the circle theorem, the theorem of Blasius, some worked examples.

Unit-II

Compressibility effects in real fluids, The elements of wave motion, The speed of sound in a gas, Equation of motion of a gas, Subsonic, sonic and Supersonic flows, Isentropic gas flow, Reservoir discharge through a channel of varying section, Shock waves.

Unit-III

Stress components in a real fluid, Relations between Cartesian components of stress, Translational motion of fluid element, The rate of strain quadratic and principle stresses, Some further properties of the rate of strain quadratic, Stress analysis in fluid motion, Relation between stress and rate of strain, The coefficient of viscosity and laminar flow. The Naiver Stokes equations of motion of a viscous fluid.

Unit-IV

Flow between two parallel planes, Steady flow through tube of uniform circular cross section, some solvable problems in viscous flow, Steady viscous flow between concentric rotating cylinders. Uniqueness theorem, Diffusion of vorticity, Energy dissipation due to viscosity, Steady flow past a fixed sphere, Prandtl's Boundary Layer.

Text Book:

Text book of Fluid Dynamics, by F Charlton, Reprint 1998, C B S Publishers and distributors, Delhi – 110 002
Scope:
Unit-I Chapter 5, 5.7 to 5.9
Unit-II Chapter 7, 7.1-7.7
Unit-III Chapter 8, 8.1-8.9
Unit-IV Chapter 8, 8.10-8.13

Reference Books:

1, G.K. Batchelor- An Introduction to Fluid Mechanics (Foundation Book-New Delhi 1994)
2. W.H. Besaint and A.S. Ramsey – A Treatise on Hydro Mechanics Part II, CBS Publisher-1998.
3. S.W. Yuan – Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd- New Delhi 1976

Paper No – XXII(C)

Difference Equations – II

Max. Periods: 60(04 Credits)

Course Objective:

The course introduced the elementary analysis and linear algebra to investigate solution to difference equation. To study self adjoint second order linear equation, the sturm-liouville problem, discrete calculus of variations, Boundary value problem for nonlinear equations.

Course Outcome:

After completing this course, the student will be able to:

CO1: Study self adjoint equation..

CO2: Analyze sturm-liouville problem for difference equations.

CO3: Understand the Lipschitz case and existence of solutions.

CO4: Discuss the boundary value problem for nonlinear equations.

Unit-I:

Introduction, Sturmian theory, Green's functions, Disconjugacy, The Riccati equations, Oscillation.

Unit – II:

Introduction, Finite Fourier analysis, Non-homogeneous problem.

Unit – III:

Introduction, The Lipschitz case, Existence of solutions, Boundary value Problems for differential Equations.

Unit – IV:

Introduction, The Lipschitz case, Existance of solutions, Boundary value problem for differential equations.

Text Book:

1. Walter G. Kelley and Allan C. Peterson, “Difference Equations”, Academic Press, Second Edition.

Scope : Unit-I Chapter 6.

Unit-II Chapter 7.

Unit-III Chapter 8.

Unit-IV Chapter 9.

Reference Books:

1. Calvin Ahlbrandt and Allan C. Peterson, “Discrete Hamiltonian Systems: Difference Equations, Continued Fractions and Riccati Equations, “Kluwer, Boston, 1996.
2. Saber N. Elaydi “An Introduction to Difference Equations” Springer, Second Edition.

Paper – XXIII(A)

Machine Learning

Max. Periods: 60 (04 Credits)

Course Objectives:

This course introduces the concepts of machine learning, supervised learning, univariate support vector, kernel methods, dimensionality reduction, principal component analysis, Bayes learning and inference, Bayesian network, perceptron, learning overview, elements of reinforcement learning.

Course Outcomes:

After completion of the course, student will be able to

CO1: Describe the concept of machine learning and its types.
CO2: Comprehend dimensionality reduction, principal component analysis, kernel PCA, matrix factorisation.
CO3: Analyze Bayes learning and inference, Bayesian network, bagging and boosting random forest.
CO4: Discuss deep learning feature representation learning, learning overview.

Unit-I

Types of machine learning, supervised learning, linear regression, multivariate linear regression, regularized regression, logistic regression, decision trees, linear classification, univariate support vector, kernel methods.

Unit-II:

Unsupervised learning, clustering, K means, cluster analysis, vector quantization, self-organizing feature map, association rule mining, dimensionality reduction, principal component analysis, kernel PCA, matrix factorisation.

Unit-III:

Evaluating machine learning algorithms, model selection, feature selection, Bates selection, Bayes learning and inference, Bayesian network, bagging and boosting random forest.

Unit-IV:

Perceptron, multilayer networks, learning neural networks structure, deep learning feature representation learning, learning overview, elements of reinforcement learning.

Text Book:

Tom Mitchell, Machine Learning, McGraw Hill Education
Scope: Article 1 to 13

Reference Books:

1. Kevin Murphy, Machine learning, A probabilistic perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The elements of Stastical learning, Springer 2009.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009.

4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

Paper-XXIII(B)

Integral Equations: Theory and Applications

Max. Periods: 60(04 Credits)

Course Objectives:

This course enables the students to get the detailed idea about the integral equation, its classification, different types of kernals, the relationship between the integral equations and ordinary differential equations and how to solve the linear integral equations by different methods with some problems which give rise to integral equations. Many physical problems that are usually solved by differential equation methods can be solved more effectively by integral equation.

Course Outcomes:

After the completion of this course, the students will

CO1. Acquire sound knowledge of different types of Integral equations.

CO2. Obtain integral equations from ODEs and PDEs arising in applied mathematics and different engineering branches and solve accordingly using various method of solving integral equation.

CO3. Demonstrate a depth of understanding in advanced mathematical topics in relation to geometry of curves and surfaces.

CO4. Apply the knowledge of integral transformation like Laplace transformation, Fourier transformation to solve different types of integral equation.

Unit-I

Preliminary Concepts, Integral Equation: Definition, Linear and nonlinear Integral Equations, Fredholm Integral Equations, Volterra Integral Equations, Singular Integral Equations, Special Kinds of Kernels, and classification of integral equations, Special kinds of kernels, Convolution integrals, Conversion of an initial value problem into a Volterra integral equation, Conversion of a boundary value problem into a Fredholm integral equation, Homogeneous integral equations of the second kind with separable kernel

Unit-II

Solution of Fredholm integral equations of the second kind with separable kernel, Fredholm alternative, an approximate method Method of successive approximation: Iterated kernel, Resolvent kernel, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive substitutions, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive approximations: Neumann series.

Unit-III

Integral equations with symmetric kernels: Regularity conditions, Complex Hilbert space, An orthonormal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen functions and bilinear form, Hilbert-Schmidt theorem and some immediate consequences, Definite Kernels and Mercer's theorem

Unit-IV

Singular integral equations, the solution of Abel integral equation, general form of Abel integral equation, another general form of Abel integral equation, Integral transform method, Application of Laplace transform to solve Volterra integral equations with convolution type kernels, Examples.

Text Books:

1. Dr. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand and Company Pvt. Ltd., New Delhi.

Scope:

Unit-I: Chapter 1 complete, Chapter 2 complete, Chapter 3 complete,
Unit-II Chapter 4 complete
Chapter 5 sections 5.1 to 5.15
Unit-III Chapter 7 sections 7.1 to 7.5
Unit-IV Chapter 8 sections 8.1 to 8.4, Chapter 9 section 9.1 to 9.5

Reference Books:

1. R.P. Kanwal, Linear Integral Equantions Theory and Technique, Academic Press, Inc., New York.
2. S.G. Mikhlin, Linear integral equations (Translated from Russian) “Hindustan Book Agency 1960.
3. B.L. Moiseiwitsch, Integral Equations, Longman, London & New York.
4. M. Krasnov, A Kiselev, G.Makaregko, Problems and Exercises in integral equations (Translated from Russian) by George Yankovsky) MIR Publishers Moscow, 1971.

Paper No – XXIII(C)

Dynamical Systems and Applications

Max. Periods: 60(04 Credits)

Course Objective:

The objective of this course is to introduce students the Discrete and Continuous Dynamical Systems, their formulation concerned to real world problems, finding more and more accurate ways of the solutions and a systematic study of the nature of the solutions. The students will be introduced with the concepts of Fatou Sets, Julia Sets, Fractal Geometry, Bifurcations, Cellular Automata, Julia Set etc. The students will also learn the advanced course in continuous dynamical system and its application to differential equations.

Course Outcomes:

After completion of the course student will be able to

CO1: Classify the different types of dynamical systems they come across.

CO2: Formulate the physical problem under consideration in terms discrete and continuous type of dynamical systems.

CO3: Describe more accurate solutions, analyze the nature of the solutions, study the long term behavior of the dynamical system.

CO4: Explain the occurrence of chaos in real world and the control of chaos.

Unit-I

One Dimensional Dynamics: Examples of dynamical systems, Preliminaries from calculus, Elementary Definitions, Hyperbolicity, an example of the quadratic family, Symbolic Dynamics, Topological Conjugacy, chaos, Structural stability, Sarkovaskii's theorem, The Schwarzian derivative, Bifurcation theory, another view of period three, The period doubling route to chaos

Unit-II

Linear Systems: Uncoupled linear systems, diagonalization, exponentials of operators, the fundamental theorem for linear systems, linear systems in R^2, complex eigenvalues, multiple eigenvalues, Jordan forms, stability theory, nonhomogeneous linear systems

Unit-III

Nonlinear systems: Local Theory: Some preliminary concepts, the fundamental existence-uniqueness theorem, dependence on initial conditions and parameters, the maximal interval of existence, the flow defined by a differential equation, linearization, the stable manifold theorem, the Hartman-Grobman theorem, stability and Liapunov functions, saddles, nodes, foci and centers, nonhyperbolic critical points in R^2, Center manifold theory, Normal form theory, gradient and Hamiltonian systems

Unit-IV

Nonlinear systems: Global Theory: Dynamical systems and global existence theorem, limit sets and attractors. periodic orbits, limit cycles and separatrix cycles, the Poincare map, the stable manifold theorem for periodic orbits, Hamiltonian systems with two degrees of freedom, the Poincare-Bendixson theory in R^2, Lineard systems, Bendixson's criteria, the Poincare sphere and the behavior at infinity, global phase portraits and separatrix configurations, index theory

Text Books:

1. Robert L. Devaney, An Introduction to Chaotic Dynamical Systems, Second Edition, Addition-Wesley Publishing Company Inc.

Scope: Part one: One Dimensional Dynamics Sections 1.1 to 1.13, 1.17

2. Lawrence Perko, Differential Equations and Dynamical Systems, Third Edition, Springer Verlag, 2001.

Scope: Unit-II Chapter 1 complete

Unit-III Chapter 2 complete

Unit-IV Chapter 3 complete

Reference Books:

1. Berry, J. and Arnold, (1996), Introduction to Non-Linear Systems, Great Britain.

2. Strogatz S. H., (1994), Non Linear Dynamics and Chaos, Perseus Books Publishing L.L.C.

3. Wiggins, S., (1990), Introduction to Applied Non-Linear Dynamical systems and Chaos (Vol-2), TAM, Springer-Verlag, NewYork.

4. Hirsch, M. W., Smale, S., and Devaney, R. L., (2004), Differential Equations, Dynamical Systems and an Introduction to Chaos, Elsevier.

5. R.L. Devaney, A First Course in Chaotic Dynamical Systems: Theory and Experiment, CRC Press, Taylor & Francis, 2018.

6. M.W. Hirsch, S. Smale, R. L. Devaney, Differential Equations, Dynamical Systems, and an Introduction to Chaos, Third Edition, Academic Press, 2013. [3] S.H. Strogatz, Nonlinear Dynamics and Chaos, Second Edition, CRC Press, Taylor & Francis, 2018.

Paper – XXIV

Project Work 05 Credits

Distribution of Marks

Project Submission: 100 marks Viva Voce: 25 Marks

Project work as per S.R.T. M. University, Nanded rules and regulation.

Swami Ramanand Teerth Marathwada University, Nanded

Question paper Pattern

M.Sc. (Second year) (Applied Mathematics) (CBCS Pattern)

w.e.f. June 2020 onwards

Time: 03:00 Hrs Max. Marks:

Q.No.1) Attempt the following

a) Theory 15 marks

OR

b) Theory/Problem 15 marks

Q.No.2) Attempt the following

a) Theory 15 marks

OR

b) Theory/Problem 15 marks

Q.No.3) Attempt the following

a) Theory 15 marks

OR

b) Theory/Problem 15 marks

Q.No.4) Attempt the following

a) Theory 15 marks

OR

b) Theory/Problem 15 marks

Q.No.5) Attempt any three of the following 15 marks

a) Theory

b) Theory/Problem

c) Theory/Problem

d) Theory/Problem