Chaudhary Bansi Lal University

(A State University established under Haryana Act No. 25 of 2014)

SCHEME AND SYLLABI

for

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. MATHEMATICS

As per NEP 2020

WITH EFFECT FROM THE SESSION 2025-26

Department of Mathematics
Chaudhary Bansi Lal University,
Prem Nagar-127031
Bhiwani
Haryana, India

Date of PGBOS&R: July 22, 2025

Vision and Mission of the University

Vision

To be known as a university having capacity to transform the society through continual innovations in education, research, creativity and entrepreneurship in the domain of higher education.

Mission

To create an environment in which new ideas, research and scholarship flourish and from which the leaders and innovators of tomorrow emerge.

To use local resources and environment as testing laboratory by the faculty and the students for generating new ideas and solutions of local problems.

To provide a challenging and rigorous curriculum which is global in outlook and simultaneously provides an understanding of the needs of society and industry.

To collaborate with leading academic and research institutes around the world to strengthen the education and research ecosystem.

To integrate ICT into teaching-learning processes and administrative systems for enhancing their effectiveness.

To create forums and to encourage students to participate in curricular and extra-curricular activities, to showcase and hone their talent and creativity.

To promote continuous engagement with stakeholders at all levels i.e. students, faculties, administration, alumni, industries, management of affiliated institutions, government regulatory bodies and community for their support, new ideas and feedback.

Vision and Mission of the Department

Vision

•To provide an environment where students can learn and become competent users of Mathematics and Mathematical applications in real life, industry and other disciplines.

- To impart quality education combining academics with joy of discovery and inculcation of the spirit of research through innovative teaching and research methodologies.

Mission

- To provide quality education to the students to prepare them as a good academician to serve the society better.
- To achieve high standards of excellence in generating and propagating knowledge in Mathematics with research and academic excellence.

Programme Learning Outcomes

PLO No.	Component	Outcomes
PLO 1.	Basic Knowledge and critical thinking	Capable of delivering basic disciplinary knowledge and able to understand critically the results.
PLO 2.	In- depth knowledge and problem-solving abilities	Capable of describing advance knowledge gained during the programme and applying acquired knowledge to solve the problems.
PLO 3.	Creativity, analytical innovation and computation skills	Capable to identify, formulate, investigate and analyse the scientific problems innovatively to design through mathematical software and solutions to real life problems.
PLO 4.	Research aptitude and global competency	Ability to cultivate a research aptitude and use information to solve demanding research issues in the relevant and related fields globally.
PLO 5.	Holistic, multidisciplinary skill enhancement	Ability to learn through a multidisciplinary & holistic approach in various subjects, acquiring specialized talents and advanced methods consequently applying them to enhanced humanity.
PLO 6.	Ethical and professional responsibility	Encourage a moral, professional mind-set and the capacity to connect to societal issues.
PLO 7.	Employment-ready and entrepreneurial skills	Ability to adapt to the future of work by responding to rapid technological developments and innovations that continuously reshape employers' skill demands and work processes.

Scheme and Syllabus of Two Year Post Graduate Programme (Semester I & II) M.Sc. in Mathematics:2025-26

First Year (Semester I and II) of 2 years PG programme (NHEQF level6)

Courses	Nomenclature of Course	Course Code	Credits Distribution			Total Credits	Total Workload	Marks				
			L	T	P		Total Contact Hours	Theory		Practical		Total Marks
								Internal	External	Internal	External	
SEMESTER-I (23 Credits)												
CC-1 4 credits	Real Analysis-I	25PN-MTH101	4	0	0	4	4	30	70	-	-	100
CC-2 4 credits	Modern Algebra	25PN-MTH102	4	0	0	4	4	30	70	-	-	100
CC-3 4 credits	Ordinary Differential Equations	25PN-MTH103	4	0	0	4	4	30	70	-	-	100
CC-4 4 credits	Mechanics	25PN-MTH104	4	0	0	4	4	30	70	-	-	100
PC-1 3 credits	Programming in FORTRAN 90/95	25PN-MTH105	1	0	2	3	1+4	-	-	20	50	70
Any one of the followings												
DEC-1 4 credits	Mathematical Statistics	25PN-MTH106	4	0	0	4	4	30	70	-	-	100
	Mathematical Modeling	25PN-MTH107	4	0	0	4	4	30	70	-	-	100
	Discrete Mathematics	25PN-MTH108	4	0	0	4	4	30	70	-	-	100
SEMESTER-II (25 Credits)												
CC-5 4 credits	Real Analysis-II	25PN-MTH201	4	0	0	4	4	30	70	-	-	100
CC-6 4 credits	Linear Algebra	25PN-MTH202	4	0	0	4	4	30	70	-	-	100
CC-7 4 credits	Partial Differential Equations and Fourier Analysis	25PN-MTH203	4	0	0	4	4	30	70	-	-	100
CC-8 4 credits	Complex Analysis	25PN-MTH204	4	0	0	4	4	30	70	-	-	100
PC-2 3 credits	Computational work using R-Programming	25PN-MTH205	1	0	2	3	1+4	-	-	20	50	70
Any one of the followings												
DEC-2 4 credits	Operation Research Techniques	25PN-MTH206	4	0	0	4	4	30	70	-	-	100
	Mathematics for Finance and Insurance	25PN-MTH207	4	0	0	4	4	30	70	-	-	100
	Fuzzy Set Theory	25PN-MTH208	4	0	0	4	4	30	70	-	-	100
	MOOC'S Course		4	0	0	4	4	30	70	-	-	100
Any one of the followings												
IKS/VAC 2 credits	Indian Mathematics and Astronomy in IKS	25PN-MTH-IKS-201	2	0	0	2	2	15	35	-	-	50
	Vedic Mathematics and its Applications	25PN-MTH-VAC-201	2	0	0	2	2	15	35	-	-	50

Semester-II

Name of the Course: Real Analysis-II	**Course Code: 25PN-MTH201**	**Course:CC** **Credits:4**
Maximum Marks **Theory: 30(Internal)+70(External)=100**	**Time of Examinations: 3 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO): **CLO1:** Students would be able to explain the fundamental concepts of Reimann-Stieltjes integral. **CLO2:** Analyze the geometric interpretation of metric space, construct and interpret various proper and improper integrals and operate with real numbers, real functions. **CLO3:** By use of characteristics of study of metric spaces in the related fields such as geometry and complex analysis etc. **CLO4:** Understand continuity, uniform continuity and compactness of metric spaces and properties.	
Section – I Contribution of Indian mathematicians in real analysis, Riemann-Stieltjes integral, Existence and properties, Integration and differentiation, condition of integrability, Integration of vector-valued functions, Fundamental theorem of Calculus, Relation between Riemann Integral and Riemann-Stieltjes integral, Rectifiable curves.	15 hrs
Section-II Sequence and series of functions, Point wise and uniform convergence, Comparison tests, Cauchy criterion for uniform convergence, Weirstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem. Improper integrals and their convergence, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter. Power series, uniform convergence and uniqueness theorem, Abel theorem, Tauber theorem.	15 hrs
Section-III Definition and examples of metric spaces, neighbourhoods, limit points, interior points, open and closed sets, closure and interior, boundary points, subspace of a metric space, equivalent metrics, Cauchy sequences, completeness, Cantor's intersection theorem, Baire's category theorem, contraction Principle	15 hrs
Section-IV Continuous functions, uniform continuity, compactness for metric spaces, sequential compactness, Bolzano-Weierstrass property, total boundedness, finite intersection property, continuity in relation with compactness, connectedness, components, continuity in relation with connectedness.	15 hrs

Books Recommended:

1. Jain P.K., Ahmad K., 2004, Metric Spaces, 2nd Ed., Narosa Publishing House, New Delhi
2. Ram B., 2004, Metric Spaces, Vinayaka Publication
3. Apostol T.M., 1985, Mathematical Analysis, Narosa Publishing House, New Delhi.
4. Goldberg R.R.,1970, Real analysis, Oxford & IBH publishing Co., New Delhi.
5. Somasundaram D., Choudhary B., 1997, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
6. Narayan S., Mittal P.K.,2013, A Course of Mathematical Analysis, S. Chand & Co., New Delhi
7. Copson E.T., 1968, Metric Spaces, Cambridge University Press.
8. Simmons G.F., 1963, Introduction to Topology and Modern Analysis, McGraw Hill.

Mapping of PLOs with Course Contents of 25PN-MTH201

PLO No.	PLO Description	Mapped Course Content / CLO	Overall Mapping level
PLO 1	Basic Knowledge and Critical Thinking	CLO1: Riemann-Stieltjes integral, existence, properties, integration and differentiation; Section I: Fundamental concepts, rectifiable curves.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	CLO2: Sequence and series of functions, improper integrals, uniform convergence, power series; Section II: Convergence tests, Weierstrass approximation, Frullani's integral.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	CLO3: Metric spaces, neighbourhoods, limit points, open/closed sets, completeness, Baire's theorem; Section III: Metric space theory and applications .	S
PLO 4	Research Aptitude and Global Competency	CLO4: Continuity, uniform continuity, compactness, connectedness; Section IV: Advanced metric space properties and their implications .	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	CLO1, CLO2, CLO3, CLO4: Integration of analysis concepts with geometry, complex analysis, and applied mathematics .	M
PLO 6	Ethical and Professional Responsibility	CLO4: Rigorous mathematical reasoning, logical consistency, ethical approach to proofs .	M
PLO 7	Employment ready and entrepreneurial skills	CLOs:Problem-solving, analytical skills applicable in research and technical fields.	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: Linear Algebra	**Course Code: 25PN-MTH202**	**Course:CC Credits:4**
Maximum Marks **Theory: 30(Internal)+70(External)=100**	**Time of Examinations: 3 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1 Get familiar with vector spaces, subspaces and existence theorem for basis of a finitely generated vector space.

CLO 2 Describe the concepts of homomorphism, isomorphism and dual spaces.

CLO 3 Learn singular and non-singular linear transformations, eigen values and eigen vectors of linear transformations.

CLO 4 Understand the Gram Schmidt orthogonalization process, inner product spaces, orthogonal vectors, and orthogonal sets.

Section-I Contribution of Indian mathematicians in linear algebra, Vector spaces, Subspaces, Sum and direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space, Finitely generated vector space, Existence theorem for basis of a finitely generated vector space, Finite dimensional vector spaces.	15 hrs
Section-II Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension, Homomorphism and isomorphism of vector spaces, Linear transformations and linear forms on vector spaces, Vector space of all the linear transformations.	15 hrs
Section -III Dual spaces, Bidual spaces, Annihilator of subspaces of finite dimensional vector spaces, Null space, Range space of a linear transformation, Rank and Nullity theorem.	15 hrs
Section-IV Algebra of linear transformation, Minimal polynomial of a linear transformation, Singular and non-singular linear transformations, Matrix of a linear transformation, Change of basis, Eigen values and eigen vectors of linear transformations.	15 hrs

References:

1. I.N. Herstein,: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2nd edition).
3. Vivek Sahai and Vikas Bist, Linear Algebra, Narosa Publishing House.
4. I.S. Luther and I.B.S. Passi, Algebra, Vol.-II, Narosa Publishing House.
5. Kenneth M Hoffman, Ray Kunze, Linear Algebra, 2nd Edition, PRENTICE-HALL, INC., Englewood Cliffs, New Jersey, 1971.

Mapping of PLOs with Course Contents of 25PN-MTH202

PLO No.	PLO Description	Mapped Course Content / CLO	Overall Mapping level
PLO 1	Basic Knowledge and Critical Thinking	CLO1: Vector spaces, subspaces, basis, finite-dimensional spaces; Section I: Vector spaces, linear independence, basis, dimension.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	CLO2: Homomorphism, isomorphism, linear transformations; Section II: Homomorphism, isomorphism, quotient spaces, dimension.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	CLO3: Singular/non-singular transformations, eigenvalues, eigenvectors; Section IV: Linear transformations, eigenvalues, eigenvectors, matrix representation.	MS
PLO 4	Research Aptitude and Global Competency	CLO4: Inner product spaces, orthogonalization; Section IV: Gram-Schmidt process, inner product spaces.	M
PLO 5	Holistic, Multidisciplinary Skill Enhancement	CLO1, CLO2, CLO3, CLO4: Integration of linear algebra concepts with geometry, physics, and engineering.	M
PLO 6	Ethical and Professional Responsibility	CLO4: Logical consistency, rigorous reasoning in mathematical proofs .	M
PLO 7	Employment ready and entrepreneurial skills	CLOs:Problem-solving, analytical skills applicable in industry, research, and technical fields.	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: **Partial Differential Equations and Fourier Analysis**	**Course Code: 25PN-MTH203**	**Course:CC** **Credits:4**
Maximum Marks **Theory: 30(Internal)+70(External)=100**	**Time of Examinations: 3 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Solve Lagrange's linear equations using Charpit's general method and Jacobi's method.

CLO2 Classify partial differential equations and transform them into canonical forms. And Solution of partial differential equations of second order by Monge's method.

CLO3 Understand the characteristic equations and characteristic curves of second order partial differential equations and solution of Lapace equation, Wave equation and diffusion equation.

CLO4: Understand to expend the function as Fourier series and evaluation of Fourier transformation.

Section – I Contribution of Indian mathematicians in PDE & Fourier Analysis, Linear partial differential equations of second and higher orders. Linear and non-linear homogeneous and non-homogeneous equations with constant coefficients, Partial differential equation with variable co-efficients reducible to equations with constant coefficients, Complimentary functions and particular Integrals, Equations reducible to linear equations with constant coefficients.	15 hrs
Section - II Classification of linear partial differential equations of second order, Hyperbolic, Parabolic and Elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions, Solution of linear hyperbolic equations, Monge's method for partial differential equations of second order.	15 hrs
Section – III Cauchy's problem for second order partial differential equations, Characteristic equations and characteristic curves of second order partial differential equations, Method of separation of variables: Laplace's equation, Wave equation (one and two dimensions), Diffusion (Heat) equation (one and two dimension) in Cartesian Co-ordinate system.	15 hrs
Section – IV Fourier Analysis: Fourier Series- arbitrary period, even and odd function, half-range expansion, Forced oscillations, Fourier integral, Fourier sine integral, Fourier cosine integral, Fourier transforms, solution of PDE using Fourier transforms, Convolution Theorem, Inverse function theorem.	15 hrs

References:

1. D.A. Murray: Introductory Course on Differential Equations, Orient Longman, (India), 1967
2. Erwin Kreyszing : Advanced Engineering Mathematics, John Wiley & Sons, Inc., New York, 1999
3. A.R. Forsyth : A Treatise on Differential Equations, Macmillan and Co. Ltd.
4. Ian N.Sneddon : Elements of Partial Differential Equations, McGraw Hill Book Company, 1988
5. Frank Ayres : Theory and Problems of Differential Equations, McGraw Hill Book Company, 1972
6. J.N. Sharma & Kehar Singh : Partial Differential Equations

Mapping of PLOs with Course Contents of 25PN-MTH 203

PLO No.	PLO Description	Mapped Course Content / CLO	Overall Mapping level
PLO 1	Basic Knowledge and Critical Thinking	CLO1: Solving Lagrange's linear equations; Section I: Linear PDEs, complementary functions, particular integrals.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	CLO2: Classification and canonical forms of PDEs; Section II: Classification, reduction to canonical forms, Monge's method.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	CLO3: Characteristic equations, separation of variables, Laplace, wave, and diffusion equations; Section III: Cauchy's problem, characteristic curves, solution methods.	S
PLO 4	Research Aptitude and Global Competency	CLO4: Fourier series, Fourier transforms, solution of PDEs using Fourier methods; Section IV: Fourier analysis, convolution theorem, inverse function theorem.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	CLO1, CLO2, CLO3, CLO4: Integration of PDE and Fourier analysis with physics, engineering, and applied sciences.	M
PLO 6	Ethical and Professional Responsibility	CLO4: Rigorous mathematical reasoning, ethical approach to modeling and problem-solving.	M
PLO 7	Employment ready and entrepreneurial skills	Problem-solving, analytical skills applicable in industry and research.	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: Complex Analysis	**Course Code: 25PN-MTH204**	**Course:CC Credits:4**
Maximum Marks Theory: 30(Internal)+70(External)=100	**Time of Examinations: 03 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Be familiar with function of complex variables and represent the sum function of a power series as an analytic function with radius of convergence.
CLO 2: Understand complex integration, integral formulas and Liouville theorem.
CLO 3: Demonstrate the ideas of singularities and understanding the argument principle along with fundamental theorem of algebra.
CLO 4: Understand concept of residues, evaluate contour integrals and solve polynomial equations.

Section-I Contribution of Indian mathematicians in complex analysis, Function of a complex variable, Continuity, Differentiability, Analytic functions and their properties, Cauchy-Riemann equations in cartesian and polar coordinates, Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference to argz, logz and z^a.	15 hrs
Section-II Path in a region, Contour, Complex integration, Cauchy theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Poisson integral formula, Higher order derivatives, Complex integral as a function of its upper limit, Morera theorem, Cauchy inequality, Liouville theorem, Taylor theorem.	15 hrs
Section-III Zeros of an analytic function, Laurent series, Isolated singularities, Cassorati-Weierstrass theorem, Limit point of zeros and poles. Maximum modulus principle, Schwarz lemma, Meromorphic functions, Argument principle, Rouche theorem, Fundamental theorem of algebra, Inverse function theorem.	15 hrs
Section-IV Calculus of residues, Cauchy residue theorem, Evaluation of integrals of the types $\int_0^{2\pi} f(\cos t, \sin t)dt$, $\int_{-\infty}^{\infty} f(x)dx$, $\int_0^{\infty} f(x) \sin mx\, dx$ and $\int_0^{\infty} f(x) \cos mx\, dx$, Conformal mappings. Space of analytic functions and their completeness, Hurwitz theorem, Montel theorem, Riemann mapping theorem.	15 hrs

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of One Complex Variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 2002.
3. Liang-Shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London, 1972.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London, 1939.
6. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company, 2009.
7. H.S. Kasana, Complex Variable Theory and Applications, PHI Learning Private Ltd, 2011.
8. Dennis G. Zill and Patrik D. Shanahan, A First Course in Complex Analysis with Applications, John Bartlett Publication, 2nd Edition, 2010.

Mapping of PLOs with Course Contents of 25PN-MTH 204

PLO No.	PLO Description	Mapped Course Content / CLO	Overall Mapping level
PLO 1	Basic Knowledge and Critical Thinking	CLO1: Functions of complex variables, power series, analytic functions, Cauchy-Riemann equations; Section I: Continuity, differentiability, branches of many-valued functions.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	CLO2: Complex integration, Cauchy theorem, integral formulas, Liouville theorem; Section II: Path, contour, complex integration, Morera theorem, Taylor theorem.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	CLO3: Singularities, Laurent series, argument principle, fundamental theorem of algebra; Section III: Zeros, poles, maximum modulus principle, Rouche theorem.	S
PLO 4	Research Aptitude and Global Competency	CLO4: Residues, contour integrals, conformal mappings, Riemann mapping theorem; Section IV: Residue calculus, evaluation of integrals, advanced mapping theorems.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	CLO1, CLO2, CLO3, CLO4: Integration of complex analysis with physics, engineering, and applied sciences.	M
PLO 6	Ethical and Professional Responsibility	CLO4: Logical consistency, ethical reasoning in proofs and modeling.	M
PLO 7	Employment ready and entrepreneurial skills	Section IV: Use of mathematical software, problem-solving for real-world applications.	SM

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: **Computational work using R-Programming**	**Course Code:** **25PN-MTH205**	**Course:CC** **Credits:1L+2P=3**
Maximum Marks **Practical: 20(Internal)+50(External)=70**	**Time of Examinations: 3 Hours**	

Course Learning Outcomes (CLO):

CLO1: Students would be able to carry out mathematical formulations of the given real problems as LPPs, solve LPP's using Graphical /Simplex methods for the given problem using R language.

CLO2: Solve different types of transportation problems, assignment problems, crew assignment problems, travelling salesman problems, game problems for the given data using R..

Practical/ Computational Work

Practical: 20(Internal)+50(External)=70

There will be five questions in all, and the students must attempt any three questions. The question paper will set on the spot jointly by the internal and external examiners.

Distribution of Marks will be as follows:

i) Written Practical/ Lab work : 25 Marks

ii) Viva-voce and practical record: 25 Marks

R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes, R Programming Structures, Control Statements, Loops, Operators, No Pointers in R, Recursion, Doing Math and Simulation in R, Graphics: Creating Graphs, The Workhorse of R Base Graphics, the plot() Function Customizing Graphs, Saving Graphs to Files.

List of Practicals

Following is the list of programmes to be performed on R-Programming:

1. To show basic syntax of R language
2. To demonstrate Normal Distribution,
3. To demonstrate Binomial Distribution
4. To find Correlation and Covariance
5. To demonstrate T-Tests and ANOVA Test
6. To demonstrate Sorting in R
7. To demonstrate Linear Algebra Operation on Vectors and Matrices
8. To plot functions in R
9. To solve simplex problem
10. To solve assignment problem
11. To solve transportation problem

References:

1. Teetor P., 2011, R Cookbook, Oreilly.
2. Kabacoff R., 2015, R in Action: Data Analysis and Graphics in R, Manning publications.
3. Matloff N., 2011, The Art of R Programming, Cengage Learning.
4. Lander J.P., 2018, R for Everyone: Advanced Analytics and Graphics, Pearson Publications.
5. Venables W. N.,Ripley B. D., 2002, Modern Applied Statistics with S (Statistics and Computing), 4th ed., Springer.

Mapping of PLOs with Course Contents of 25PN-MTH 205

PLO No.	PLO Description	Mapped Course Content / CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	CLO1: Mathematical formulation of LPPs, graphical/simplex methods using R; Practical: Basic syntax, variables, data types, vectors.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	CLO2: Solving transportation, assignment, crew assignment, TSP, and game problems using R; Practical: Solving LPPs, sorting, linear algebra operations.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	CLO2: Applying R for various optimization problems; Practical: Graphics, simulation, advanced data structures, recursion.	S
PLO 4	Research Aptitude and Global Competency	CLO2: Using R for statistical and mathematical analysis; Practical: Normal and binomial distributions, correlation, covariance, T-tests, ANOVA.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	CLO1, CLO2: Integration of R programming with statistics, operations research, and data analysis.	M
PLO 6	Ethical and Professional Responsibility	CLO2: Ethical use of data, logical consistency in programming and analysis.	M
PLO 7	Employment ready and entrepreneurial skills	. Using R for data analysis, visualization, and problem-solving	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: Operation Research Techniques	**Course Code: 25PN-MTH206**	**Course:DEC Credits:4**
Maximum Marks Theory: 30(Internal)+70(External)=100	**Time of Examinations: 03 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO 1: Students will be able to illustrate the concept of optimization techniques and LPP.
CLO 2:Students will be familiar with transportation problems and assignments problems.
CLO3 : Student will be able to understand the application of queuing models in practical problems.
CLO 4: Student will be able to learn the application of Economic order quantity model in different field.

Section-I **Operations Research:** Origin, definition and its scope, Linear Programming: Formulation and Solution of linear programming problems by Graphical and Simplex methods, Big - M and Two-phase methods, Degeneracy, Duality in linear programming.	15 hrs
Section-II **Transportation Problems:** Basic Feasible Solutions, Optimum solution by stepping stoneand modified distribution methods, unbalanced and degenerate problems, trans-shipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem, case of maximization, travelling salesman and crew assignment problems.	15 hrs
Section-III **Queuing models:** Basic components of a queuing system, General birth-death equations, steady-state solution of Markovian queuing models with single and multiple servers (M/M/1, M/M/C, M/M/1/k, M/M/C/k).	15 hrs
Section-IV **Inventory control models:** Economic order quantity (EOQ) model with uniform demand and with different rates of demands in different cycles, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.	15 hrs

References:

1. F. Hillier and G.J. Lieberman, Introduction to Operation Research, Holden Day,1990.
2. H. A. Taha, Operation Research-An Introduction, Printice Hall of India, 2017.
3. J.K. Sharma, Mathematical Model in OperationS Research, Tata McGraw Hill,1989.
4. Kanti Swaroop, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand and Sons, 2010.
5. N.S. Kambo, Mathematical Programming Techniques, McGraw Hill, 2008.
6. P. K. Gupta, and D.S. Hira, Operations Research, S. Chand & Co., 1976.
7. S. D. Sharma, Operation Research, Kedar Nath Ram Nath Publications, 2009.

Mapping of PLOs with Course Contents of 25PN-MTH 206

PLO No.	PLO Description	Mapped Course Content/CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	Section I: Linear Programming, formulation, graphical and simplex methods, duality.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	Section II: Transportation, assignment, trans-shipment, travelling salesman, crew assignment problems.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	Section III: Queuing models (M/M/1, M/M/C, etc.), Section IV: Inventory control models, EOQ, shortages, price breaks.	S
PLO 4	Research Aptitude and Global Competency	Section III & IV: Practical applications of queuing and inventory models, optimization in real-world scenarios.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	Integration of OR techniques in economics, management, engineering, and practical problems .	M
PLO 6	Ethical and Professional Responsibility	Ethical decision-making in optimization, resource allocation, and modeling .	M
PLO 7	Employment ready and entrepreneurial skills	Section II & IV: Solving real-world optimization problems	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.

Semester-II

Name of the Course: **Mathematics for Finance and Insurance**	**Course Code:** **25PN-MTH207**	**Course:DEC** **Credits:4**
Maximum Marks **Theory: 30(Internal)+70(External)=100**	**Time of Examinations: 03 Hours**	

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Demonstrate knowledge of the terminology related to nature, scope, goals, risks and decisions of financial management.

CLO2: Predict various types of returns and risks in investments and take necessary protective measures for minimizing the risk.

CLO3: Develop ability to understand, analyze and solve problems in bonds, finance and insurance.

CLO4: Build skills for computation of premium of life insurance and claims for general insurance using probability distributions.

Section-I Financial Management –overview. Nature and scope of financial management. Goals and main decisions of financial management. Difference between risk, Speculation and gambling. Time value of Money - Interest rate and discount rate. Present value and future value discrete case as well as continuous compounding case. Annuities and its kinds.	15 hrs
Section-II Meaning of return. Return as Internal Rate of Return (IRR). Numerical methods like Newton Raphson method to calculate IRR. Measurement of returns under uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe Single Index Model- Systematic Risk and Unsystematic Risk.	15 hrs
Section-III Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds. Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, Peril, Hazard, proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures- feature of a loss that is ideal for insurance.	15 hrs
Section-IV Life Insurance Mathematics – Construction of Morality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life. Determination of claims for General Insurance – Using Poisson Distribution and Negative Binomial Distribution –the Polya Case. Determination of the amount of Claims of General Insurance – Compound Aggregate claim model and its properties, Claims of reinsurance. Calculation of a compound claim density function F, Recursive and approximate formulae for F.	15 hrs

References:

1. Ross, S. M. An Introduction to Mathematical Finance. Cambridge University Press, 2019.
2. 2. Elliott, R. J. and Kopp, P. E. Mathematics of Financial Markets. Sprigner Verlag, New York Inc, 2018.
3. 3. Damodaran, A. Corporate Finance - Theory and Practice. John Wiley & Sons, Inc, 2012.
4. 4. Hull, J. C. Options, Futures, and Other Derivatives. Prentice-Hall of India Private Ltd, 2010.
5. 5. Daykin, C. D., Pentikainen, T. and Pesonen, M. Practical Risk Theory for Actuaries. Chapman & Hall, 2008.
6. 6. Dorfman, M. S. Introduction to Risk Management and Insurance. Prentice Hall, Englwood Cliffs, New Jersey, 1999.
7. 7. Neftci, S. N. An Introduction to the Mathematics of Financial Derivatives. Academic Press, Inc, 1991.

Mapping of PLOs with Course Contents of 25PN-MTH207

PLO No.	PLO Description	Mapped Course Content/CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	Section I: Financial management overview, time value of money, annuities.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	Section II: Returns, risks, Markowitz model, Sharpe model, IRR calculation.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	Section III: Bond valuation, duration, convexity, insurance fundamentals.	S
PLO 4	Research Aptitude and Global Competency	Section IV: Life and general insurance, premium and claim calculations, probability distributions.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	Integration of finance, insurance, and probability concepts in real-world applications	M
PLO 6	Ethical and Professional Responsibility	Ethical decision-making in financial and insurance contexts.	M
PLO 7	Employment ready and entrepreneurial skills	Practical computations for finance/insurance.	M

S: Strong; MS: Moderate to Strong; M: Moderate, W: Weak.

Semester-II

Name of the Course: Fuzzy Set Theory	**Course Code: 25PN-MTH208**	**Course :DEC Credits:4**
Maximum Marks Theory: 30(Internal)+70(External)=100	**Time of Examinations: 03 Hours**	

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Learn fuzzy sets using linguistic words and represent these sets by membership functions.

CLO 2: Define mapping of fuzzy sets by a function and fuzzy-set-related notions; such as α-level sets, convexity, normality, support, etc.

CLO 3: Know the concepts of fuzzy graph, fuzzy relation, fuzzy morphism and fuzzy numbers.

CLO 4: Become familiar with the extension principle, its compatibility with the α-level sets and its usefulness in performing fuzzy number arithmetic operations

Section-I	15 hrs
Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T- norms and T- conorms.	
Section-II	15 hrs
Product Set, Definition of Relation, Characteristics of Relation, Representation Methods of Relations, Operations on Relations, Path and Connectivity in Graph, Fundamental Properties, Equivalence Relation, Compatibility Relation, Pre-order Relation, Order Relation, Definition and Examples of Fuzzy Relation, Fuzzy Matrix, Operations on Fuzzy Relation, Composition of Fuzzy Relation, α- cut of Fuzzy Relation, Projection and Cylindrical Extension, Extension by Relation, Extension Principle, Extension by Fuzzy Relation, Fuzzy distance between Fuzzy Sets.	
Section-III	15 hrs
Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, α- cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism.	
Section-IV	15 hrs
Interval, Fuzzy Number, Operation of Interval, Operation of α- cut Interval, Examples of Fuzzy Number Operation, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number.	

References:

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition, 2005.
2. H.J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers Ltd., New Delhi, 1991.
3. John Yen, Reza Langari, Fuzzy Logic-Intelligence, Control and Information, Pearson Education,1999.

Mapping of PLOs with Course Contents of 25PN-MTH 208

PLO No.	PLO Description	Mapped Course Content/CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	Section I: Definition, operations, and standard concepts of fuzzy sets.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	Section II: Fuzzy relations, operations, extension principle, α-level sets.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	Section III: Fuzzy graphs, fuzzy morphisms, connectivity, relations.	S
PLO 4	Research Aptitude and Global Competency	Section IV: Fuzzy numbers, interval operations, approximation, applications.	MS
PLO 5	Holistic, Multidisciplinary Skill Enhancement	Integration of fuzzy logic with engineering, computer science, and decision-making.	M
PLO 6	Ethical and Professional Responsibility	Logical consistency, ethical modeling in fuzzy logic applications.	M
PLO 7	Employment ready and entrepreneurial skills	Practical applications of fuzzy logic in industry	MS

S: Strong; MS: Moderate to Strong; M: Moderate; W: Weak

Semester-II

Name of the Course **Indian Mathematics & Astronomy in IKS**	Course Code: **25PN-MTH-IKS 201**	Course: IKS Credits:2
Maximum Marks **Theory: 15(Internal)+35(External)=50**	Time of Examinations: 2 Hours	

Note:
Examiner will set five questions, and the candidates will be required to attempt three questions in all. Question number one will be compulsory containing seven short answer type questions (7x1) from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section (2x14).

Course Learning Outcomes (CLO):

CLO1: To introduce fundamentals of Ancient Indian Educations to understand the pattern and purpose of studying vedas, vedangas, upangas, upveda, purana & Itihasa.

CLO2: To provide information about great Mathematicians and astronomers who given significant contribution in Indian Mathematics and Astronomy.

Section – I Introduction to Indian Knowledge System(IKS) : Caturdaéa Vidyästhänan, 64 Kalas, Shilpa Sästra, Four Vedas, Vedäniga, Indian Philosophical Systems, Vedic Schools of Philosophy (Sämkhya and Yoga, Nyaya and Vaisésika, Pürva-Mimämsä and Vedänta), Non-Vedic schools of Philosophical Systems (Cärväka, Buddhist, Jain), Puranas (Maha-puranas, Upa-Puranas and Sthala-Puranas), Itihasa (Ramayana, Mahabharata), Niti Sastras, Subhasitas	15 hrs
Section-II Indian Mathematics & Astronomy: Indian Mathematics, Great Mathematicians and their contributions, Arithmetic Operations, Geometry (Sulba Sutras, Aryabhatiya-bhasya), value of π, Trigonometry, Algebra, Chandah Sastra of Pingala, Indian Astronomy, celestial coordinate system, Elements of the Indian Calendar, Aryabhatiya and the Siddhantic Tradition, Pancanga — The Indian Calendar, System Astronomical Instruments (Yantras) Jantar Mantar of Raja Jai Singh Sawai.	15 hrs

Refrences:

1. Mahadevan ,B Textbook on IKS, IIM, Bengaluru
2. Bora ,M.C. ,Bhartiya Knowledge Systems, Khanna Publishing House, 2024
3. Mahadevan B. etal ,Introduction to Indian Knowledge System; Concepts and Applications, PHI, 2023
4. Rao, S.B.,Indian Mathematics and Astronomy: Some Landmarks, Bhartiya Vidhya Bhavan, 2012

Mapping of PLOs with Course Contents of 25PN-MTH-IKS 201

PLO No.	PLO Description	Mapped Course Content/CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	Section I: Introduction to IKS, Vedic and non-Vedic systems, Puranas, Itihasa.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	Section II: Indian mathematics, astronomy, contributions of mathematicians, calendar, instruments.	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	Section II: Indian mathematical and astronomical innovations, problem-solving approaches.	M
PLO 4	Research Aptitude and Global Competency	Section II: Historical and research-oriented contributions in Indian mathematics and astronomy.	M
PLO 5	Holistic, Multidisciplinary Skill Enhancement	Integration of Indian knowledge systems with mathematics, astronomy, philosophy, and culture.	M
PLO 6	Ethical and Professional Responsibility	Ethical values, cultural context, and responsible study of ancient knowledge.	M
PLO 7	Employment ready and entrepreneurial skills	Collaborative learning, group discussions on IKS and its applications. Appreciation of Traditional Knowledge in Modern Context.	M

S: Strong; MS: Moderate to Strong; M: Moderate, W:Weak

Name of the Course: Vedic Mathematics and its applications	Course Code: 25PN-MTH-VAC 201	Course : VAC Credits:2
Maximum Marks Theory: 15(Internal)+35(External)=50	Time of Examinations: 2 Hours	

Note:
Examiner will set five questions, and the candidates will be required to attempt three questions in all. Question number one will be compulsory containing seven short answer type questions (7x1) from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section (2x14).

Course Learning Outcomes (CLO):

CLO1: Student will be able to Describe the multiplication of polynomials by Vedic sutras.
CLO2: Student will be able to Understand and Apply meaning of 6 to 11 Vedic sutras
CLO3: Student will be able to Examine division of polynomials, Quotient & Remainder
CLO4: Student will be able to Evaluate complex sums with Division algorithm and also be able to Construct problems, develop algorithms and implement for various applications.

SECTION-I Multiplication of polynomials by Urdhwatiryagbhyam, Nikhilam methods. Verification by Gunit Samuchchayah. Awareness of I to 16 Vedic sutras (as per Shankaracharya Bharthikrishan Teerthji Swamiji's book) Division of polynomials, Quotient & Remainder. Division algorithm. Applications of division methods.	15 hrs
SECTION-II Factorization of polynomials up to degree 3 using Aanurupyen Lopan-Sthapanabhyam Aadyam Aadyen Antyam Antyen methods. Verification by Beejank. Simultaneous equations of 3 variables. Meru Prastar - Expansion of (a+b)". Determinants of 3rd order. Partial Fractions.	15 hrs

Refrences:

1. C. N. Srinivasiengar (1967). History of Mathematics in India. The World Press Pvt. Ltd., Calcutta.
2. Swami Shri Bharti Krishan Tirthji Maharaj (1981). Vedic Mathematics, (Dr.V.S. Agrawala, Editor), Motilal Banarsidas Indological Publishers and Booksellers. New Delhi.
3. G.G. Emch, R. Sridharan and M.D. Srinivas (2005). Contribution to the History of Indian Mathematics. Hindustan Book Agency.
4. Rajesh Kumar Thakur (2013). The Essentials of Vedic Mathematics, Rupa Publications India.
5. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi
6. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi
7. V.G. Unkalkar (2016). Excel with Vedic Mathematics, Vandana Publishers, Banglore

Mapping of PLOs with Course Contents of 25PN-MTH-VAC 201

PLO No.	PLO Description	Mapped Course Content/CLO	Overall Mapping Level
PLO 1	Basic Knowledge and Critical Thinking	Section I: Multiplication, division, and verification of polynomials using Vedic sutras.	S
PLO 2	In-depth Knowledge and Problem-solving Abilities	Section II: Factorization, simultaneous equations, determinants, partial fractions	S
PLO 3	Creativity, Analytical Innovation, and Computation Skills	Section II: Meru Prastar, problem construction, algorithm development	M
PLO 4	Research Aptitude and Global Competency	Section I & II: Application of Vedic methods in modern mathematics and research-oriented problem-solving	M
PLO 5	Holistic, Multidisciplinary Skill Enhancement	Integration of Vedic mathematics with modern math and real-world applications	M
PLO 6	Ethical and Professional Responsibility	Ethical use of Vedic mathematics, logical consistency in problem-solving .	M
PLO 7	Employment ready and entrepreneurial skills	Algorithm development, computational techniques.	M

S: Strong; MS: Moderate to Strong; M: Moderate,W:Weak.