।। 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

25 1994 - 2019 SILVER JUBILEE YEAR

ACADEMIC (1-BOARD OF STUDIES) SECTION

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संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याच्या दृष्टीने मा. कुलगुरू महोदयांनी मा. विद्या परिषदेच्या मान्यतेच्या अधीन राहून मान्यता दिलेली आहे.

1. Mathematics (M.A./M.Sc.)
2. Applied Mathematics (M.A./M.Sc.)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेत–स्थळावर 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/२०१९–२०/**१२८३**
दिनांक : ०९.०९.२०१९.

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) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
५) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
६) सीनिअर प्रोगामर, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED.

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

FACULTY OF ARTS / SCIENCE

M.A. /M. Sc. (First Year) (Mathematics)

Revised Syllabus

Effective from June-2019 onwards

Swami Ramanand Teerth Marathwada University, Nanded.

M.A. /M. Sc. (First Year) (Mathematics) (CBCS) Revised Syllabus

Effective from June-2019

Semester	Paper No.	Name of the paper	Hrs./Week	Credits	Max. Marks		
					IA	EA (ESE)	Total
I	I	Abstract Algebra-I (Group and Ring Theory)	4	4	25	75	100
	II	Real Analysis	4	4	25	75	100
	III	Ordinary Differential Equations	4	4	25	75	100
	IV	Complex Analysis-I	4	4	25	75	100
	Elective-I V(A) V(B) V(C) V(D)	Choose any one Discrete Mathematics Dynamics and Continuum Mechanics-I Theory of Probability Differential Geometry of Manifolds- I	4	4	25	75	100
	VI	Tutorial-I/Lab Work (Compulsory)	2 Hrs./ Batch / Week. Max-25, Min-20	5		125	125
I I	VII	Linear Algebra	4	4	25	75	100
	VIII	Measure and Integration Theory	4	4	25	75	100
	IX	Partial Differential Equations	4	4	25	75	100
	X	Complex Analysis-II	4	4	25	75	100
	Elective-II XI(A) XI(B) XI(C) XI(D)	Choose any one Combinatorics Dynamics and Continuum Mechanics-II Operation Research Differential Geometry of Manifolds- II	4	4	25	75	100
	XII	Tutorial-II/Lab work (Compulsory)	2 Hrs./ Batch / Week. Max-25, Min-20	5		125	125
		Total		50			1250

Swami Ramanand Teerth Marathwada University, Nanded.

M.A. /M. Sc. (First Year) (Mathematics) (CBCS) Revised Syllabus

Effective from June-2019

First Semester		Second Semester	
Paper No.	**Name of the paper**	**Paper No.**	**Name of the paper**
I	Abstract Algebra-I (Group and Ring Theory)	VII	Linear Algebra
II	Real Analysis	VIII	Measure and Integration Theory
III	Ordinary Differential Equations	IX	Partial Differential Equations
IV	Complex Analysis-I	X	Complex Analysis-II
One paper to be chosen from following papers which are taught in the department.			
V(A)	Discrete Mathematics	XI(A)	Combinatorics
V(B)	Dynamics and Continuum Mechanics-I	XI(B)	Dynamics and Continuum Mechanics-II
V(C)	Theory of Probability	XI(C)	Operation Research
V(D)	Differential Geometry of Manifolds- I	XI(D)	Differential Geometry of Manifolds- II
VI	Tutorial-I (Compulsory)	XII	Tutorial-II (Compulsory)

Swami Ramanand Teerth Marathwada University, Nanded.

M.A. /M. Sc. (First Year) (Mathematics) (CBCS)

(2 years program)

Program Educational Objectives (PEOs):

PEO1: To equip students with knowledge, abilities and insight in mathematics and related fields.

PEO2: Have the ability to pursue interdepartmental research in Universities in India and abroad.

PEO3: To develop the ability to utilize the mathematical problem solving methods such as analysis, modeling, programming and mathematical software applications in addressing the practical and heuristic issues.

PEO4: To enable them to work as a mathematical professional or qualify for training as scientific researcher.

PEO5: To enable students to recognize the need for society and the ability to engage in life-long learning.

PROGRAMME OUTCOMES (POs):

After the completion of the program, students will able to:

PO1: Identify, formulate, and analyze the complex problems using the principles of Mathematics.

PO2: Solve critical problems by applying the Mathematical tools.

PO3: Apply the Mathematical concepts, in all the fields of learning including higher research, and recognize the need and prepare for lifelong learning.

PO4: Able to crack competitive examinations, lectureship and fellowship exams approved by UGC like CSIR-NET and SET.

PO5: Apply ethical principles and commit to professional ethics, responsibilities and norms in the society.

PO6: Gain the knowledge of software which will be useful in Industry

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: To understand the basic concepts of advanced mathematics.

PSO2: To develop the problems solving skills and computational skills.

PSO3: To enhance self learning and improve own performance.

PSO4: To formulate mathematical models.

M.A. / M.Sc. (First Year) Mathematics Programme: Course objectives and outcomes

Paper No.	Name of Paper	Course Objectives	Course Outcomes (CO) After the completion of the program, students will able to:
I	Abstract Algebra-I (Group and Ring Theory)	To introduce the concepts and to develop working knowledge on Groups, Normal Subgroups, Automorphism groups, Solvable groups, Cyclic Decomposition, Finitely Generated Abelian Groups and types of Rings.	CO1: Identify the concept of Normal subgroups, Quotients groups and Isomorphism. CO2: Analyze Permutation groups and cyclic Decomposition. CO3: Explain Fundamental theorem of finite Abelian group and its applications. CO4: Provide information on ideals and Quotient Rings, Integral domain, PID, UFD and ED.
II	Real Analysis	To introduce the concept of continuous, differentiable and Riemann stieltjes integrable functions and its properties, fundamental theorem of calculus, pointwise and uniform convergence of sequence and series of functions, directional derivative, inverse and implicit function theorem.	CO1: Identify the concepts of continuity, Differentiability and Integrability of functions. CO2: Discuss the concept of pointwise and uniform convergence. CO3: Apply the Stone-Weierstrass theorem and to solve the problems. CO4: Enumerate the derivative, directional derivative, inverse and implicit function theorem.
III	Ordinary Differential Equations	To study linear differential equations with constant and variable coefficients, Wronskian, linear equations with regular singular points, Bessel equation, existence and uniqueness of solutions to first order equation.	CO1: Identify the linear differential equations with constant and variable coefficients. CO2: Discuss the concept of Wronskian, linear dependent and Independent, Legendre Equation. CO3: Comprehend the Euler equations, the Bessel equation and Regular singular points. CO4: Examine the existence and uniqueness of solutions to first order linear differential equations.
IV	Complex Analysis-I	To introduce the Rectangular and Polar representation of Complex numbers, mappings, complex valued functions, continuity and differentiability, Cauchy–Riemann Equations, Analyticity, Harmonic Functions, Domain, Parameterizations, Line Integrals, Cauchy's Theorem and Cauchy's Integral Formula.	CO1: Describe the Rectangular and Polar Representation of Complex numbers. CO2: Comprehend the various types of mappings and complex functions. CO3: Analyze C-R Equations, Analytic functions, harmonic functions. CO4: Evaluate the line integrals and different Forms of Cauchy's Theorem.

V(A)	Discrete Mathematics	This course introduce the concepts of Lattices, basic properties of algebraic system, digital networks, switching circuits, brief history of graph theory, the travelling salesman problem, trees, fundamental circuits and cut-sets, matrix representation of graphs, some types of diagraphs.	CO1: Explain design and implementation of digital network and switching circuits. CO2: Analyze Hamiltonian paths, circuits, Euler graphs, connected and disconnected graphs. CO3: Discuss the different properties of trees and fundamental circuits. CO4: Establish the matrix representation of graphs.
V(B)	Dynamics and Continuum Mechanics-I	This course introduce the basic concepts and describe various motion of a rigid body, Newton's law of motion, moments and products of inertial, kinetic energy of a rigid body, problems illustrating the law of motion and impulsive motion.	CO1: Define vector moment about a point and scalar moment about an axis. CO2: Explain Newton's law of motion , various forces and angular momentum. CO3: Compare the theorem of parallel and Perpendicular axes. CO4: Describe the law of motion , the law of conservation of energy and impulsive motion.
V(C)	Theory of Probability	To study the mathematical and statistical probability, conditional probability, Baye's theorem, distribution function, discrete and continuous random variable, variance, moment generating function, binomial distribution function, Poisson and normal distribution.	CO1: Discuss the multiplication theorem of probability for independent events and its Examples. CO2: Explain Moment Generating function Technique and its applications. CO3: Compare recurrence relation for moments of binomial and Poisson distribution. CO4: Analyze the normal distribution as a limiting form of binomial distribution.
V(D)	Differential Geometry of Manifold-I	This course is aimed to provide differentiable manifolds, Lie-derivatives, Immersions and embedding Lie groups and Lie algebras, one parameter subgroups and exponential mapping, homomorphism and isomorphism.	CO1: Define tangent spaces, Jocobian map. CO2: Discuss Lie-derivative, exterior algebra and Derivative. CO3: Analyze topological groups, Lie groups and Lie algebra. CO4: Identify homomorphism and isomorphism of Lie transformation groups.
VI	Tutorial-I / Lab work (Compulsory)		
VII	Linear Algebra	This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge of vector spaces, linear transformations, canonical forms, Inner product space.	CO1: Identify the concepts of Liner Independence, bases and Dual spaces. CO2: Discuss Algebra of Linear Transformations and Characteristics roots. CO3: Explain canonical forms and Cayley-Hamilton Theorem. CO4: Analyze rational canonical forms and Determinants.

VIII	Measure and Integration Theory	This course introduce the concepts of Lebesgue outer measure, measurable set, integration of non-negative functions, Fatou's Lemma, Riemann and Lebesgue Integrals, function of bounded variations, four derivative, Abstract measure spaces, Jordan and Hahn decomposition theorem, Raydon–Nikodym theorem.	CO1: Comprehend of measurable sets, Lebesgue measure, Fatou's Lemma, Lebesgue's Dominated Convergence and Integration of series. CO2: Discuss the four derivatives, Functions of bounded variations. CO3: Define Hereditary class and Measure spaces. CO4: Explain signed measure and their derivatives.
IX	Partial Differential Equations	To study partial differential equations of the first order, partial differential equations of the second order, classification of second order partial differential equations, Dirichlet problem, Neumann problem, Harnack's theorem, heat conduction problem, Duhamel's principle.	CO1: Analyze the origin of first order partial differential equations and solving them using Charpit's method. CO2: Justify non-linear first order partial differential equation. CO3: Classify second order partial differential Equation. CO4: Discuss boundary value problems and classification in the case of n-variables. .
X	Complex Analysis-II	To study Taylor's Theorem, Applications of Cauchy's Inequality, Liouville's Theorem and Applications, Picard Theorem, Identity Theorem, Maximum Modulus Theorem, Singularities, Principle and Analytic Part of Laurent Series, Applications of Residue Theorem, Rouche's Theorem, Open Mapping Theorem, Conformal Mapping, Meromorphic Functions.	CO1: Define Liouville's Theorem, Picard Theorem, Maximum Modulus Theorem. CO2: Analyze the concepts of Laurent Series, Singularities, Principle & analytic part of Laurent Series. CO3: Compare Residue theorem and argument Principle. CO4: Discuss Conformal Mapping, Meromorphic Functions.
Elective-II XI(A)	Combinatorics	This course introduce the basic concepts of counting principles, arrangements and selections, Permutations and Combinations, Generating Functions, Recurrence Relations, Inclusion-exclusion principle and Rook polynomials.	CO1: Comprehend the rules of Sum and Product of Permutations and Combinations. CO2: Identify the solutions technique of Generating Functions. CO3: Discuss the Recurrence relations, Divide and Conquer relations. CO4: Analyze the Inclusion-exclusion principle and Rook polynomials.

XI(B)	Dynamics and Continuum Mechanics-II	This course introduce the concept of indices, tensor, scalar and vector fields , gradient, description of motion of continumm , deformation, compatibility conditions of infinitesimal strain components, Newtonian fluid.	CO1: Define the basic concept of indices, tensor, scalar and vector fields. CO2: Discuss the description of motion of a Continuum, rate of deformation. CO3: Analyze strain component, stress tensor, components of symmetry of stress tensor. CO4: Explain the Newtonian fluids, mathematical principles.
XI(C)	Operation Research	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.	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.
XI(D)	Differential Geometry of Manifold-II	To introduce the concept of principle of fibre bndle, bundle of homomorphism, Riemannian manifolds and connection, Schurs theorem, confirmal curvature tensor, Gauss formulae, Nijenhuis tensor, contravariant and covariant analytic vector field and F-connection.	CO1: Define principle fibre bundle, tangents Bundle. CO2: Discuss the curvature tensors, sectional curvature and Geodesics in a Reimannian manifolds. CO3: Explain Gauss formula, Weingarten equation and lines of curvature. CO4: Analyze generalized Gauss and Mainardi Codazzi equation and contravarient and covariant almost analytic vector field.
XII	Tutorial-II / Lab work (Compulsory)		

Semester-I

Paper-I

Abstract Algebra-I (Group and Ring Theory)

Max. Periods: 60(04 Credits)

Course Objective(s):

To introduce the concepts and to develop working knowledge on Groups, Normal Subgroups, Automorphism groups, Solvable groups, Cyclic Decomposition, Finitely Generated Abelian Groups and types of Rings.

Course Outcome(s):

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

CO1: Identify the concept of Normal subgroups, Quotients groups and Isomorphism.
CO2: Analyze Permutation groups and cyclic decomposition.
CO3: Explain Fundamental theorem of finite Abelian group and its applications.
CO4: Provide information on ideals and Quotient rings, Integral domain, PID, UFD and ED.

Unit-I:

Semi groups and groups, Subgroups and Cosets, Cyclic groups, Generators and relations, Normal subgroup and quotient group, Isomorphism theorems, Automorphism.

Unit-II:

Conjugacy and *G*-sets, Normal series, Solvable groups, Nilpotent groups, Permutation Groups, Cyclic decomposition, alternating groupA_n.

Unit-III:

Structure of groups, Direct product, Finitely Generated Abelian Groups, Invariants of a finite abelian group.

Unit-IV:

Rings, Examples of rings, Types of rings, Subrings and Characteristic of a ring, Ideals and homomorphisms, Maximal and Prime Ideals, Principal ideal, Nilpotent and Nil ideals, Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains.

Text Book:

1. **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 4 (Art. 1, 2, 3, 4, 5, 6), Chapter 5 (Art. 1, 2, 3)
   Unit II – Chapter 5 (Art. 4), Chapter 6 (Art. 1, 2, 3), Chapter 7 (Art. 1, 2).
   Unit III –Chapter 8 (Art 1, 2, 3, 4, 5).
   Unit IV – Chapter 9 (Art. 1, 2, 3, 4), Chapter 10 (Art. 1, 2, 3, 4, 5), Chapter 11 **(**Art. 1, 2, 3, 4).

Reference Books:

1. **Joseph A. Gallian**, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.
2. **S. Luthar and I. B. S. Passi**, "Algebra-Vol. 1: Groups", Narosa, New Delhi, 1996.
3. **V. K. Khanna, S. K. Bhambri**, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)
4. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

Paper-II
Real Analysis

Max. Periods: 60 (04 Credits)

Course Objective(s):

To introduce the concept of continuous, differentiable and Riemann stieltjes integrable functions and its properties, fundamental theorem of calculus, pointwise and uniform convergence of sequence and series of functions, directional derivative, inverse and implicit function theorem.

Course Outcome(s):

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

CO1: Identify the concepts of continuity, differentiability and Integrability of functions.
CO2: Discuss the concept of pointwise and uniform convergence.
CO3: Apply the Stone-Weierstrass theorem and to solve the problems.
CO4: Enumerate the derivative, directional derivative, inverse and implicit function theorem.

Unit-I:

The Riemann Stieltjes Integral: Definition and existence of integral, Properties of the integral, Theorem on change of variable, Integration and Differentiation, The fundamental theorem of calculus, integration by parts, integration of vector-valued functions, Rectifiable curves, Examples.

Unit-II:

Sequence and series of functions: Pointwise convergence of a sequence and series of functions, Discussion of main problem, Uniform Convergence, Cauchy criterion for uniform convergence, Weierstrass M-Test for sequence and series of functions, Uniform Convergence and Continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation.

Unit-III:

Equicontinuous Families of Functions, The Stone-Weierstrass theorem (Statements only), Examples, Power Series, Abel's and Taylor's theorems, Uniqueness theorem for power series.

Unit-IV:

Derivative, Directional Derivative, Examples, Continuously differentiable functions, Mean Value Theorem, Chain rule, Examples, Inverse function theorem and Implicit function theorem, Examples.

Text books:

1. **Walter Rudin**, "Principles of Mathematical Analysis", Third Edition, McGraw Hill, International Editions.
   Scope: Unit-I Chapter 6 (Article 6.1 to 6.27).
   Unit-II Chapter 7 (Article 7.1 to 7.18).
   Unit-III Chapter-7 (Article 7.19 to 7.28) & Chapter-8 (Article 8.1 to 8.5).

2. **J. R. Munkres**, "Analysis on Manifolds", Addison-Wesley Publishing Company.
   Scope: Unit-IV Chapter 2.

Reference books:

1. **Robert G. Bartle, Donald R. Sherbert**, "Introduction to Real Analysis", Wiley India Edition.
2. **N.L. Carothers**, "Real Analysis", Cambridge University Press.
3. **H.L. Royden**, "Real Analysis', PHI Learning Pvt. Ltd.(Third Edition).

Paper-III
Ordinary Differential Equations
Max. Periods: 60 (04 Credits)

Course Objective(s):

To study linear differential equations with constant and variable coefficients, Wronskian, linear equations with regular singular points, Bessel equation, existence and uniqueness of solutions to first order equation.

Course Outcome(s):

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

CO1: Identify the linear differential equations with constant and variable coefficients.
CO2: Discuss the concept of Wronskian, linear dependent and Independent, Legendre equation.
CO3: Comprehend the Euler equations, the Bessel equation and Regular singular points.
CO4: Examine the existence and uniqueness of solutions to first order linear differential equations.

Unit-I:

Linear Equations with Constant Coefficients: Linear dependence and independence, A formula for the Wronskian, the non-homogeneous equation of order two, the homogeneous equation of order n, initial value problems for nth order equations, equations with real constants, the non-homogeneous equation of order n, a special method for solving the non-homogeneous equation.

Unit-II:

Linear Equations with variable Coefficients: Initial value problems for the homogeneous equations, Solution of homogeneous equation, the Wronskian and linear independence, reduction of the order of homogeneous equation, the non homogeneous equation, homogeneous equation with analytic coefficients, the Legendre equation.

Unit-III:

Linear Equations with Regular Singular Points: the Euler equation, second order equations with regular singular points-an example, second order equations with regular singular points-the general case, the Bessel equation.

Unit-IV:

Existence and Uniqueness of Solutions to first order Equations: equations with variable separated, exact equations, the method of successive approximations, the Lipschitz condition and convergence of successive approximation.

Text Book:

1. **E. A. Coddington**, "An Introduction to Differential Equation", Prentice Hall of India Private Limited.

Scope: Unit I- Chapter 2.4 – 2.12.
Unit II- Chapter 3.1 – 3.8.
Unit III- Chapter 4.1 – 4.6.
Unit IV- Chapter 5.1 to 5.7.

Reference Books:

1. **G. F. Simmons and S.G. Krantz**, Differential Equations, Tata McGraw Hill publication.
2. **Daniel A., Murray,** Introductory course in Differential Equation, University Press.
3. **William F. Trench.** Elementary Differential Equations with Boundary value problems**.**

Paper No-IV

Complex Analysis- I

Max. Periods: 60(04 Credits)

Course Objective(s):

To introduce the Rectangular and Polar representation of Complex numbers, mappings, complex valued functions, continuity and differentiability, Cauchy–Riemann Equations, Analyticity, Harmonic Functions, Domain, Parameterizations, Line Integrals, Cauchy's Theorem and Cauchy's Integral Formula.

Course Outcome(s):

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

CO1: Describe the Rectangular and Polar representation of Complex numbers.
CO2: Comprehend the various mappings and complex functions.
CO3: Analyze C-R Equations, Analytic functions, harmonic functions.
CO4: Evaluate the line integrals and different forms of Cauchy's Theorem.

Unit I:

Complex Number, Algebra of complex numbers, Rectangular and Polar representation of Complex numbers, De-Moivre Theorem, Mappings, Translation, rotation, rotation and Magnification, rotation and contraction, linear transformation, Inversion, Linear Fractional Transformation, cross ratio.

Unit II:

Other Mappings, The Exponential Function, Mapping Properties, The Logarithmic Function, Branches of Logarithm, Principal Branch of Logarithm, Complex Exponents.

Unit III:

Continuity, Differentiability, Cauchy–Riemann Equations, Analyticity, Harmonic Functions, Curves, Initial and terminal points, simply and multiply connected domains, contour integration, Parameterizations, M-L Inequality, Examples.

Unit IV:

Line Integrals, Green's Theorem, Fundamental theorem of Integration. Cauchy's weak Theorem, Cauchy's main theorem, Cauchy's Integral Formula, Cauchy's Generalized Integral Formula.

Text Book:

1. **S. Ponnusamy and Herb Silverman**, "Complex Variables with Applications", Birkhauser Publication.

Scope: **Unit 1**- Art.1.1, 1.2, 1.3,3. 1, 3.2
Unit 2- Art.3.3, 4.1, 4.2, 4.3, 4.4
Unit 3- Art.5.1, 5.2, 5.3, 7.1, 7.2,
Unit 4- Art. 7.3, 7.4, 8.1

Reference Books:

1. **John B. Convey**, "Function of one complex variable", Narosa Publication, House, 1980.
2. **S. Ponnusamy**, "Foundations of Complex Analysis", Narosa Publishing House.
3. **Lars V. Ahlofors**, "Complex Analysis", McGraw Hill Company.
4. **Silverman Herb**, "Complex Analysis".

Paper-V (A)

Discrete Mathematics

Max. Periods: 60(04 Credits)

Course Objective(s):

This course introduce the concepts of Lattices, basic properties of algebraic system, digital networks, switching circuits, brief history of graph theory, the travelling salesman problem, trees, fundamental circuits and cut-sets, matrix representation of graphs, some types of diagraphs.

Course Outcome(s):

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

CO1: Explain design and implementation of digital network and switching circuits.
CO2: Analyze Hamiltonian paths, circuits, Euler graphs, connected and disconnected graphs.
CO3: Discuss the different properties of trees and fundamental circuits.
CO4: Establish the matrix representation of graphs.

Unit-I:

Lattices and Algebraic systems, Principle of duality, Basic properties of Algebraic systems defined by lattices, Distributive and Complemented lattices, Boolean lattices and Boolean algebras, Uniqueness of finite Boolean algebras, Boolean functions and Boolean expressions, Propositional Calculus, Design and Implementation of Digital Networks, Switching Circuits.

Unit-II:

What is a Graph, Application of Graphs, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, Brief History of Graph Theory. Paths and Circuits: Isomorphism, Subgraphs, Walks, Paths and Circuits, Connected graphs, Disconnected Graphs, and Components, Euler Graphs, Operations of Graphs, More on Euler Graphs, Hamiltonian Paths and Circuits, The Travelling Salesman Problem.

Unit-III:

Trees and Fundamental Circuits: Trees, Some Properties of Trees, Pendant Vertices in a Tree, Distance and Centre in a Tree, Rooted and Binary Tree, On Counting Trees, Spanning Trees, Fundamental Circuits, Finding all Spanning trees of a Graph, Finding Spanning Trees in Weighted Graph, Cut-Sets and Cut-Vertices: Cut-sets, Some properties of Cut-sets, All cut-sets in a graph, Fundamental Circuits and Cut-sets, Connectivity and Separability, Network Flows

Unit-IV:

Matrix representation of graphs, Incidence matrix, Sub matrices of A(G), Circuit matrix, Fundamental circuit matrix and its rank, An application to a switching network,

Adjacency matrix, What is a Directed graph, Some types of digraphs, Digraphs and binary relations, Directed paths and Connectedness, Euler digraphs.

Text books:

1. **C L Liu**, "Elements of Discrete Mathematics", Tata McGraw-Hill, Publishing Company (Second Edition).
   Scope: Chapter 12: Complete

2. **Narsingh Deo**, "Graph theory with applications to engineering and computer science", Prentice –Hall of India Pvt. Ltd.
   Scope: Chapter 1: Complete
   Chapter 2: Complete
   Chapter 3: Complete
   Chapter 4: 4-1 to 4-6
   Chapter 7: 7-1 to 7-5
   Chapter 9: 9-1 to 9-5

Reference Books:

1. **J.P. Tremblay, R. Manohar**, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt. Ltd.
2. **Kenneth N Rosen**, "Discrete Mathematics and its applications with combinatorics and graph theory", Tata-McGraw Hill Education Pvt.Ltd.
3. **Sanjeev Kumar, Sanjay Chaudhary**, "Applied Discrete Mathematics Theory and applications", Ram Prasad and Sons (India) Educational Publishers.

Paper-V (B)

Dynamics and Continuum Mechanics-I

Max. Periods: 60(04 Credits)

Course Objective(s):

This course introduce the basic concepts and describe various motion of a rigid body, Newton's law of motion, moments and products of inertial, kinetic energy of a rigid body, problems illustrating the law of motion and impulsive motion.

Course Outcome(s):

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

CO1: Define vector moment about a point and scalar moment about an axis.
CO2: Explain Newton's law of motion, various forces and angular momentum.
CO3: Compare the theorem of parallel and Perpendicular axes.
CO4: Describe the law of motion, the law of conservation of energy and impulsive motion.

Unit I:

Vector moment about a point and scalar moment about an axis, Vector and scalar couples, Centroids, Vector calculus, Velocity and acceleration of a Particle along a curve, Motion in plane radial and transverse components, Relative velocity and acceleration.

Unit-II:

Vector angular velocity, General motion of rigid body, Moving axes, Mass, Momentum, Force, Newton's laws of motion, Work, Energy and Power, Conservative forces, Potential energy, Impulsive forces, Linear momentum of system of particles.

Unit-III:

Angular momentum, Rate of change of angular momentum, Use of centroids, Moving origin, Impulsive force, Moments and products of Inertia, The theorem of parallel and perpendicular axes, Angular Momentum, Principal axes, Kinetic Energy of a rigid body.

Unit-IV:

Momental Ellipsoid, Coplanar distribution, General motion of a rigid body, Problems illustrating the laws of motion, Problems illustrating the law of conservation of energy, Problems illustrating impulsive motion.

Text Book:

1. **F. Chorlton**, "A text book of Dynamics", (E.L.B.S.)(2nd Edition).
   Scope: Unit I: Chapter1: 1.7, 1.8, 1.9, 1.11; Chapter 2: 2.1-2.3, 2.5, 2.6, 2.9.
   Unit II: Chapter3: 3,1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.8.
   Unit III: Chapter 6: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6.
   Unit IV: Chapter 7: 7.1, 7.2, 7.3,7.4 7.5,7.6,7.77.8.

Reference Books:

1. **J.L. Synge and Griffith**, "Classical Mechanics",
2. **Atkin R.H**., "Classical Dynamics",

Paper-V (C)

Theory of Probability

Max. Periods: 60(04 Credits)

Course Objective(s):

To study the mathematical and statistical probability, conditional probability, Baye's theorem, distribution function, discrete and continuous random variable, variance, moment generating function, binomial distribution function, Poisson and normal distribution.

Course Outcome(s):

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

CO1: Discuss the multiplication theorem of probability for independent events and its Examples.
CO2: Explain Moment Generating function Technique and its applications.
CO3: Compare recurrence relation for moments of binomial and Poisson distribution.
CO4: Analyze the normal distribution as a limiting form of binomial distribution.

Unit-I:

Basic Definitions, Mathematical and statistical probability, Axiomatic approach, Theorems on probability, Conditional probability, Multiplication theorem of probability, independent events, Multiplication theorem of probability for independent events, Baye's theorem

Unit-II:

Distribution Function, Discrete and Continuous Random variable, Mathematical Expectation of a Random Variable, Properties of expectation, Properties of Variance, Moment Generating function, Properties of Moment generating function, Cumulants and its properties.

Unit-III:

Binomial distribution, Moments of Binomial distribution, Recurrence relation for Moments of Binomial distribution, Poisson distribution, Moments of Poisson distribution, Recurrence relation for Moments of Poisson distribution, MGF of Poisson distribution, Cumulants of Poisson distribution

Unit-IV:

Normal distribution, Normal Distribution as a limiting form of Binomial Distribution, MGF and CGF of Normal Distribution, Area Property.

Text Book:

1. **S .C. Gupta, V. K. Kapoor**, "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi.

   Scope: Chapter 3: 3.1 to 3.13, Chapter 4: 4.2, Chapter 5: 5.1 to 5.4, 5.4.1, Chapter 6: 6.1 to 6.5, Chapter 7: 7.1, 7.2, 7.2.1, Chapter 8: 8.1 to 8.3, 8.4, 8.4.1, 8.4.2, 8.5, 8.5.1, 8.5.2, 8.5.4, 8.5.5, 8.5.7, Chapter 9: 9.1, 9.2, 9.2.1, 9.2.5, 9.2.6, 9.2.7, 9.2.11

Reference Books:

1. **Rohatgi V.K**., Introduction to Probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi. Student Edition.
2. **Dudewicz E.J. & Mishra S.N.,** Modern Mathematical Statistics, Wiley Series.
3. **S. C. Saxena**, "Mathematical Statistics", S. Chand and Co. Ltd.

Paper-V (D)

Differential Geometry of Manifolds-I

Max. Periods: 60(04 Credits)

Course Objective(s):

This course is aimed to provide differentiable manifolds, Lie-derivatives, Immersions and embedding Lie groups and Lie algebras, one parameter subgroups and exponential mapping, homomorphism and isomorphism.

Course Outcome(s):

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

CO1: Define tangent spaces, Jocobian map.
CO2: Discuss the Lie-derivative, exterior algebra and derivative.
CO3: Analyze the topological groups, Lie groups and algebra.
CO4: Identify the homomorphism and isomorphism of Lie transformation groups.

Unit-I:

Definition and examples of Differentiable Manifolds, Tangent spaces, Jocobian map, One parameter group of transformations,

Unit-III:

Lie–derivatives, Immersions and imbedding, Distributions, Exterior algebra, Exterior Derivative.

Unit-III:

Topological groups, Lie groups and Lie algebras, Product of two Liegroups, One parameter subgroups and exponential map, Examples of Lie-groups.

Unit-IV:

Homomorphism and Isomorphism, Lie transformation groups, General linear groups.

Reference Books:

1. **R. S. Mishra**, "A course in tensors with applications to Riemannian Geometry", Potishala (Pvt) Ltd. 1965.
2. **R. S. Mishra**, "Structures on a differentiable manifold and their applications", Chandrama Prakashan, Allahabad, 1984.
3. **B. B. Sinha**, "An Introduction to Modern Differential Geometry", Kalyani Publishers, New Delhi, 1982.
4. **K. Yono and M. Kon**, "Structure of Manifolds", World Scientific Publishing, Co. Pvt. Ltd. 1984.

Paper-VI

Tutorial –I — 05 Credits

Papers	Marks	Credits
Tutorial on theory paper -I	25	1
Tutorial on theory paper-II	25	1
Tutorial on theory paper-III	25	1
Tutorial on theory paper-IV	25	1
Tutorial on theory paper – V(A/B/C/D)	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: -----

Name of the teacher: -----

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

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 the department of examination 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

Semester-II

Paper-VII

Linear Algebra

Max. Periods: 60(04 Credits)

Course Objective(s):

This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge of vector spaces, linear transformations, canonical forms and Inner product space.

Course Outcome(s):

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

CO1: Identify the concepts of Liner Independence, bases and Dual spaces.
CO2: Discuss Algebra of Linear Transformations and Characteristics roots.
CO3: Explain canonical forms and Cayley-Hamilton Theorem.
CO4: Analyze rational canonical forms and Determinants.

Unit-I:

Introduction, Vector spaces, subspaces, Quotient Spaces, Linear combinations and system of linear equations, linear dependence and independence, Bases and dimension, Maximal Linear Independent Subsets

Unit-II:

Linear Transformations, Null spaces, Ranges, The matrix representation of a linear transformation, Composition of linear transformations, Invertibility and Isomorphism, The change of Co-ordinate matrix, Dual spaces.

Unit-III:

Elementary Matrix Operations and elementary matrices, The rank of a matrix, System of linear equations-Theoretical Aspects, System of linear equations-Computational Aspects, Eigen values and Eigen vectors, Diagonalizability, Triangulable Operators, Invariant Subspaces, Cayley-Hamilton Theorem.

Unit-IV:

Inner products and Norms, The Gram-Schmidt Orthogonalization process and orthogonal complements, the adjoint of a linear operator, Bilinear forms, Quadratic forms. Jordan Canonical form-I, Jordan Canonical form-II, The Minimal Polynomial, Rational Canonical form.

Text Book:

1. **S.H. Friedberg, A.J. Insel, L.E. Spence**, "Linear Algebra", Prentice-Hall, International, Inc., 3rd Edition.

Scope: Unit I - Chapter 1- Art 1.1 to 1.7
Unit II - Chapter 2 - Art 2.1 to2.6.
Unit III - Chapter 3 - Art 3.1 to 3.4, Chapter 5 - Art 5.1, 5.2, 5.4.
Unit IV - Chapter 6 - Art 6.1, 6.2, 6.3, 6.4, 6.8. Chapter 7 - Art 7.1 to 7.4.

Reference Books:

1. **Vivek Sahai and Vikas Bist**, "Linear Algebra", Narosa Publishing House, 2nd Edition.
2. **S.Lang**, "Introduction to Linear algebra", Springer International Edition, 2nd Edition.
3. **K.Hoffman, R.Kunze**, "Linear Algebra", Prentice Hall of India.
4. **S.Kumaresan**, "Geometrical approach to Linear Algebra", Prentice Hall India Learning Private Limited; New title edition (2000).

Paper-VIII

Measure and Integration Theory

Max. Periods: 60 (04 Credits)

Course Objective(s):

This course introduce the concepts of Lebesgue outer measure, measurable set, integration of non-negative functions, Fatou's Lemma, Riemann and Lebesgue Integrals, function of bounded variations, four derivative, Abstract measure spaces, Jordan and Hahn decomposition theorem, Raydon–Nikodym theorem.

Course Outcome(s):

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

CO1: Comprehend the measurable sets, Lebesgue measure, Fatou's Lemma, Lebesgue's Dominated Convergence and Integration of series.
CO2: Discuss the four derivatives, Functions of bounded variations.
CO3: Define the Hereditary class and Measure spaces.
CO4: Explain signed measure and their derivatives.

Unit-I:

Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability, Integration of non-negative functions, Fatou's Lemma, Lebesgue's Monotone Convergence Theorem, The general integral, Lebesgue's Dominated Convergence, Integration of series, Riemann and Lebesgue Integrals.

Unit-II:

Differentiation: The four derivatives, Continuous non-differentiable functions, Functions of bounded variations, Lebesgue Differentiation Theorem (Statement only), Differentiation and integration, The Lebesgue Set.

Unit-III:

Abstract measure spaces: Measure and outer measure, Hereditary, Complete Measure, Extension of measure, Uniqueness of the extension, Completion of measure, Measure spaces, Integration with respect to measure.

Unit-IV:

Signed measure and their derivatives: Signed measure and the Hahn-Decomposition, The Jordan decomposition, The Raydon–Nikodym theorem (Statement only).

Text book:

1. **G.de Barra**, “Measure theory and integration”, New Age International (P) Ltd. Publishers.
   Scope: Unit I- Chapter-2 (2.1-2.5), Chapter-3.
   Unit II- Chapter-4.
   Unit III- Chapter-5.
   Unit IV- Chapter-8 (8.1 to 8.3).

Reference Books:

1. **P.K. Jain and V.P. Gupta**, “Lebesgue measure and Integration” New Age International (P) Ltd. Publishers.
2. **P.R. Halmos**, “Measure theory”, Van Mostranel Princeton, 1950.
3. **Inder K. Rana**, “An introduction to measure and Integration”, Narosa Publishing House, Delhi, 1997.

Paper-IX

Partial Differential Equations

Max. Periods: 60(04 Credits)

Course Objective(s):

To study partial differential equations of the first order, partial differential equations of the second order, classification of second order partial differential equations, Dirichlet problem, Neumann problem, Harnack's theorem, heat conduction problem, Duhamel's principle.

Course Outcome(s):

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

CO1: Analyze the origin of first order partial differential equations and solving them using Charpit's method.
CO2: Justify non-linear first order partial differential equation.
CO3: Classify second order partial differential equations.
CO4: Discuss boundary value problems and classification in the case of *n*-variables.

Unit I:

Curves and surfaces, Genesis of first order PDE, classification of integrals, linear equations of first order, Pfaffian differential equations, Compatible systems.

Unit II:

Charpits method, Jacobi's method, integral surface through a given curve, Quasi-linear equations, non-linear first order partial differential equation.

Unit III:

Genesis of second order partial differential equation, classification of second order partial differential equation, vibrations of an infinite string, vibrations of semi-infinite string, vibrations of a string of finite length, method of separation of variables.

Unit IV:

Boundary value problems, Maximum and Minimum principles, the Cauchy problem, the Dirichlet problem, Neumann problem, Harnacks theorem, heat conduction problem, Duhamels principle, classification in the case of n-variables.

Text Book:

1. **T. Amarnath**, "An Elementary course in Partial Differential Equations" (2^{nd} edition), Narosa Publishing House, New Delhi.

Scope: Unit I: Chapter 1.1-1.6.
Unit II: Chapter1.7-1.11.
Unit III: Chapter 2.1 to 2.3.
Unit IV: Chapter 2.4 to 2.7.

Reference Books:

1. **I .N. Sneddon**, Elements of partial differential equations, Mc-Graw Hill Book Company.
2. **E.T. Copson**, Partial differential equations, Cambridge university press.
3. **K. Sankara Rao**, Introduction to partial differential equations, Prentice-Hall Of India Pvt. Limited.

Paper No-X

Complex Analysis- II

Max. Periods: 60(04 Credits)

Course Objective(s):

To study Taylor's Theorem, Applications of Cauchy's Inequality, Liouville's Theorem and its applications, Picard Theorem, Identity Theorem, Maximum Modulus Theorem, Singularities, Principle and Analytic Part of Laurent Series, Applications of Residue Theorem, Rouche's Theorem, Open Mapping Theorem, Conformal Mapping, Meromorphic Functions.

Course Outcome(s):

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

CO1: Define Liouville's Theorem, Picard Theorem, Maximum Modulus Theorem.
CO2: Analyze the concepts of Laurent Series, Singularities, Principle & analytic part of Laurent Series.
CO3: Compare Residue theorem and the argument principle.
CO4: Discuss Conformal Mapping, Meromorphic Functions.

Unit I:

Taylor's Theorem, Cauchy's Inequality, Applications of Cauchy's Inequality, Liouville's Theorem and Applications, Picard Theorem, Identity Theorem, Maximum Modulus Theorem, Gauss' Mean Value Theorem.

Unit-II:

Laurent Series, Laurent's Theorem, Singularities, Isolated Singularity, Non- Isolated Singularity, Riemann's Theorem, Casorati –Weierstrass Theorem, Principle and Analytic Part of Laurent Series,

Unit III:

Residue of function, Residue Theorem, Residue Theorem for $\mathbb{C}_\infty$, Applications of Residue Theorem, Evaluation of real Integrals, The Argument Principle, Rouche's Theorem, Open Mapping Theorem.

Unit IV:

Comparison with Analytic functions, Conformal Mapping, Isogonal Mapping, Sequences of Functions, Infinite Products: Meromorphic Functions Convergence and absolute convergence of products, Examples.

Text Book:

1. **S. Ponnusamy and Herb Silverman**, "Complex Variables with Applications", Birkhauser Publication.

Scope: **Unit 1:**- Art.8.2, 8.3,
Unit 2:- Art.9.1, 9.2
Unit 3:- Art.9.3, 9.4,
Unit 4:- Art.10.1, 11.1, 12.1

Reference Books:

1. **John B. Convey**, "Function of one complex variable", Narosa Pub. House, 1980.
2. **S. Ponnusamy**, "Foundations of Complex Analysis", Narosa Publishing House.
3. **Lars V. Ahlofors**, "Complex Analysis", McGraw Hill Co.
4. **Silverman Herb**, "Complex Analysis",

Paper-XI (A)

Combinatorics

Max. Periods: 60(04 Credits)

Course Objective(s):

This course introduce the basic concepts of counting principles, arrangements and selections, Permutations and Combinations, Generating Functions, Recurrence Relations, Inclusion-exclusion principle and Rook polynomials.

Course Outcome(s):

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

CO1: Comprehend the rules of Sum and Product of Permutations and Combinations.
CO2: Identify Solutions by the technique of Generating Functions.
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-XI (B)

Dynamics and Continuum Mechanics-II

Max. Periods: 60(04 Credits)

Course Objective(s):

This course introduce the concept of indices, tensor, scalar and vector fields , gradient, description of motion of continumm , deformation, compatibility conditions of infinitesimal strain components, Newtonian fluid.

Course Outcome(s):

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

CO1: Define the basic concept of indices, tensor, scalar and vector fields.
CO2: Discuss the description of motion of a Continuum, rate of deformation.
CO3: Analyze strain component, stress tensor, components of symmetry of stress Tensor.
CO4: Explain the Newtonian fluids, mathematical principles.

Unit-I: Tensors

Indicial Notation, Summation convention, Dumy indices, Free indices, Kronecker delta, Permutation symbol, Tensor as a linear transformation, Components, Sum, Dyadic product, Product of tensors, Identity, Transpose, Orthogonal tensors, Symmetric and antisymmetric tensors, Eigen values and Eigenvectors of a tensor, The dual vector of an antisymmetric tensor, Principal values and principal directions of real symmetric tensors.

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Unit-II: Tensor Calculus

Tensor Valued function of a scalar, Scalar field and Gradient of a scalar function, Vector field and Gradient of vector Function, Divergence of a vector field and divergence of a tensor field, Curl of Vector filed, Laplacian of Scalar field, Laplacian of Vector field.

Unit-III: Kinematics of Continuum

Description of motion of a continumm, Material and spatial description, Material derivatives, Infinitesimal Deformation, Principle strain, Dilatation, Rate of deformation, Equation of conservation of mass, Compatibility conditions of infinitesimal strain components.

Unit-IV: Stress and Newtonian Viscous Fluid

Stress vector, Stress tensor, Components of symmetry of stress tensor, Principle of moment of momentum, Principal stresses, Maximum shearing stress, Equations of motion, Principle of linear momentum, Fluids, Compressible and incompressible fluid, Equations of hydrostatics, Newtonian Fluid, Interpretation of Incompressible Newtonian fluid.

Text Book:

1. **Lai W. M. Rubin D and Kremple E**, ‘‘Introduction to continuum Mechanics’’,
   Scope: **Unit I:** Chapter 2: 2.1-2.4, 2.6-2.15, 2.20-2.23.
   Unit II: Chapter 2:.2.6-2.32.
   Unit III: Chapter 3: 3.1-3.3, 3.7, 3.9, 3.10, 3.13, 3.15, 3.16.
   Unit IV: Chapter 4:4.1-4.4, 8 Chapter6: 6.1-6.6.

Reference Book:

1. **Lang R.R.**, “Mechanics of Solids and fluids”, Prentice hall.

Paper-XI(C)

Operation Research

Max. Periods: 60(04 Credits)

Course Objective(s):

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(s):

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:

1. **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-XI (D)

Differential Geometry of Manifolds-II

Max. Periods: 60(04 Credits)

Course Objective(s):

To introduce the concept of principle of fibre bundle, bundle of homomorphism, Riemannian manifolds and connection, Schurs theorem, confirmal curvature tensor, Gauss formulae, Nijenhuis tensor, contravariant and covariant analytic vector field and F-connection.

Course Outcome(s):

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

CO1: Define principle fibre bundle, tangents bundle.
CO2: Discuss the curvature tensors, sectional curvature and Geodesics in a Reimannian Manifolds.
CO3: Explain Gauss formula, Weingarten equation and lines of curvature.
CO4: Analyze generalized Gauss and Mainardi Codazzi equation and contravarient and Covariant almost analytic vector field.

Unit-I:

Principal fibre bundle, Linear frame bundle, Associated fibre bundle, Vector bundle, Tangent bundle, Induced bundle, Bundle Homomorphisms.

Unit-II:

Riemannian manifolds, Riemannian connection, Curvature tensors, Sectional Curvature, Schur's theorem, Geodesics in a Riemannian manifold.

Unit-III:

Projective curvature tensor, Con-formal curvature tensor, Submanifolds and Hypersurfaces, Gauss formulae, Weingarten equations, Lines of Curvature.

Unit-IV:

Generalized Gauss and Mainardi Codazzi equations, Almost complex manifolds, Nijenhuis tensor, Contravariant and covariant Almost Analytic vector field, F-connection.

Reference Books:

1. **R. S. Mishra**, "A course in tensors with applications to Riemannian Geometry", Potishala (Pvt) Ltd. 1965.
2. **R. S. Misiira**, **"**Structures on a differentiate manifold and their applications", Chandrama Prakashan, Allahabad, 1984.
3. **B. B. Sinha**, **"**An Introduction to Modern Differential Geometry", Kalyani Publishers, New Delhi, 1982.
4. **B. B. Sinha**, "Structure of Manifolds", World Scientific Publishing Co. Pvt. Ltd. 1984.

Paper-XII

Tutorial –II — 05 Credits

Papers	Marks	Credits
Tutorial on theory paper -VII	25	1
Tutorial on theory paper-VIII	25	1
Tutorial on theory paper-IX	25	1
Tutorial on theory paper-X	25	1
Tutorial on theory paper – XI(A/B/C/D)	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: -----

Name of the teacher: -----

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

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 the department of examination 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

Swami Ramanand Teerth Marathwada University, Nanded.

Question Paper pattern

FACULTY OF ARTS / SCIENCE

M.A. /M. Sc. (First Year) (Mathematics) (CBCS Pattern)

w. e. f. June-2019 onwards

Time: 03.00 Hrs. **Max.Marks:75**

Q. No. 1:	**Attempt the following.**	**Unit No. I**
	a) Theory	8 marks
	b) Problem	7 Marks
	or	
	c) Theory	8 marks
	d) Problem	7 Marks
Q. No. 2:	**Attempt the following.**	**Unit No. II**
	a) Theory	8 marks
	b) Problem	7 Marks
	or	
	c) Theory	8 marks
	d) Problem	7 Marks
Q. No. 3:	**Attempt the following.**	**Unit No. III**
	a) Theory	8 marks
	b) Problem	7 Marks
	or	
	c) Theory	8 marks
	d) Problem	7 Marks
Q. No. 4:	**Attempt the following.**	**Unit No. IV**
	a) Theory	8 marks
	b) Problem	7 Marks
	or	
	c) Theory	8 marks
	d) Problem	7 Marks
Q. No. 5:	**Attempt any three of the following.**	**Unit No. I, II, III, IV**
	a) Theory / Problem	
	b) Theory / Problem	5 Marks Each
	c) Theory / Problem	
	d) Theory / Problem	

Total **75**