Department
of
Mathematics and Statistics

School of Mathematical and Physical Science

Curriculum Framework
B.A./ B.Sc.-Mathematics

Based on National Education Policy- 2020

Date of BoS – 11/06/2024

Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh-470003

Passed by Board of Studies Dated 11/06/24

About the Department:

The Department of Mathematics & Statistics was established with the very inception of the University in the year of 1946. The founder of the university and the founder vice-chancellor Dr. Harisingh Gour had himself appointed Mr. R.B. Rabugunday as the first Head of the Department. Mr. Rabugunday was a scholar of Madras University and a Wrangler of Cambridge tradition.

Curriculum Framework based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Mathematics and Statistics have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points aswell as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects of

1. **Mathematical Science**

Under Graduate Curriculum Framework for Bachelor of Science

1. **Name of the Programme: (1) Certificate in Science (After exit of one year)**
   (2) Diploma in Science (After exit of two years)
   (3) Bachelor in Science (After exit of three years)
2. **About the Programme:**
   Mathematics is backbone of all discipline. Aim of this programme is to train young minds to handle the critical problems that occur in Mathematical Sciences as well as in real life.
3. **Objectives of the Programme**
   - To develop students' skills in mathematical science through various tools and techniques.
   - To provide rigorous instruction in fundamental mathematical concepts and skills presented in the context of real-world applications.
   - To introduce students to the enormous diversity and complexity of real-life problems in Mathematics.
   - To provide the opportunity to gain familiarity with the applications of mathematics.
4. **Programme Learning Outcomes :**
   The programme learning outcomes are attained by learners through the essential learnings acquired on completion of selected courses of study within a programme. The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study.

a) After completion of this program of study the students will have an enhanced knowledge and understanding of mathematics.

b) The Mathematical skills learned through this course will provide analytical understanding for approaching problems that the students encounter in real life situations.

c) Students who will pass out this course be better able to draw inferences that rest on mathematical logics.

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5. Structure of the Programme (B.A./B.Sc. Mathematics) for: (1) Certificate in Science (After exit of one year)

	Semester I				
Level 5	**Nature of Course**	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-111	Calculus	6	Dr. U.K.Khedlekar
	Multi-Disciplinary Major	MTS-MDM-111	Matrix Theory	6	Dr. Bhupendra
	Ability Enhancement Course	MTS-AEC-111	Graph Theory	2	Dr. K.Shrivastava
	Skill Enhancement Course	MTS-SEC-111	Vector Calculus	2	Dr. Bhupendra
	Semester II				
	Nature of Course	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-211	Basic Algebra	6	Dr. U.K.Khedlekar
	Multi-Disciplinary Major	MTS-MDM-211	Numerical Methods	6	Dr. R.K.Pandey
	Ability Enhancement Course	MTS-AEC-211	Fundamental of Computer	2	Prof. D.Shukla
	Skill Enhancement Course	MTS-SEC-211	Boolean Algebra	2	Dr. K.Shrivastava

Structure of the Programme (B.A./B.Sc. Mathematics) for: (2) Diploma in Science (After exit of two years)

	Semester III				
Level 6	**Nature of Course**	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-311	Differential Equations	6	Dr. U.K. Khedlekar
	Multi-Disciplinary Major	MTS-MDM-311	Mechanics	6	Dr. Bhupendra
	Ability Enhancement Course	MTS-AEC-311	Portfolio Optimization	2	Dr. M.K.Yadav
	Semester IV				
	Nature of Course	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-411	Real Analysis-I	6	Dr. R.K. Pandey
	Multi-Disciplinary Major	MTS-MDM-411	Metric Space	6	Dr. K. Shrivastava
	Skill Enhancement Course	MTS-SEC-411	Tautology	2	Dr. Bhupendra

Structure of the Programme (B.A./B.Sc. Mathematics) for: (3) Bachelor in Science (After exit of three years)

	Semester V				
Level 7	**Nature of Course**	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-511	Linear Algebra	6	Dr. R.K. Pandey
	Multi-Disciplinary Major	MTS-MDM-511	Algebra	6	Dr. Bhupendra
	Ability Enhancement Course	MTS-AEC-511	Transportation and Assignment Problems	2	Dr. U.K. Khedlekar
	Semester VI				
	Nature of Course	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major	MTS-DSM-611	Basic Complex Analysis	6	Dr. S. Kumar
	Multi-Disciplinary Major	MTS-MDM-611	Dynamics	6	Dr. Bhupendra
	Skill Enhancement Course	MTS-SEC-611	Latex	2	Dr. S. Kumar

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6. **Exit: (1) Certificate in Science (After exit of one year)**
   (2) Diploma in Science (After exit of two years)
   (3) Bachelor in Science (After exit of three years)

7. **Teaching Learning Approach:**

Mainly this programme will transact the under given pedagogic approach-

- Lecture/ Seminar format
- Demonstration
- Readings/written assignments and Field Projects
- Group discussions/tutorial Community visit
- Project work
- Field Visit/Survey/Dissertation

8. **Assessment**

The learner in the programme will be assessed throughout the duration of the programme in a formative and summative evaluations i.e. Mid (I&II) and End Semester examinations. To be eligible to appear in End semester examination a student must appear in Mid semester examinations along with 75 per cent attendance in classroom processes

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester III (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Sem. III	MTS-DSM-311	Differential Equations	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. U.K. Khedlekar

Lectures Hrs. 90

Learning Objectives:

1. To understand the basic concept of differential equations and its uses.
2. To be familiar with the application of exact equations and its applications.
3. To aware students for the use of differential equations to real life problems.

Course Learning Outcomes:

After completion of this course, student will be able to:

CO 1: Awareness about creation of differential equation.
CO 2: Learning of several methods for approaching to solution of problems
CO 3: Strong understanding about linear difference equations and their applications.

Unit Wise Learning Outcomes:

UO1: Learning of construction of exact differential equation of first order.
UO2: Learning of the concept of linearly dependent and independent differential equations.
UO3: Solution of the differential equation by method of variation of parameter.
UO4: Constructing the partial differential equations.
UO5: Classification of the second order partial differential equation and solving by Charpit's method.

Unit-I:
First order exact differential equations, integrating factors, rules to find an integrating factor, first order higher degree equations solvable for x, y and p, Methods for solving higher-order differential equations.

Unit-II:
Basic theory of linear differential equations, Wronskian and its properties, solving a differential equation by reducing its order, linear homogenous equations with constant coefficients, linear non-homogenous equations.

Unit-III:
Method of variation of parameters, Cauchy-Euler equation, simultaneous differential equations, total differential equations.

Unit-IV:
Order and degree of partial differential equations, concept of linear and non-linear partial differential equations, formation of first order partial differential equations, linear partial differential equation of first order, Lagrange's method.

Unit-V:
Charpit's method, classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Essential Readings:

1. Shepley L. Ross, (1984): *Differential Equations*, 3rd Ed., John Wiley and Sons.
2. Sneddon, (1967): *Elements of Partial Differential Equations*, McGraw-Hill, International Editi

Suggested Readings

1. Video lecture on ordinary differential equation of first order-Exact differential equation
   Link https://www.youtube.com/watch?v=suvzwN2Df7k
2. Video lecture on Partial Differential Equation - Charpit's Method for Non Linear PDE
   Link https://www.youtube.com/watch?v=2_hfp8JPP30

E-resource:

1. Differential Equations, **Shepley L. Ross,** John Wiley and Sons (WIE),ISBN: 9780471814504, 0471814504
   http://booksdescr.org/item/index.php?md5=1A0161B225BA96E5FC760145FB5F1E7B
2. **Partial Differential Equations, F. John (auth.),** Applied Mathematical Sciences, Springer ISBN: 0387906096, 9780387906096, 3540906096
   http://booksdescr.org/item/index.php?md5=1F0898E6DA3882791DB68EEE5780CACB
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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester III (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L6 Sem. III	MTS-MDM-311	Mechanics	5	1	0	6	IA (Mid) - 40 EA (End Sem) - 60	Dr. Bhupendra

Lectures Hrs. 90

Learning Objectives:

1. To develop the knowledge of coplanar forces, virtual works
2. To develop applications and solve problems using mechanics.

Course Learning Outcomes:

After completion of this course, student will be able to:

CO1: Understand different kind of forces.
CO2: Solve the problems of Catenary and its applications.
CO3: Derive the equations of Poinsot's central axis.

Unit Wise Learning Outcomes:

UO1: Learning about coplanar forces.
UO2: Understanding about virtual work and its properties.
UO3: Understanding about Catenary and its real life application.
UO4: Knowledge about nature of stability.
UO5: Learning about the forces in three dimensions and null lines and planes.

Unit - I: Coplanar forces Analytical conditions of equilibrium of coplanar forces. Theorems on coplanar forces and moment of couple. Lami's theorem.
Unit - II: Virtual work Virtual work. Principle of virtual work for a system of coplanar forces.
Unit - III: Catenaries Geometrical properties of the Catenary sag of telegraph wires.
Unit - IV: Stable and unstable equilibrium Equilibrium of a heavy body, stable, unstable and neutral equilibrium, test for determining the nature of stability.
Unit - V: Forces in three dimensions Forces in three dimensions. Poinsot's central axis. Screws and Wrenches, resultant of two given wrench, pitchs. Null lines and planes.

Essential Readings:

1. S. L. Loney: *Statics*, Macmillan & Co., London.
2. M. Ray, R. D. Manglik & G.C. Sharma, (1994): *A Text Book on Statics,* S. Chand & Company Ltd. Ram Nagar, New Delhi-110055.

Suggested Readings :

1. R.S.Verma: *A Text book on Statics*, Pothishala Prakashan Pvt. Ltd, Allahabad.
2. P.K.Mittal, (2016): *Mathematics for Degree Students,* S. Chand & Company Ltd. (AN ISO 9001: 2008 Company), Ram Nagar, New Delhi-110055.

E-resource:

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester III (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Sem. III	MTS-AEC-311	Portfolio Optimization	2	0	0	2	IA (Mid) - 40 EA (End Sem)- 60	Dr. M.K. Yadav

Lectures Hrs. 30

Learning Objectives:

1. To learn various financial markets worldwide.
2. To learn understanding about the designing portfolio.
3. To study the expected risk and return of portfolio.
4. To study portfolio optimization by using mean variance method.
5. To find various measures of portfolio.

Course Learning Outcomes:

After completion of this course the students will be able to:

CO1: Understand investment objectives and outcomes thereon.
CO2: Understand diversification in financial market.
CO3: Understand efficient frontiers and risk existing in financial market.

Unit Wise Learning Outcomes:

UO1: Learning about how to optimize a portfolio.
UO2: Understanding about more than one securities portfolio
UO3: Knowledge about one and two fund theorems.
UO4: Awareness about various measures relating to portfolio.
UO5: Learning about risk and return in various methods of performance evaluation in financial sector.

Unit-I: Financial markets. Investment objectives.
Unit-II: Measures of return and risk. Types of risks. Portfolio of assets.
Unit- III: Expected risk and return of portfolio. Diversification.
Unit-IV: Mean-variance portfolio optimization- Markowitz model and the two-fund theorem, risk free assets and one fund theorem, efficient frontier.
Unit-V: Portfolio performance evaluation measures.

Essential Readings:

1. H.M. Markowitz, (1987): Mean-Variance Analysis in Portfolio Choice and Capital Markets, Blackwell, New York.
2. D.G. Luenberger, (2013): Investment Science, 2nd Ed., Oxford University Press.

Suggested Reading:

1. F.K. Reilly, Keith C. Brown, (2011): Investment Analysis and Portfolio Management, 10thEd., South Western Publishers.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester IV (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Sem. IV	MTS-DSM-411	Real Analysis- I	5	1	0	6	IA(Mid) –40 EA(End Sem)-60	Dr. R.K.Pandey

Lectures Hrs. 90

Learning Objectives:

1. To explain fundamentals of cardinality of a set and to classify sets on the basis of cardinality.
2. To explain limit point of a set and Bolzano Weierstrass theorem.
3. To introduce the notion of convergence of sequence.
4. To explain the convergences of an infinite series and various tests for convergence and also to introduce the concept of Riemann integration.
5. To explain the convergence of sequence and series of functions applications of uniform convergence in case of sequence/series of continuous, differentiable and Riemann integrable functions.

Course Learning Outcomes: This course will enable the students to:

CO-1: Interpret the order structure of set of real numbers and its properties.
CO-2: Learn limit and sub sequential limits of sequence.
CO-3: Understand the convergence of an infinite series.
CO-4: Learn the notion of Riemann integration.
CO-5: Learn the notion of continuity and differentiability and related important theorems.

Unit wise Learning Outcomes:

UO-1: Developing better intuition to check the cardinality of set.
UO-2: Learning about skills to examine the convergence of a sequence and sub sequential limits.
UO-3: Learning about the skills to find the limit sequences using the Cauchy theorem.
UO-4: Understanding the skills to test the convergence of series with nonnegative terms.
UO-5: Awaring about the concepts of uniform and point wise convergence and its consequences in preservation of limit, continuity, integration etc.

Unit-I: Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, supremum and infimum, completeness property of R, Archimedean property of R, intervals, Interior points and limit points, open, closed, and perfect sets. Statement of Bolzano-Weierstrass theorem, compact sets.
Unit-II: Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences, Cauchy's theorem on limits, Order preservation and squeeze theorem. Subsequence, limsup and liminf and convergence criterion using them. Monotone sequences and their convergence (monotone convergence theorem without proof).
Unit-III: Infinite series and their convergence, geometric series. Cauchy criterion, comparison test. Series of non-negative terms, convergence of p-series. Cauchy's condensation test, integral test, ratio and root tests (Tests of convergence without proof).
Unit-IV: Absolute and conditional convergence, alternating series, and Leibnitz's theorem. Riemann integration, necessary and sufficient condition of Riemann integration, algebra of Riemann integrable functions, fundamental theorem of integral calculus.
Unit-V: Sequences and series of functions, point-wise and uniform convergence, Mn-test, Weiertrass M-test, Statements of the results and applications on uniform convergence and continuity, uniform convergence and integration and differentiability of functions, Power series and radius of convergence.

Essential Readings:

1. R.G. Bartle and D. R Sherbert, (2000): *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd.
2. T.M. Apostal, (1985): Mathematical analysis, Narosa.

Suggested Readings:

1. Walter Rudin: Principles of Mathematical Analysis, McGraw Hill.
2. Terence Tao, (2014): Analysis I, Hindustan Book Agency (third edition).
3. Terence Tao, (2015): Analysis II, Springer and Hindustan Book Agency (third edition).

E-Resource:

4. https://nptel.ac.in/courses/111106053
5. https://nptel.ac.in/courses/111105098
6. https://ocw.mit.edu/courses/18-100a-real-analysis-fall-2020/#:~:text=Course%20Description,the%20interchange%20of%20limit%20operations.
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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester IV (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Sem. IV	MTS-MDM-411	Metric Space	5	1	0	6	IA (Mid) - 40 EA (End Sem)- 60	Dr. Kavita Shrivastava

Lectures Hrs. 90

Learning Objectives:

1. To study besic definition of Metric spaces.
2. To understand basics of Topology.
3. To examine the convergence of sequence in Metric spaces.
4. To differenciate in continuity and uniform continuity.
5. To study connectedness and compactness in Metric space.

Course Learning outcomes:

After completion of this course the students will be able to:

CO1: Understand the basic concept of metric space.
CO2: Correlate these concepts to their counter parts in real analysis.
CO3: Aware about the abstractness of the concepts such as open balls, closed balls, compactness, connectedness beyond their geometrical imaginations.

Unit Wise Learning Outcomes:

UO 1: Understanding to the definition of Metric space.
UO 2: Learning about the concept of open sets and closed sets.
UO 3: Awareness of the concept of convergence.
UO 4: Understand the concept of limit and continuity, Banach Fixed point theorem.
UO 5: Knowledge about continuous functions on compact spaces.

Unit 1: Metric spaces: Definition and examples of metric spaces, diameter and boundedness, subspace.
Unit II: Open and closed ball, neighbourhood, open set, interior of a set, limit point of a set, derived set, closed set, closure of a set, Cantor's theorem, dense set.
Unit III: Convergence and completeness- convergence of sequence, Cauchy sequence, completeness
Unit IV: Limit and continuity, uniform continuity, contraction mapping, Banach fixed point theorem.
Unit V: Basics of connectedness, connectedness and continuity, compactness and boundedness, continuous functions on compact spaces.

Essential Readings:

1. Kumaresan, S. (2014): Topology of Metric Spaces, (2nd ed.). Narosa Publishing House.
2. Simmons, G. F. (2004): Introduction to Topology and Modern Analysis. Tata McGraw Hill.

Suggested Readings:

1. Dugundji, J., Topology, Allyn and Bacon Series in Advanced Mathematics, Allyn & Bacon.
2. Munkres, J.R., Topology (2nd Edition), Prentice-Hall.
3. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian print.

E-Resources

1. Link-NPTEL :: Mathematics - Topology
2. https://nptel.ac.in/courses/111101158
3. National Digital Library

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester IV (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L6 Sem. IV	MTS-SEC-411	Tautology	2	0	0	2	IA (Mid)-40 EA (End Sem)- 60	Dr. Bhupendra

Lectures Hrs. 30

Learning Objectives:

1. To develop the knowledge of logical connectives and tautology.
2. To discuss applications of Tautology among student.
3. To develop capability for reaching to ultimate logical conclusions.

Course Learning Outcomes:

After completion of this course, student will be able to:

CO1: Have an understanding about the different kinds of logical sentences.
CO2: Have intense knowledge about to prepare truth tables.
CO3: Have understanding about comparison of different kinds of logical equivalences.

Unit Wise Learning Outcomes:

UO1: Learning about logic and sentence.
UO2: Understanding about basic logical operations and ability to solve the examples.
UO3: Knowledge of tautology and contradiction.
UO4: Learning about different types of logical equivalence laws.
UO5: Awareness about normal or canonical form.

Unit - I: Introduction of logic, logical connectives, kinds of sentences, truth value of a statement and its examples.
Unit - II: Truth tables, basic logical operations and its applications.
Unit - III: Tautology and Contradiction of statements with examples.
Unit - IV: Logical equivalence, Algebra of propositions: Distributive laws, De-Morgan's laws.
Unit - V: Normal or Canonical forms, Disjunctive normal form and Conjunctive normal form, and its applications.

Essential Readings:

1. C. L. Liu, (1985): *Elements of Discrete Mathematics*, McGraw Hill, New Delhi.

Suggested Readings :

1. J.P. Tremblay & R. Manobar, (1997): *Discrete Mathematical Structures*, McGraw Hill, New Delhi.
2. D.C. Agrawal, (2012): *Discrete Structrue*, Shree Sai Prakashan, Meerut.

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester V (Mathematics)

Level & Semester	Course Code	Title of the Course	Credits				Marks	Course Designer
			L	T	P	C		
L7 Sem. V	MTS-DSM-511	Linear Algebra	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. R.K.Pandey

Lectures Hrs. 90

1. Learning Objectives:

1. To study Vector spaces.
2. To understand dimension and basis of a subspace.
3. To explain matrix representation of a linear transformation.
4. To understand dual space & characteristics polynomial.
5. To study isomorphism & change of coordinate matrix.

2. Course Learning Outcomes: This course will enable the students will be able to:

CO 1: understand vector space and dual space properties with Isomorphisms.
CO 2: able to understand linear span an independency of vectors.
CO 3: understand the characteristic of rank and nudity.

3. Unit-wise Learning Outcomes: After completion of this course students will be able to:

UO 1: Learn about the algebra of vector space.
UO 2: Learn about the Basis and dimension of vector spaces.
UO 3: Learn about the range rank and nudity of a linear transform.
UO 4: Learn about Eigen values and Eigen vectors of matrices.
UO 5: Learn about the inversion of isomorphism.

Unit-I: Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces.
Unit-II: Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.
Unit-III: Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations.
Unit-IV: Dual Space, Dual basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.
Unit-V: Isomorphisms, Isomorphism theorems, Invertibility and Isomorphisms, Change of coordinate matrix.

Essential Readings:

1. **S. Lang:** *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
2. **Gilbert Strang:** *Linear Algebra and its Applications*, Thomson, 2007.

Suggested Readings:

1. **Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence:** *Linear Algebra,* 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. **David C. Lay**: *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

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B.A./ B.Sc.- Semester V (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 7 Sem. V	MTS-MDM-511	Algebra	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. Bhupendra

Lectures/ Hrs. 90

Learning Objectives:

(i) Develop the theory for roots of polynomial equations.
(ii) Importance of Descarte's rules of sign for algebraic equations.
(iii) Idea of ring, integral domain and field in algebra.

Course Learning Outcomes: After completion of this course the students will be able to

CO1: finding roots of polynomial equations.
CO2: solve cubic and bi-quadratic equations.
CO3: concepts related to ring, integral domain and field.

Unit Wise Learning Outcomes:

UO1: Learn about the transformation of equations.
UO2: Learn the application of Descarte's rules of sign.
UO3: Understanding the theory of Ring in the algebra.
UO4: Learn properties of Integral domain and its applications.
UO5: Learn types of Fields and its applications.

Unit I: Roots of polynomial equations and relation of roots, multiplicity of roots, reciprocal roots & reciprocal equations, transformation of equations by removal of terms.
Unit II: Descartes's rules of sign, Solution of cubic and bi-quadratic equations.
Unit III: Definition of Ring, Types of Rings, Subring, Union and intersection of Rings, ideal, Ring-homomorphism.
Unit IV: Integral domain, sub domains and ordered integral domain, characteristic of an integral domain & its applications.
Unit V: Field, sub field, prime field, skew field, ordered field and its applications.

Essential Readings:

1. Leonard Eugene Dickson, First course in the theory of equations, Mjp publisher, Maxwell press.
2. N. Jacobson, Basic Algebra, Vol. I, II & III Hindustan Publishing Company.
3. S. Lang, Algebra, Addision-Wisley.
4. I.S. Luther & IBS Passi, Algebra Vol. I, II & III Narosha Pub. House, New Delhi.
5. M. Artin, Algebra, Prentice- Hall of India, 1991.

Suggested Readings

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University press.
2. I.N. Herstein, Topic in Algebra, Wiley Eastern, New Delhi.

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester V (Mathematics)

Level & Semester	Course Code	Title of the paper	Credits				Marks	Course Designer
			L	T	P	C		
L7 Sem. V	MTS-AEC-511	Transportation and Assignment Problems	2	0	0	2	IA (Mid)-40 EA (End Sem)- 60	Dr. U. K. Khedlekar

Lectures/Hrs.:30

Learning Objectives: This course is designed to provide applications of linear programming to solve real-life problems, including transportation problems, and assignment problems. Additionally, it will equip students with practical skills to formulate and analyze these problems using advanced mathematical techniques.

Course Learning Outcomes: Upon completion of this course, students will be able to:

CO 1: Formulate and solve transportation problems.
CO 2: Formulate and solve assignment problems.
CO 3: Apply linear programming techniques to optimize various real-life scenarios and enhance decision-making processes.

Unit Wise Learning Outcomes:

UO 1: To study formulation of transportation problems and determine initial basic feasible solution.
UO 2: To apply matrix row minima and column minima method, and Vogel's Approximation Method for solving transportation problems.
UO 3: To find optimal solutions for transportation problems and address degeneracy.
UO 4: To formulate and solve assignment problems using the Hungarian Method and understand the Fundamental Theorem of Assignment Problems.
UO 5: To analyse and solve crew-based and Traveling-Salesman problems, and address unbalanced assignment problems.

Unit-I: Transportation problem and its mathematical formulations, Transportation problem-initial basic feasible solution. Initial Basic Feasible Solution by North-West Corner Method.
Unit-II: Matric row minima method and Column minima method, Vogel's approximation method.
Unit-III: Optimal solution of degeneracy in transportation problems.
Unit-IV: Assignment Problems and its mathematical formulations, Fundamental theorem of assignment problems, Hungarian Method for solution.
Unit-V: Crew based problems, Traveling-Salesman (Routing) problems. Introduction to unbalance assignment problems.

Essential Readings

1. S.D. Sharma. Operations Research, Kedar Nath Ram Sons & co. Publisher Meerut (thirteenth-edition) 2001.
2. H.A. Taha, Operations Research-An Introduction, Macmillan Publishing INC., New- York.
3. F.S. Hillier & G.J. Lieberman, Introduction to Operations Research, (sixth-edition), McGraw, Hill International Edition

Suggested Readings

1. J.C. Pant, Operations Research and optimization, Jain publisher (7th edition)
2. Kanti Swarup, P.K. Gupta & Man Mohan, Operations Research., Sultan Chand &sons, New Delhi.

Essential E-Resources

1. https://www.youtube.com/watch?v=BDBhpxRzImI&list=PLWoXNEI-KK1mCv_EL4OdF_-FXryaZ11N
2. www.cs.toronto.edu/~stacho/public/IEOR4004-notes1.pdf

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11/6/24

Passed by Board of Studies Dated. 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester VI (Mathematics)

Course Designer	Course Designer	Course Designer	Course Designer				Course Designer	Course Designer
			L	T	P	C		
L7 Sem. VI	MTS-DSM-611	Basic Complex Analysis	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. S. Kumar

Lectures/Hrs. 90

1. Learning Objectives:

(i) Representation of complex numbers and its geometrical interpretation.
(ii) Knowledge of limit of complex-valued function of a complex variable.
(iii) Importance of theory related to continuity and differentiability of function.
(iv) Idea of curves in the complex plane and evaluation of Contour integrals.
(v) Develop the theory related to sequences and series of complex numbers.

2. Course Learning Outcomes:

CO 1: Learn the basic concept of the limit of function.
CO 2: Learn continuity, differentiability and analyticity of functions.
CO 3: Learn about the contour integrals, and convergence and divergence of sequences and series.

3. **Unit-wise Learning Outcomes:**

UO 1. Learn about the concept related to set in the complex plane.
UO 2. Learn about the theory of complex-valued function of a complex variable.
UO 3. Learn about the necessary and sufficient conditions for differentiability of functions.
UO 4. Learn about the different types of domain and curves in the complex plane.
UO 5. Learn about the transformation for complex-valued function of a complex variable.

Unit-I: Cartesian and polar representations of complex numbers, Basic algebraic properties of complex numbers, Arguments of complex numbers, Exponential form of complex numbers, Roots of complex numbers, Regions in the complex plane, Neighborhood of point in the complex plane.
Unit-II: Interior, exterior and boundary points of set, Open set, Limit point of set, Closed set, Bounded set, Connected set, Domain in the complex plane, Convex set, Functions of a complex variable, Limit of function at point, Theorem on limits, Limit of function involving the point at infinity
Unit-III: Exponential, Logarithmic, Trigonometric and Hyperbolic functions, Complex exponents, Continuity and differentiability of functions, Cauchy-Riemann equations, Necessary and sufficient conditions for differentiability of functions.
Unit-IV: Analytic functions, Harmonic functions, Basic definitions related to curves, Parametric curves, Simply and Multiply connected domains, Contour integrals of functions, Cauchy-Goursat theorem, Cauchy integral formula.
Unit-V: Convergence of sequences and series, Power series, Absolute and uniform convergence of power series, Bilinear transformation and their results, Cross ratio of numbers, Fixed points of a transformation, Inverse points, Conformal mapping.

Essential Readings:

1. J.E. Brown, R.V. Churchill, Complex Variables and Applications, McGraw-Hill.
2. L.V. Ahlfors, Complex Analysis, McGraw-Hill.
3. J.B. Conway, Functions of One Complex Variable, Narosa Publishing House.

Suggested Readings:

1. S. Ponnusamy, Foundation of complex analysis, Narosa publication.
2. E.C. Titchmarsh, The Theory of Functions, Oxford University Press.
3. H.A. Priestley, Introduction to Complex Analysis, Oxford University Press.

Essential e-Resources:

1. https://video.search.yahoo.com/search/video?fr=mcafee&p=video+related+to+basic+complex+analysis&type=C211US660D20151202#id=7&vid=8c9577fe26abc5d7e1c763aaa8f8a151&action=view\
2. https://video.search.yahoo.com/search/video?fr=mcafee&p=video+related+to+basic+complex+analysis&type=C211US660D20151202#id=3&vid=ad7d2ae24a949173f9fbbfd677e7d036&action=click

11/6/24

Passed by Board of Studies Dated. 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester VI (Mathematics)

Level & Semester	Course Code	Title of the Course	Credits				Marks	Course Designer
			L	T	P	C		
L7 Sem. VI	MTS-MDM-611	Dynamics	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. Bhupendra

Lectures/Hrs. 90

1. **Learning Objectives:**
   (1) To learn velocity of a particle along a plane curve.
   (2) To learn acceleration of a particle along a plane curve.
   (3) To study simple harmonic motion.
   (4) To understand horizontal and vertical elastic strings.
   (5) To study various types of central orbits.

2. **Course Learning Outcomes:**
   CO 1: Learn the radial, transverse, tangential and normal components of velocity acceleration of a particle along a plane curve.
   CO 2: Learn to geometrical representation of simple harmonic motion.
   CO 3: Learn to motion on a smooth plane curve.
   CO 4: Learn to central orbits.

3. **Unit-wise Learning Outcomes:**
   UO 1: Learn about the radial, transverse, tangential and normal components of velocity & acceleration of a particle along a plane curve.
   UO 2: Learn about the writing sections and new lines in Latex.
   UO 3: Learn about the writing Mathematical tools in Latex.
   UO 4: Learn about slide preparation in Latex.
   UO 5: Learn about the writing papers and books in Latex.

Unit-I: Velocity and acceleration of a particle along a plane curve: Radial and Transverse components, Tangential and Normal components.
Unit-II: Simple harmonic motion, Geometrical representation of Simple harmonic motion. Projectile Motion: Velocity and direction of projectile at a given time and height of horizontal plane.
Unit-III: Elastic Strings: Hooke's law, Horizontal and Vertical Elastic Strings.
Unit-IV: Motion on a smooth plane curve, Principle of conservation of energy, Motion on a rough curve under gravity.
Unit-IV: Central Orbits: Elliptic, Hyperbolic and Parabolic Orbits, Apse, apsidal distance and angle.

Suggested Book :

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.

Additional Book :

1. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester VI (Mathematics)

Level & Semester	Course Code	Title of the Course	Credits				Marks	Course Designer
			L	T	P	C		
L7 Sem. VI	MTS-SEC-611	Latex	1	0	1	2	IA (Mid)-40 EA (End Sem)- 60	Dr. S. Kumar

Lectures/Hrs. 30

1. Learning Objectives:
(i) Installation of the Latex and saving a folder in Latex.
(ii) Develop the idea of writing sections and paragraphs in Latex.
(iii) Easy way to writing Mathematics in the Latex.
(iv) To develop the idea of writing papers and books.

2. Course Learning Outcomes: This course will enable the students will be able to:
CO 1: Learn the fundamental concepts of Latex.
CO 2: Learn to write Mathematical symbols in Latex.
CO 3: Learn Commands and environments for inserting simple figures.

3. **Unit-wise Learning Outcomes:** After completion of this course students will be able to:
UO 1: Learn about the importance of Latex input file and syntax.
UO 2: Learn about the writing sections and new lines in Latex.
UO 3: Learn about the writing Mathematical tools in Latex.
UO 4: Learn about slide preparation in Latex.
UO 5: Learn about the writing papers and books in Latex.

Unit-I: Installation of the software Latex, Understanding of Latex input file and Latex compilation, Saving a folder, Latex syntax, Keyboard characters in Latex.
Unit-II: Fonts selection, Sections and subsections, Labeling and referring numbered items, new lines and paragraphs, Page numbering, Listing texts.
Unit-III: Equation writing, Basic notations and delimiters, Mathematical operators, Mathematical expressions in text mode, Mathematical equations, Matrices, Array of equations, Labeling of equations.
Unit-IV: Commands and environments for inserting simple figures, References and their citations, Slide preparation.
Unit-V: Writing reports, books, research papers, official letters and question papers.

Essential Readings:

1. Dilip Datta, LATEX in 24 Hours; A Practical Guide for Scientific Writing, Springer.
2. Stefan Kottwitz, LaTeX Beginner's Guide; Create high-quality and professional-looking texts, articles, and books for business and science using LaTeX, PACKT Publishing.

Suggested Readings:

1. Tobias Oetiker, Marcin Serwin, Hubert Partl, Irene Hyna, Elisabeth Schlegl, The Not So Short Introduction to LATEX Or LATEX in 280 minutes.

Essential e-Resources:
1. Link- http://www.tezu.ernet.in/dmech/people/ddatta_files/attachment/LaTeX_24H_Note.pdf
2. Link- https://cloudflare-ipfs.com/ipfs/bafykbzacebqf4ywni7cvdzsq2tnwbej3ysm7lg6kll3ppxuzt3ogcx3t5rccw?filename=[]%20Stefan%20Kottwitz%20-%20LaTeX%20Beginner%27s%20Guide:%20Create%20high-quality%20and%20professional-looking%20texts,%20articles,%20and%20books%20for%20business%20and%20science%20using%20LaTeX%20(2011,%20Packt%20Publishing).pdf

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Passed by Board of Studies Dated. 11/06/24

School Board Meeting held on 14th June, 2024

The School Board has approved the minute of meeting of BOS of Department of Mathematics and Statistics held on 11/06/2024.

Prof. A.K. Saxena
External Member
Department of Mathematics, Maharaja Chhatrasal University, Chhatarpur (M.P.)

Prof. K.S. Varsney
External Member
HoD Physics, D.S. College, Aligarh, U.P.

Prof. Narendra Pandey
External Member
Department of Physics,
University of Lucknow (U.P.)

Prof. Diwakar Shukla
Member
HoD, Department of Mathematics & Statistics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Ashish Verma
Member
HoD, Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. R.K. Rawat
Member
Department of Applied Geology,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Ranveer Kumar
Member
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. U.K. Patil
Member
Department of Pharmaceutical Science,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Abhishek Bansal
Member & Associate Professor
HoD, Department of Computer Science & Applications
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. U.K. Khedlekar
Member & Associate Professor
Department of Mathematics & Statistics,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Rekha Garg Sonaki
Member & Associate Professor
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Kamal Kant Ahirwar
Member & Assistant Professor
Dept. of Computer Science & Applications
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Mahesh Kumar Yadav
Member & Assistant Professor
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Maheshwar Panda
Member & Assistant Professor
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Ms. Shivani Khare
Member & Assistant Professor
Department of Vedic Studies
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. R.K. Sangele
Chairman, School Board & Dean, SMPS
Dr. Harisingh Gour V.V., Sagar (M.P.)