NEP and Learning Outcome-based Curriculum Framework (LOCF)

For

Post Graduate
M.Sc. (Mathematics) Programme
(Effective from the Academic Session 2026-27)

Department of Mathematics
Gurugram University, Gurugram

(A State Govt. University Established Under Haryana Act17 of 2017)

Background

- The Department of Mathematics, Gurugram University, Gurugram, Haryana, India, was established in 2020.
- The Department started the P.G. Programme, M.Sc. Mathematics, w.e.f. the academic session 2020–2021.
- The programme offers specialization in Pure and Applied Mathematics.

Vision

The vision of the Department of Mathematics is to promote excellence and innovation in teaching and research in Pure and Applied Mathematics, as well as in interdisciplinary areas related to Mathematics and Statistics.

Mission

- To promote research and creative activities among faculty and students.
- To impart high-quality mathematical education for global competence in Mathematics.

2. Programme Outcomes(POs)

Upon successful completion of the Master's Degree Programme in Mathematics, students will be able to attain the following Programme Outcomes:

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behavior such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

3. Programme Specific Outcomes (PSOs)

Upon completion of the Master's Degree Programme in Mathematics, students will be able to achieve the following outcomes:

PSO1	Have deep understanding and knowledge in the core areas of Mathematics and demonstrate understanding and application of the concepts/theories/principles/ methods/ techniques in different areas of pure and applied Mathematics.
PSO2	Have capability to read and understand mathematical texts, demonstrate and communicate mathematical knowledge effectively and unambiguously through oral and/or written expressions and attain skills of computing/programming/using software tools/formulating models.
PSO3	Attain abilities of critical thinking, logical reasoning, investigating problems, analysis, problem solving, application of mathematical methods/techniques, disciplinary knowledge so as to develop skills to solve mathematical problems having applications in other disciplines and/or in the real world.
PSO4	Have strong foundation in basic and applied aspects of Mathematics so as to venture into research in different areas of mathematical sciences, jobs in scientific and various industrial sectors and/or teaching career in Mathematics.

4. Qualification Descriptors

B.A./B.Sc. (Hons.) in Mathematics /B.A. or B.Sc. (Pass) with Mathematics as one of the subjects with atleast 50% marks(47.5% marks of SC/ST candidates of Haryana only) in aggregate or any other examination recognized by State University of Haryana as equivalent thereto.

Scheme of M.Sc. Mathematics

(Scheme PG A1: Postgraduate Programmes (Course work only)

Semester 1

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A01	Real Analysis	241/MAT/CC101	3	1	--	3	1	--	4	30	70	--	--	100
CC-A02	Ordinary Differential Equations	241/MAT/CC102	3	1	--	3	1	--	4	30	70	--	--	100
CC-A03	Abstract Algebra	241/MAT/CC103	3	1	--	3	1	--	4	30	70	--	--	100
Discipline Specific Elective Courses														
DSE-01	Numerical Analysis	241/MAT/DS101	2	1	--	2	1	--	3	25	50	--	--	75
Multidisciplinary Course(s)														
MDC-01	One from Pool		2	1	--	2	1	--	3	25	50	--	--	75
Ability Enhancement Course(s)														
AEC-01	One from Pool		2	--	--	2	--	--	2	15	35	--	--	50
Value-added Course(s)														
VAC-01	One from Pool		2	--	--	2	--	--	2	15	35	--	--	50
Total Credits						**17**	**5**		**22**					

Semester 2

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A04	Topology	241/MAT/CC201	3	1	--	3	1	--	4	30	70	--	--	100
CC-A05	Complex Analysis	241/MAT/CC202	3	1	--	3	1	--	4	30	70	--	--	100
CC-A06	Partial Differential Equations	241/MAT/CC203	3	1	--	3	1	--	4	30	70	--	--	100
Discipline Specific Elective Courses														
DSE-02	Measure and Integration Theory	241/MAT/DS201	2	1	--	2	1	--	3	25	50	--	--	75
Multidisciplinary Course(s)														
MDC-02	One from Pool		2	1	--	2	1	--	3	25	50	--	--	75
Ability Enhancement Course(s)														
AEC-02	One from Pool		2	--	--	2	--	--	2	15	35	--	--	50
Skill Enhancement Course(s)														
SEC-01	One from Pool		1	--	2	1	--	1	2	5	20	5	20	50
Total Credits						**16**	**5**	**1**	**22**					

Semester 3

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
		Core Course(s)												
CC-A07	Functional Analysis	241/MAT/CC301	3	1	--	3	1	--	4	30	70	--	--	100
CC-A08	Advanced Abstract Algebra	241/MAT/CC302	3	1	--	3	1	--	4	30	70	--	--	100
CC-A09	Fluid Dynamics	241/MAT/CC303	3	1	--	3	1	--	4	30	70	--	--	100
		Discipline Specific Elective Courses												
DSE-03	Discrete Mathematics OR Mathematical Statistics	241/MAT/DS301A / 241/MAT/DS301B	2	1	--	2	1	--	3	25	50	--	--	75
		Multidisciplinary Course(s)												
MDC-03	One from Pool		2	1	--	2	1	--	3	25	50	--	--	75
		Skill Enhancement Course(s)												
SEC-02	One from Pool		1	--	2	1	--	1	2	5	20	5	20	50
		Value-added Course(s)												
VAC-02	One from Pool		2	--	--	2	--	--	2	15	35	--	--	50
		Seminar												
Seminar		241/MAT/SM301	--	--	4	--	--	2	2	--	--	15	35	50
		Internship/Field Activity#												
		241/MAT/IN301	--	--	8	--	--	4	4	--	--	30	70	100
Total Credits						**16**	**5**	**7**	**28**					

#Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Semester 4

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Total Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
Core Course(s)														
CC-A10	Number Theory	241/MAT/CC401	3	1	--	3	1	--	4	30	70	--	--	100
CC-A11	Classical Mechanics & Calculus of Variations	241/MAT/CC402	3	1	--	3	1	--	4	30	70	--	--	100
Discipline Specific Elective Courses														
DSE-04	Operations Research OR Fuzzy Set Theory	241/MAT/DS401A 241/MAT/DS401B	2	1	--	2	1	--	3	25	50	--	--	75
Multidisciplinary Course(s)														
MDC-04	One from Pool		2	1	--	2	1	--	3	25	50	--	--	75
Ability Enhancement Course(s)														
AEC-03	One from Pool		2	--	--	2	--	--	2	15	35	--	--	50
Community Engagement/Field Work/Survey/Seminar														
Seminar		241/MAT/SM401	--	--	12	--	--	6	6	--	--	50	100	150
Total Credits						**12**	**4**	**6**	**22**					

Multidisciplinary Course from the department for pool of the Courses in the University (These courses are to be offered to students of different discipline/Subject)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-1	Aptitude Reasoning-I	241/MAT/MD101	2	1	--	2	1	--	3	25	50	--	--	75

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-2	Aptitude Reasoning-II	241/MAT/MD201	2	1	--	2	1	--	3	25	50	--	--	75

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-3	Fundamentals of Mathematics	241/MAT/MD301	2	1	--	2	1	--	3	25	50	--	--	75

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-4	Fundamentals of Statistics	241/MAT/MD401	2	1	--	2	1	--	3	25	50	--	--	75

Skill Enhancement Course from the department for pool of the Courses in the University

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Computational Techniques using MATLAB	241/MAT/SE201	1	--	2	1	--	1	2	5	20	5	20	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-2	LaTeX	241/MAT/SE301A	1	--	2	1	--	1	2	5	20	5	20	50
	Python for Statistical Analysis	241/MAT/SE301B	1	--	2	1	--	1	2	5	20	5	20	50

Ability Enhancement Course from the department for pool of the Courses in the University

(These courses are offered by department of Indian and Foreign Languages for students of other departments/same department and leads to enhancement in the ability of learn
Regional and foreign languages)

Semester 1

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
AEC-1	Language		2	--	--	2	--	--	2	15	35	--	--	50

Semester 2

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
AEC-2	Language		2	--	--	2	--	--	2	15	35	--	--	50

Semester 4

Course Code	Course Title	Course ID	L (Hrs)	T (Hrs)	P (Hrs)	L Credits	T Credits	P Credits	Credits	MARKS TI	MARKS TE	MARKS PI	MARKS PE	MARKS Total
AEC-3	Language		2	--	--	2	--	--	2	15	35	--	--	50

Value Added Course from the department for pool of the Courses in the University

(All the departments will offer value added course for the students of same or different departments.

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-1	Mathematics in Everyday Life	241/MAT/VA101	2	--	--	2	--	--	2	15	35	--	--	50

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-2	Vedic Mathematics	241/MAT/VA301	2	--	--	2	--	--	2	15	35	--	--	50

M.Sc. MATHEMATICS 1st SEMESTER

Real Analysis

CC-A01

Credits: 4(3L+1T)

Max. Time: 3 hrs.

Course ID: 241/MAT/CC101

Maximum Marks: 100

External Examination:70

Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Learn about the Riemann-Stieltjes integral and its characteristics. Integrate vector- valued functions using rectifiable curves as an example.

CLO2 Comprehend the assertion and proof of the Weierstrass approximation theorem; and manage the convergence of sequences and series of functions.

CLO3 Comprehend differentiability and continuity of multivariable functions, relate to partial derivatives, and apply implicit and inverse function theorems.

CLO4 Understand about the ideas of Power series, exponential, logarithmic functions and trigonometric functions; use the knowledge to prove specific theorems.

Unit-I

Definition and existence of the Riemann-Stieltjes integral, properties of the integral, integration and differentiation, the fundamental theorem of calculus, integration of vector- valued functions.

Unit-II

Sequences and series of functions: Pointwise and uniform convergence of sequences of functions, Cauchy criterion for uniform convergence, Dini's theorem, uniform convergence and continuity, uniform convergence and Riemann integration, uniform convergence and differentiation. Convergence and uniform convergence of series of functions, Weierstrass M-test, integration and differentiation of series of functions, Weierstrass approximation theorem.

Unit-III

Functions of several variables: Linear transformations, the space of linear transformations on R^n to R^m as a metric space, open sets, continuity, derivative in an open subset of R^n, chain rule, partial derivatives, continuously differentiable mappings, the contraction principle, the inverse function theorem (statement only), the implicit function theorem(statement only).

Unit-IV

Power Series: Uniqueness theorem for power series, Abel's and Tauber's theorem, Taylor's theorem, Exponential & Logarithmic functions, trigonometric functions.

Reference Books:

1. Walter Rudin, Principles of Mathematical Analysis (3rd Edition) McGraw-Hill, 2013.
2. R.R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing, 2020.
3. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
4. Gabriel Klambauer, Mathematical Analysis, Marcel Dekker, Inc. New York, 1975.
5. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi, 4th Edition 2010.
6. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.

CLO-PO matrix for the course 241/MAT/CC101 (Real Analysis)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC101.1	3	3	3	3	3	3	3	3	3	-	2
241/MAT/CC101.2	3	3	2	3	2	3	2	2	3	-	-
241/MAT/CC101.3	3	3	2	3	2	3	2	2	3	-	-
241/MAT/CC101.4	3	3	3	3	3	3	3	3	3	-	3
Average	3	3	2.5	3	2.5	3	2.5	2.5	3	-	2.5

CLO-PSO matrix for the course 241/MAT/CC101 (Real Analysis)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC101.1	3	3	3	3
241/MAT/CC101.2	3	2	2	3
241/MAT/CC101.3	3	3	3	3
241/MAT/CC101.4	3	3	3	3
Average	3	2.75	2.75	3

M.Sc. MATHEMATICS 1st SEMESTER
Ordinary Differential Equations

CC-A02
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC102

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Learn initial value problems' fundamentals, solutions' existence, uniqueness, continuity, and apply to solve problems and prove theorems.

CLO2 Understand Sturm-Liouville boundary-value problem and adjoint equations.

CLO3 Describe characteristics of critical points-node, spiral, centre and saddle points.

CLO4 Summarize the basic concepts of Lyapunov function and Lyapunov's method for non-linear systems.

Unit-I

Preliminaries: Initial value problem and equivalent integral equation. Approximate solution, Cauchy-Euler construction of an approximate solution, Equicontinuous family of functions, Ascoli-Arzela Lemma, Cauchy-Peano existence theorem. Uniqueness of solutions, Lipschitz condition, Picard-Lindelof existence and uniqueness theorem for dy/dt= f(t,y), Dependence of solutions on initial conditions and parameters.

Unit-II

Sturm-Liouville BVPs, Sturm's Separation and Comparison theorems, Lagrange's identity and Green's formula for second order differential equations, Properties of eigenvalues and eigenfunctions, Prufer transformation, Adjoint systems, Self-adjoint equations of second order. Linear systems, Matrix method for homogeneous first order system of linear differential equations, Fundamental set and fundamental matrix, Wronskian of a system.

Unit-III

Nonlinear differential system, Plane autonomous systems and critical points, Classification of critical points – rotation points, foci, nodes, saddle points. Stability, Asymptotic stability and unstability of critical points.

Unit-IV

Almost linear systems, Lyapunov function and Liapunov's method to determine stability for nonlinear systems, Periodic solutions and Floquet theory for periodic systems, Limit cycles, Bendixson non-existence theorem, Poincare-Bendixson theorem(Statement only), Index of a critical point.

Reference Books:

1. Coddington E.A. and Levinson N., Theory of Ordinary Differential Equations, Tata McGraw Hill, 2017.
2. Deo S.G., Lakshmikantham V. and Raghavendra V., Textbook of Ordinary Differential Equations, Tata McGraw Hill, 2017.
3. Goldberg J. and Potter M.C., Differential Equations –A System Approach, Prentice Hall, 1998
4. Hartman P., Ordinary Differential Equations, John Wiley & Sons, 1987.
5. Ross S.L., Differential Equations, John Wiley and Sons Inc., New York, 1984.
6. Simmons G.F., Differential Equations, Tata McGraw Hill, New Delhi, 2003.
7. Somasundram D., Ordinary Differential Equations, A First Course, Narosa Pub. Co., 2016.
8. Boyce W.E. and Diprima R.C., Elementary Differential Equations and Boundary Value Problems, John Wiley and Sons, Inc., New York, 2009, 9th edition.

CLO-PO matrix for the course 241/MAT/CC102 (Ordinary Differential Equations)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC102.1	3	2	3	3	2	2	3	2	3	-	-
241/MAT/CC102.2	3	2	3	3	2	2	3	2	3	-	-
241/MAT/CC102.3	3	2	3	3	2	2	3	2	3	-	2
241/MAT/CC102.4	3	2	3	3	2	2	3	2	3	-	2
Average	3	2	3	3	2	2	3	2	3	-	2

CLO-PSO matrix for the course 241/MAT/CC102 (Ordinary Differential Equations)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC102.1	3	3	3	3
241/MAT/CC102.2	3	3	3	3
241/MAT/CC102.3	3	3	3	3
241/MAT/CC102.4	3	2	2	3
Average	3	2.75	2.75	3

M.Sc. MATHEMATICS 1st SEMESTER

Abstract Algebra

CC-A03
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC103

Maximum Marks: 100
External Examination:70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Comprehends normal subgroups, quotient groups, isomorphisms, automorphisms, conjugacy, G-sets, normal series, composition series, and refinement theorem.

CLO2 Learn about conjugacy, G-sets, normal series, composition series, and refinement theorem.

CLO3 Explain Sylow's theorem and its applications, alternating group □ , simplicity of □ for n=5, and cyclic decomposition.

CLO4 Recognize modules, submodules, direct sum, R-homomorphism, quotient module, free modules, linear mappings, ranks, and Jordan forms.

Unit-I

Normal subgroup, quotient group, normalizer and centralizer of a non-empty subset of a group G, commutator subgroups of a group, first, second and third isomorphism theorems, correspondence theorem, Aut(G), Inn(G), automorphism group of a cyclic group, G-sets, orbit of an element in group G, Cayley's theorem.

Unit-II

Conjugate elements and conjugacy classes, class equation of a finite group G and its applications, Burnside theorem. normal series, composition series, Jordan Holder theorem, Zassenhaus lemma, Schreier's refinement theorem, solvable group, nilpotent group.

Unit-III

Cyclic decomposition, even and odd permutation, Alternation group A_n, Simplicity of the Alternating group A_n ($n \geq 5$), Cauchy's theorem, Sylow's first, second and third theorems and its applications to group of smaller orders, Groups of order p^2 and pq ($q>p$).

Unit-IV

Modules, submodules, direct sums, finitely generated modules, cyclic module, R-homomorphism, quotient module, completely reducible modules, Schur's lemma, free modules, representation and rank of linear mapping.

Nilpotent transformation, reduction of a linear transformation to triangular form, index of nilpotency of a nilpotent transformation, Jordan blocks and Jordan canonical forms.

Reference Books:

1. S. Singh and Q. Zameeruddin : Modern Algebra ,Vikas Publishing House, 1990.
2. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
3. I.S. Luther and I.B.S. Passi, Algebra, Vol.I-Groups, Vol. III-Modules, Narosa Publishing House (Vol. I–2013, Vol. III–2013).
4. Charles Lanski, Concepts in Abstract Algebra, American Mathematical Society, First Indian Edition, 2010.
5. Vivek Sahai, Vikas Bist, Algebra, Narosa Publishing House, 1999.
6. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
7. C. Musili, Introduction to Rings and Modules, Narosa Publication House, 1994.
8. N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman, 1980 (also published by Hindustan Publishing Company).
9. P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra (Second edition), Cambridge University Press, 2012.

CLO-PO matrix for the course 241/MAT/CC103 (Abstract Algebra)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC103.1	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC103.2	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC103.3	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC103.4	3	3	2	3	-	2	2	-	2	-	2
Average	3	3	2	3	-	2	2	-	2	-	2

CLO-PSO matrix for the course 241/MAT/CC103 (Abstract Algebra)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC103.1	3	2	2	2
241/MAT/CC103.2	3	2	2	3
241/MAT/CC103.3	3	2	2	2
241/MAT/CC103.4	3	2	3	3
Average	3	2	2.25	2.5

M.Sc. MATHEMATICS 1st SEMESTER

Numerical Analysis

DSE-01
Credits: 3(2L+1T)
Max. Time: 2 hrs.
Course ID: 241/MAT/DS101

Maximum Marks: 75
External Examination: 50
Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand advanced numerical techniques for solving equations and calculation errors from number representation, rounding, and truncation.

CLO2 Acquire knowledge to solve linear systems directly and iteratively, analyze solutions, and use finite difference operators in numerical differentiation.

CLO3 Learn advanced numerical methods to evaluate integrals for solving linear/non-linear first/second order IVP/BVP involving ODEs.

CLO4 Apply finite difference methods for solving hyperbolic, elliptic, and parabolic PDEs in scientific problem solving.

Unit-I

Error Analysis: Errors, Absolute, relative and percentage errors.

Solution of Polynomial and Transcendental Equations: Iteration methods; First order, second order and higher order methods, Acceleration of the convergence, Efficiency of a method, Newton-Raphson method for multiple roots, Modified Newton- Raphson method. Muller method and Chebyshev method, Birge-Vieta method, Bairstow method, Graeffe's root squaring method.

Unit-II

Systems of Linear Equations: Matrix partition method, Operation count, Ill-conditioned linear systems, Moore Penrose inverse method, Least square solutions for inconsistent systems. Iteration methods Successive over relaxation (SOR) method, Convergence analysis. Eigenvalues and eigenvectors, bounds on eigenvalues, Given's method, Rutishauser method, Householder's method for symmetric matrices, Power method.

Unit-III

Numerical Differentiation: Numerical differentiation based on difference formulae, Richardson's extrapolation method, Cubic spline method, Method of undetermined coefficients.

Numerical Integration: Weddle's rule, Newton-Cotes method, Gauss-Legendre, Gauss Chebyshev, Gauss-Laguerre, and Gauss-Hermite integration methods. Composite integration method, Euler-Maclaurin's formula, Romberg Integration, Double integration.

Unit-IV

Numerical Solution of Ordinary Differential Equations:

Estimation of local truncation error of Euler and single step methods. Bounds of local truncation error and convergence analysis of multistep methods, Predictor-Corrector methods; Adams-Bashforth methods, Adams-Moulton formula, Milne-Simpson method, System of Differential Equations. Finite difference method for solving second order IVPs and BVPs.

Reference Books:

1. Gupta, R. S., Elements of Numerical Analysis, Cambridge Univ. Press, 2015.
2. Jain, M. K., Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publishers, 2012.
3. Pal, M., Numerical Analysis for Scientists and Engineers, Narosa Publishing House Pvt. Ltd., 2008.
4. Mathews, John H. and Fink Kurtis D., Numerical Methods Using Matlab, Fourth edition; PHI Learning Private Ltd., 2009.
5. Gourdin, A. and Boumahrat, M., Applied Numerical Methods, PHI Learning Private Ltd., 2004.

CLO-PO matrix for the course 241/MAT/DS101 (Numerical Analysis)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS101.1	3	2	2	3	-	3	2	-	2	-	2
241/MAT/DS101.2	3	3	2	3	-	3	3	-	2	-	2
241/MAT/DS101.3	3	3	2	3	-	3	3	-	2	-	2
241/MAT/DS101.4	3	3	2	3	-	3	3	-	2	-	2
Average	3	2.75	2	3	-	3	2.75	-	2	-	2

CLO-PSO matrix for the course 241/MAT/DS101 (Numerical Analysis)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS101.1	3	2	2	2
241/MAT/DS101.2	3	3	3	2
241/MAT/DS101.3	3	3	3	3
241/MAT/DS101.4	3	3	3	3
Average	3	2.75	2.75	2.5

M.Sc. MATHEMATICS 2nd SEMESTER

Topology

CC-A04

Credits: 4(3L+1T)

Max. Time: 3 hrs.

Course ID: 241/MAT/CC201

Maximum Marks: 100

External Examination: 70

Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand topological spaces, neighborhoods, and characteristics, including interior, closure, boundary, and limit points of subsets.

CLO2 Create new topologies using bases on a given set and explain topological invariants and the notion of homeomorphism

CLO3 Understand connectedness and compactness of topological spaces and proofs of related theorems.

CLO4 Know about continuity and compact sets, separation axioms and their properties.

Unit-I

Definition and examples of topological spaces, Comparison of topologies on a set, Intersection and union of topologies on a set, Neighbourhoods, Interior point and interior of a set , Closed set as a complement of an open set, Adherent point and limit point of a set, Closure of a set, Derived set, Properties of Closure operator, Boundary of a set.

Unit-II

Dense subsets, Interior, Exterior and boundary operators, Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator. Relative (Induced) topology, Base and sub-base for a topology, Base for Neighbourhood system. Continuous functions, Open and closed functions.Homeomorphism. Connectedness and its characterization, connected subsets and their properties, Continuity and connectedness, Components, Locally connected spaces.

Unit-III

Compact spaces and subsets, Compactness in terms of finite intersection property. Continuity and compact sets, Basic properties of compactness, Closeness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and countably compact sets, Local compactness.

Unit-IV

First countable, Second countable and separable spaces, Hereditary and topological property, Lindelof theorem. T0, T1, T2 (Hausdorff) separation axioms, their characterization and basic properties.

Reference Books:

1. G. F. Simmons, Introduction to Topology and Modem Analysis, McGraw-Hill Book Company, 2004.
2. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 2008
3. J. R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 2017.
5. W. J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964
6. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.).
7. K. Ahmad, Introduction to Topology, Narosa Publishing House New Delhi, 2019.

CLO-PO matrix for the course 241/MAT/CC201(Topology)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC201.1	3	3	2	3	2	3	3	3	3	-	2
241/MAT/CC201.2	3	3	2	3	2	3	2	2	3	-	-
241/MAT/CC201.3	3	3	2	3	2	3	2	2	3	-	-
241/MAT/CC201.4	3	3	2	3	2	3	2	2	3	-	2
Average	3	3	2	3	2	3	2.25	2.25	3	-	2

CLO-PSO matrix for the course 241/MAT/CC201(Topology)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC201.1	3	3	3	3
241/MAT/CC201.2	3	2	2	3
241/MAT/CC201.3	3	2	3	3
241/MAT/CC201.4	3	3	2	3
Average	3	2.5	2.5	3

M.Sc. MATHEMATICS 2nd SEMESTER

Complex Analysis

CC-A05 Maximum Marks: 100
Credits: 4(3L+1T) External Examination: 70
Max. Time: 3 hrs. Internal Assessment: 30
Course ID: 241/MAT/CC202

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Recognizes the features of complex numbers and how they relate to geometry as an extension of real numbers.

CLO2 Use necessary theorems, formulas, and power series expansions to solve complex integrals of various types.

CLO3 Solve the improper integrals by applying the findings from the analysis of complex functions with singularities for zeroes and residues at poles.

CLO4 Understand argument principle, conformal mappings, transforming, and mapping integration routes to solve difficult improper integrals.

Unit-I

Function of a complex variable, continuity, differentiability. Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and Polar coordinates. Harmonic function. Concept of stereographic projection. Power series, Radius of convergence, Differentiability of sum function of a power series. Branches of logarithm.

Unit-II

Path, Region, Contour, Simply and multiply connected regions, Complex integration. Cauchy theorem. Cauchy's integral formula. Poisson's integral formula. Complex integral as a function of its upper limit. Morera's theorem. Cauchy's inequality. Liouville's theorem.

Unit-III

Zeros of an analytic function. Laurent's series. Singularities. Casorati-Weierstrass theorem, Limit point of zeros and poles. Maximum and Minimum modulus principles. Schwarz lemma. Meromorphic functions. Residues. Cauchy's residue theorem. Evaluation of improper integrals.

Unit-IV

The argument principle. Rouche's theorem, The Fundamental theorem of algebra. Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings. Space of analytic functions and their completeness, Riemann mapping theorem (Statement only).

Reference Books:

1. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London, 1976.

2. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable,

Oxford University Press, London, 1960.
3. S. Ponnusamy, Foundation of Complex Analysis, Narosa Publishing House, New Delhi, 2011.
4. H.S. Kasana, Complex Variables: Theory and Applications 2nd Edition, PHI publication Delhi, 2005.
5. J. W. Brown and R.V. Churchill, Complex Variables and Applications: 9th Edition, McGraw Hill, 2021.
6. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
7. S. Lang, Complex Analysis, Addison Wesley, 1985.

CLO-PO matrix for the course 241/MAT/CC202 (Complex Analysis)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC202.1	3	2	3	3	2	2	3	2	3	-	-
241/MAT/CC202.2	3	2	3	3	2	2	3	2	3	-	-
241/MAT/CC202.3	3	2	3	3	2	2	3	2	3	-	2
241/MAT/CC202.4	3	2	3	3	2	2	3	2	3	-	2
Average	3	2	3	3	2	2	3	2	3	-	2

CLO-PSO matrix for the course 241/MAT/CC202 (Complex Analysis)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC202.1	3	3	2	3
241/MAT/CC202.2	3	2	3	3
241/MAT/CC202.3	2	3	3	3
241/MAT/CC202.4	2	3	3	3
Average	2.5	2.75	2.75	3

M.Sc. MATHEMATICS 2nd SEMESTER
Partial Differential Equations

CC-A06
Credits: 4(3L+1T)
Max. Time: 3 hrs
Course ID: 241/MAT/CC203

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Apply the separation of variables method to solve BVPs for heat and wave equations.

CLO2 Classify PDEs, solve transport and non-homogeneous equations, and analyze Laplace equations using fundamental solutions and energy methods.

CLO3 Solve heat and wave equations in various dimensions and coordinates using diverse techniques

CLO4 Understand complete integrals, envelopes, characteristics, and Hamilton-Jacobi equations in non-linear PDEs.

Unit-I

Method of separation of variables to solve Boundary Value Problems (B.V.P.) associated with one dimensional heat equation. Steady state temperature in a rectangular plate, Circular disc, Semi-infinite plate. The heat equation in semi-infinite and infinite regions. Solution of three dimensional Laplace equations, Heat Equations, Wave Equations in cartesian, cylindrical and spherical coordinates. Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of the wave equation for semi-infinite and infinite strings.

Unit-II

Partial differential equations: Examples of PDE classification. Transport equation – Initial value problem. Non-homogeneous equations. Laplace equation – Fundamental solution, Mean value formula, Properties of harmonic functions, Green function.

Unit-III

Heat Equation – Fundamental solution, Mean value formula, Properties of solutions, Energy methods.

Wave Equation – Solution by spherical means, Non-homogeneous equations, Energy methods.

Unit-IV

Non-linear first order PDE – Complete integrals, Envelopes, Characteristics, Hamilton Jacobi equations (Calculus of variations, Hamilton ODE, Legendre transform, Hopf-Lax formula, Weak solutions, Uniqueness).

Reference Books:

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, American Mathematical Society, 2014.
2. Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
3. T. Amarnath, An Elementary Course in Partial Differential Equations, Jones & Bartlett Publishers, 2009.
4. H.F. Weinberger, A First Course in Partial Differential Equations, John Wiley & Sons, 1965.

CLO-PO matrix for the course 241/MAT/CC203(Partial Differential Equations)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC203.1	3	3	3	3	2	3	3	3	3	-	3
241/MAT/CC203.2	3	3	3	3	2	3	3	3	3	-	3
241/MAT/CC203.3	3	3	3	3	3	3	3	3	3	-	3
241/MAT/CC203.4	3	3	3	3	3	3	3	3	3	-	3
Average	3	3	3	3	2.5	3	3	3	3	-	3

CLO-PSO matrix for the course 241/MAT/CC203(Partial Differential Equations)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC203.1	3	3	3	3
241/MAT/CC203.2	3	3	3	3
241/MAT/CC203.3	3	3	3	3
241/MAT/CC203.4	3	3	3	3
Average	3	3	3	3

M.Sc. MATHEMATICS 2nd SEMESTER

Measure and Integration Theory

DSE-02

Credits: 3(2L+1T)
Max. Time: 2 hrs.
Course ID: 241/MAT/DS201

Maximum Marks: 75
External Examination: 50
Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand the basic concepts of Lebesgue outer measure, borel sets and non-measurable sets.

CLO2 Recognizes the basic ideas of measurement, Lebesgue measure, and measurable functions.

CLO3 Learn about the drawbacks of the Riemann integral and the advantages of the Lebesgue integral.

CLO4 Investigate how to use the calculus fundamental theorem, indefinite integrals, and monotonic function differentiation.

Unit-I

Countable and uncountable sets, Ring of sets, Algebra, σ-algebra, F_σ, G_δ sets and Borel sets and related theorems, Lebesgue outer measure and its elementary properties, Measurable sets and their properties, Lebesgue measure of sets of real numbers and algebra of measurable sets, Characterization of measurable sets in terms of open sets, Existence of non measurable set.

Unit-II

Lebesgue measurable functions and their properties, Simple functions, approximation of measurable functions by sequences of simple functions, Borel measurability of a function. Littlewood's three principles, measurable functions as nearly continuous functions. Lusin's theorem, almost uniform convergence, Egoroff's theorem, convergence in measure, Riesz theorem.

Unit-III

The Lebesgue Integral: Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebesgue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions. Integral of a non-negative function.

Unit-IV

Fatou's lemma, Lebesgue monotone convergence theorem, Countable additivity of Lebesgue

integral,integration of series, Lebesgue dominated convergence theorem, Vitali's covering lemma, Jensen's and Minkowski inequality, The Lp-spaces and their completeness.

Reference Books:

1. H.L. Royden, Real Analysis (3rd Edition) Prentice-Hall of India, 2008
2. G.de Barra, Measure theory and integration, New Age International, 2014.
3. P.R. Halmos, Measure Theory, Van Nostrans, Princeton, 1950.
4. I.P. Natanson, Theory of functions of a real variable, Vol. I, Frederick Ungar Publishing Co., 1961.
5. R.G. Bartle, The elements of integration, John Wiley & Sons, Inc.New York, 1966.
6. K.R. Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd.,Delhi, 1977.
7. P.K. Jain and V.P. Gupta, Lebesgue measure and integration, New Age International (P) Ltd., Publishers, New Delhi, 1986.

CLO-PO matrix for the course 241/MAT/DS201 (Measure and Integration Theory)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS201.1	3	3	3	3	2	3	3	3	3	-	2
241/MAT/DS201.2	3	3	2	3	2	3	2	3	2	-	2
241/MAT/DS201.3	3	3	3	3	2	3	3	3	3	-	2
241/MAT/DS201.4	3	3	2	3	2	3	2	3	2	-	2
Average	3	3	2.5	3	2	3	2.5	3	2.5	-	2

CLO-PSO matrix for the course 241/MAT/DS201 (Measure and Integration Theory)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS201.1	3	3	3	3

241/MAT/DS201.2	3	2	3	3
241/MAT/DS201.3	3	2	3	3
241/MAT/DS201.4	3	3	2	3
Average	3	2.5	2.75	3

M.Sc. MATHEMATICS 3rd SEMESTER

Functional Analysis

CC-A07
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC301

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand Inner product spaces, Hilbert spaces, orthonormal sets and sequences.
CLO2 Understand the completeness in normed linear spaces.
CLO3 Gain knowledge of the ideas behind spaces of bounded linear transformations, equivalent formulation of continuity, and bounded linear transformations.
CLO4 Understand and apply the Riesz Representation Theorem for bounded linear functionals on second conjugate spaces.

Unit-I

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder and Minkowski inequality, Completeness of quotient spaces of normed linear spaces. Completeness of l^p, L^p, R^n, C^n *and* $C[a,b]$. Incomplete normed spaces.

Unit-II

Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, conjugate spaces. Hahn-Banach extension theorem (Real and Complex form).Weak and Strong convergence, their equivalence in finite dimensional spaces.

Unit-III

Riesz Representation theorem for bounded linear functionals on L^p *and* $C[a,b]$. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, open mapping theorem and its application, Projections, Closed Graph theorem.

Unit-IV

Inner product spaces, Hilbert spaces and their examples, Schwarz inequality, continuity of inner product, orthogonal complements and direct sums, minimizing vector, orthogonality, projection theorem, Orthonormal sets and sequences, Bessel's inequality, series related to orthonormal sequences and sets, total (complete) orthonormal sets and sequences, Parseval's identity.

Reference Books:

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 2010.

2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley.
3. W. Rudin, Functional Analysis, McGraw-Hill, Inc., New York, 1991.
4. J.B. Conway, A Course in Functional Analysis, Springer, New York, 1990.

CLO-PO matrix for the course 241/MAT/CC301 (Functional Analysis)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC301.1	3	3	3	3	3	3	3	3	3	-	2
241/MAT/CC301.2	3	3	2	3	2	3	3	2	3	-	3
241/MAT/CC301.3	3	3	3	3	3	3	3	2	3	-	3
241/MAT/CC301.4	3	3	3	3	2	3	3	3	3	-	2
Average	3	3	2.75	3	2.5	3	3	2.5	3	-	2.5

CLO-PSO matrix for the course 241/MAT/CC301 (Functional Analysis)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC301.1	3	3	3	3
241/MAT/CC301.2	3	3	3	3
241/MAT/CC301.3	3	3	3	3
241/MAT/CC301.4	3	2	2	3
Average	3	2.75	2.75	3

M.Sc. MATHEMATICS 3rd SEMESTER

Advanced Abstract Algebra

CC-A08
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC302

Maximum Marks: 100
External Examination:70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand the ideas of algebraically closed field, field extension, algebraic and transcendental extension, irreducible polynomial, and the Eisenstein criterion.
CLO2 Demonstrate a deep understanding of splitting fields, normal extension, multiple roots, prime fields, finite fields, and separable extension.
CLO3 Gain Knowledge of Fundamental theorem of Galois theory and cyclic extensions.
CLO4 Understand the concepts of symmetric functions, ruler and compass construction, and polynomials solvable by radicals.

Unit-I

Irreducible polynomials; Eisenstein's criterion and Gauss's lemma. Field extensions: algebraic and transcendental extensions; degree of an extension. Algebraic closure and algebraically closed fields.

Unit-II

Splitting fields and their degrees of extension. Normal extensions; multiple roots of polynomials. Prime fields and their characterization. Finite fields and separable extensions.

Unit-III

Automorphism groups and fixed fields; Dedekind's lemma.Galois groups of polynomials; Galois extensions; fundamental theorem of Galois theory.Fundamental theorem of algebra; roots of unity and cyclotomic polynomials. Klein's four-group, cyclic extensions, and Frobenius automorphism of finite fields.

Unit-IV

Solvability of polynomials by radicals over $\mathbb{Q}$. Symmetric and elementary symmetric functions. Constructions using ruler and compass only.

Reference Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 2012.
2. V. Sahai and V. Bist, Algebra, Narosa Publishing House, 1999.
3. S. Singh and Q. Zameeruddin, Modern Algebra, Vikas Publishing House, 1990.
4. P. Morandi, Field and Galois Theory, Springer, 1996.
5. J.A. Gallian, Contemporary Abstract Algebra, Cengage Learning, Boston, 2016.

6. V.K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi, 2016.

CLO-PO matrix for the course 241/MAT/CC302 (Advanced Abstract Algebra)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC302.1	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC302.2	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC302.3	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC302.4	3	3	2	3	-	2	2	-	2	-	2
Average	3	3	2	3	-	2	2	-	2	-	2

CLO-PSO matrix for the course 241/MAT/CC302 (Advanced Abstract Algebra)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC302.1	3	2	2	2
241/MAT/CC302.2	3	2	2	2
241/MAT/CC302.3	3	2	2	2
241/MAT/CC302.4	3	2	3	3
Average	3	2	2.25	2.25

M.Sc. MATHEMATICS 3rd SEMESTER

Fluid Dynamics

CC-A09
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC303

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Study about basic behaviour of fluid, velocity potential of fluid, continuity equation and acceleration at a point of the fluid.

CLO2 Understand the equation of motion, pressure at a point of fluid, Bernoulli equation and some energy equations of the fluid.

CLO3 Learn about the axially symmetric flow, kinetic energy due to impulsive motion, source, sink and doublet.

CLO4 Evaluate the Stoke stream function, axisymmetric flow, irrotational motion, complex potential function, and Blasius theorem.

Unit-I

Kinematics - Velocity at a point of a fluid, Eulerian and Lagrangian methods, Stream lines, path lines and streak lines, Velocity potential, Irrotational and rotational motions, Vorticity and circulation, Equation of continuity, Boundary surfaces, Acceleration at a point of a fluid.

Unit-II

Pressure at a point of a moving fluid, Euler equation of motion, Equations of motion in cylindrical and spherical polar co-ordinates, Bernoulli equation, Impulsive motion, Kelvin circulation theorem, Kinetic energy of irrotational flow, Kelvin minimum energy theorem.

Unit-III

Axially symmetric flows, Liquid streaming part of a fixed sphere, Motion of a sphere through a liquid at rest at infinity, Equation of motion of a sphere, Three-dimensional sources, sinks and doublets, Images of sources, sinks, and doublets in rigid impermeable infinite plane.

Unit-IV

Two dimensional motion, Stream function, Stoke stream function, Stoke stream function of basic flows, Complex velocity potential, Milne-Thomson circle theorem, Two-dimensional sources, sinks, doublets and their images, Blasius theorem.

Reference Books:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydromechanics, Vol. 2, CBS Publishers and Distributors, Delhi, 2006.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 2004.
3. M.E. O'Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, Ellis

Horwood, 1986.
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
5. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

CLO-PO matrix for the course 241/MAT/CC303 (Fluid Dynamics)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC303.1	3	2	3	3	3	3	3	3	3		3
241/MAT/CC303.2	3	3	3	3	3	3	2	3	3		2
241/MAT/CC303.3	3	3	3	3	2	2	3	3	3		3
241/MAT/CC303.4	3	3	3	3	2	2	2	3	3		2
Average	3	2.75	3	3	2.5	2.5	2.5	3	3		2.5

CLO-PSO matrix for the course 241/MAT/CC303 (Fluid Dynamics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC303.1	3	3	3	3
241/MAT/CC303.2	3	3	3	3
241/MAT/CC303.3	3	2	3	3
241/MAT/CC303.4	3	3	3	3
Average	3	2.75	3	3

M.Sc. MATHEMATICS 3rd SEMESTER

Discrete Mathematics

DSE-03

Credits: 3(2L+1T)

Max. Time: 2 hrs.

Course ID: 241/MAT/DS301A

Maximum Marks: 75

External Examination: 50

Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand the basic concepts of graph theory, sub graphs and isomorphism of graphs along with paths and circuits.

CLO2 Understand concept of directed graphs, trees, spanning tree, shortest path problem and cut sets.

CLO3 Learn about formal logic, quantifier, predicates, pigeonhole principle, lattices, complemented and distributive Lattices. Join-irreducible elements, and atoms and minterms.

CLO4 Learn about Boolean algebra, boolean forms, minterm boolean forms, sum of products canonical forms, applications of boolean algebra to switching theory.

Unit-I

Graph Theory: Definitions and basic concepts, special graphs, Subgraphs, isomorphism of graphs, Walks, Paths and Circuits, Eulerian Paths and Circuits, Hamiltonian Circuits, matrix representation of graphs, Planar graphs, Coloring of Graph, Directed Graphs.

Unit-II

Trees: Isomorphism of Trees, Representation of Algebraic Expressions by Binary Trees, Spanning Tree of a Graph, Shortest Path Problem, Minimal spanning Trees, Cut Sets, Tree Searching.

Unit-III

Formal logic: Statements, symbolic representation, and tautologies. Quantifiers, predicates, validity, and propositional logic.

Lattices and their properties: Lattices as algebraic systems. Sublattices, direct products, and homomorphisms. Special lattices: complete, complemented, and distributive lattices. Join-irreducible elements, atoms, and minterms.

Unit-IV

Boolean Algebra and Applications: Boolean algebras and their structure as lattices; Boolean identities. Switching algebra as an example. Subalgebras, direct products, and homomorphisms. Boolean forms and their equivalence; minterm forms and sum of products (SOP) canonical forms. Minimization of Boolean functions. Applications of Boolean algebra in switching theory; Karnaugh map method.

Reference Books:

1. B. Ram, Discrete Mathematics, Vinayak Publishers and Distributors, Delhi, 2004.
2. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book Co.
3. J.L. Gersting, Mathematical Structures for Computer Science (3rd Edition), Computer Science Press, New York.
4. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
5. S. Lipschutz, Finite Mathematics (International Edition 1983), McGraw-Hill Book Company, New York.

CLO-PO matrix for the course 241/MAT/DS301A (Discrete Mathematics)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS301A.1	3	3	2	3	-	2	2	-	2	-	2
241/MAT/DS301A.2	3	3	2	3	-	2	2	-	2	-	2
241/MAT/DS301A.3	3	3	2	3	-	2	2	-	2	-	2
241/MAT/DS301A.4	3	3	2	3	-	2	2	-	2	-	2
Average	3	3	2	3	-	2	2	-	2	-	2

CLO-PSO matrix for the course 241/MAT/DS301A (Discrete Mathematics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS301A.1	3	3	2	3
241/MAT/DS301A.2	3	3	2	3
241/MAT/DS301A.3	3	2	2	2
241/MAT/DS301A.4	3	2	2	2
Average	3	2.5	2	2.5

M.Sc. MATHEMATICS 3rd SEMESTER
Mathematical Statistics

DSE-03

Credits: 3(2L+1T)
Max. Time: 2 hrs.
Course ID: 241/MAT/DS301B

Maximum Marks:75
External Examination:50
Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand and apply the fundamental concepts of probability, including axioms, theorems, conditional probability, and Bayes' theorem.

CLO2 Demonstrate understanding of random variables (discrete and continuous), and compute expectation, variance, and related properties.

CLO3 Analyze and apply standard probability distributions (discrete and continuous) and explain the significance of the Central Limit Theorem.

CLO4 Apply statistical inference techniques including estimation and hypothesis testing using Z-test, t-test, and Chi-square test.

Unit -I

Random experiment, Sample space, Events – simple, composite, mutually exclusive and exhaustive events, algebra of events. Various definitions of probability, Properties of probability function, Addition theorem, Boole's inequality, Conditional probability, Multiplication theorem, Independence of events, Total probability, Baye's theorem and its applications.

Unit-II

Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution function, Bivariate random variables, Mathematical expectation: Definition, mean, variance, covariance, moment generating function and their properties.

Unit-III

Discrete distributions: Binomial, Poisson and Geometric distributions with their properties. Continuous distributions: Uniform, Exponential, Gamma and Normal distributions with their properties, Central Limit Theorem.

Unit-IV

Statistical estimation, Testing of hypothesis: Null and alternative hypotheses, simple and composite hypotheses, Critical region, Level of significance, two types of errors, Tests of significance: Z-test, t-test and Chi-square test and applications.

Reference Books:

1.R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Amerind

Publishing Co. Pvt. Ltd., New Delhi, 1972.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014.
3. W.J. Freund, Mathematical Statistics (5th Edition), Prentice-Hall, Inc., Englewood Cliffs, N.J., 1994.
4. S.M. Ross, Introductory Statistics, Elsevier, 2010.
5. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2019.
6. W. Feller, An Introduction to Probability Theory and its Applications, Vol. I and II, Wiley, New York, 1968–1971.

CLO-PO matrix for the course 241/MAT/DS301B (Mathematical Statistics)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS301B.1	3	3	2	3	2	3	3	2	3	-	3
241/MAT/DS301B.2	3	3	2	3	2	3	3	3	3	-	2
241/MAT/DS301B.3	3	3	2	3	2	3	2	2	3	-	3
241/MAT/DS301B.4	3	3	2	3	2	3	3	2.	3	-	3
Average	3	3	2	3	2	3	2.75	2.25	3	-	2.75

CLO-PSO matrix for the course 241/MAT/DS301B (Mathematical Statistics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS301B.1	3	3	3	3
241/MAT/DS301B.2	3	3	3	3
241/MAT/DS301B.3	3	3	3	3
241/MAT/DS301B.4	3	3	3	3
Average	3	3	3	3

M.Sc. MATHEMATICS 3rd SEMESTER
Seminar

Credits: 2
Course ID: 241/MAT/SM301

Practical External: 35
Practical Internal: 15

Course Learning Outcomes:

CLO1 Select a topic within their area of interest while recognizing ethical considerations related to their work, maintaining integrity and objectivity, and developing a foundation for research-oriented thinking.

CLO2 Acquire in-depth knowledge and a strong conceptual understanding of a chosen topic in core or applied Mathematics, fostering a research mindset and the ability to analyze and investigate problems systematically.

CLO3 Develops the ability to read and interpret mathematical literature from books, journals, and digital resources, and effectively communicate their findings through written reports and oral presentations.

CLO4 Demonstrate sound comprehension, accuracy in work, and the ability to work independently, while cultivating an attitude that supports continuous and lifelong learning.

.

Note: *Each student must select a topic related to emerging fields of Mathematics according to their area of interest and obtain approval from the designated group in-charge before proceeding. After the approval, the student should explore various academic resources such as library books, journals, and online materials to gain a thorough understanding of the chosen topic. Based on this study, the student is required to prepare a detailed seminar report and deliver a presentation on the topic. The seminar will be evaluated by the concerned group in-charge based on the following criteria:*

i. Understanding and command over the subject matter.

ii. Appropriateness and level of complexity of the selected topic, along with evidence of research inclination and updated knowledge.

iii. Quality and organization of the seminar content.

iv. Effectiveness of communication during the presentation.

v. Ability to respond clearly and confidently to questions before the group and the group in-charge for a minimum duration of one hour.

CLO-PO matrix for the course 241/MAT/SM301 (Seminar)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/SM301.1	3	3	2	2	3	3	2	3	3	1	3
241/MAT/SM301.2	3	3	2	3	2	3	2	3	3	1	3
241/MAT/SM301.3	3	2	3	3	3	2	2	2	3	1	3
241/MAT/SM301.4	3	2	3	3	3	3	2	2	3	1	3
Average	3	2.5	2.5	2.75	2.75	2.75	2	2.5	3	1	3

CLO-PSO matrix for the course 241/MAT/SM301 (Seminar)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/SM301.1	3	3	2	3
241/MAT/SM301.2	3	3	3	3
241/MAT/SM301.3	3	3	3	3
241/MAT/SM301.4	3	3	2	3
Average	3	3	2.5	3

M.Sc. MATHEMATICS 4th SEMESTER

Number Theory

CC-A10
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC401

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Apply properties of arithmetic and multiplicative functions, including Möbius inversion, to solve recurrence and combinatorial number theory problems.

CLO2. Solve linear Diophantine equations and analyze rational solutions using unimodular matrices and quadratic forms.

CLO3. Apply Farey sequences, approximation theorems, and geometric principles to analyze irrational numbers and integer representations.

CLO4. Use continued fractions and the Euclidean algorithm to find best approximations of irrationals and solve Pell's equation.

Unit-I

Number Theoretic Functions and Applications: Greatest integer function and arithmetic functions. Multiplicative and completely multiplicative functions. Möbius inversion formula and recurrence functions. Combinational number theory.

Unit-II

Diophantine Equations and Rational Solutions: Solution of the equation $ax + by = c$; simultaneous linear equations. Unimodular matrices and Pythagorean triangles. Selected examples in Diophantine analysis. Ternary quadratic forms and rational points on curves.

Unit-III

Diophantine Approximation and Number Theory: Farey sequences and rational approximations. Hurwitz's theorem on best approximations. Irrational numbers and Blichfeldt's principle. Minkowski's convex body theorem and Lagrange's four-square theorem.

Unit-IV

Continued Fractions: Euclidean algorithm and finite/infinite continued fractions. Approximations to irrational numbers and best possible approximations. Hurwitz's theorem on continued fractions. Periodic continued fractions and Pell's equation.

Reference Books:

I. Niven, H.S. Zuckerman, and H.L. Montgomery, An Introduction to the Theory of Numbers (5th Edition), John Wiley & Sons, 1991.

2. G.H. Hardy and E.M. Wright, An Introduction to the Theory of Numbers (6th Edition), Oxford University Press, 2008.

3. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory (2nd Edition), Springer, 1990,

4. T.M. Apostol, Introduction to Analytic Number Theory, Springer, 1976

CLO-PO matrix for the course 241/MAT/CC401 (Number Theory)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC401.1	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC401.2	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC401.3	3	3	2	3	-	2	2	-	2	-	2
241/MAT/CC401.4	3	3	2	3	-	2	2	-	2	-	2
Average	3	3	2	3	-	2	2	-	2	-	2

CLO-PSO matrix for the course 241/MAT/CC401 (Number Theory)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC401.1	3	2	2	2
241/MAT/CC401.2	3	2	2	3
241/MAT/CC401.3	3	2	2	2
241/MAT/CC401.4	3	2	2	3
Average	3	2	2	2.5

M.Sc. MATHEMATICS 4th SEMESTER

Classical Mechanics & Calculus of Variations

CC-A11
Credits: 4(3L+1T)
Max. Time: 3 hrs.
Course ID: 241/MAT/CC402

Maximum Marks: 100
External Examination: 70
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Learn the laws of conservation of momentum, angular momentum, and energy, along with moments and products of inertia.

CLO2 Learn about generalised coordinates and rigid body dynamics in three dimensions.

CLO3 Understand the Hamiltonian, Canonical transformations, Variational concepts, and Lagrange's equation for potential forces.

CLO4 Understand variational issues involving various types of functionals, one must comprehend the ideas of variational calculus.

Unit-I

Moments and products of inertia; theorems of parallel and perpendicular axes.
Angular momentum of a rigid body about a fixed point and fixed axes; principal axes of inertia.
Kinetic energy of a rigid body rotating about a fixed point; momental ellipsoid and equimomental systems. Coplanar mass distributions and general motion of a rigid body.

Unit-II

Euler's equations for rigid body motion about a fixed point; properties of rigid motion without external forces; examples of three-dimensional rigid body motion; dynamics of the rotating Earth.
Introduction to dynamical systems; generalized coordinates and velocities; virtual work and generalized forces. Lagrange's equations for holonomic systems; case of conservative forces; generalized momentum and impulse; impulsive forces and corresponding Lagrangian formulation.
Kinetic energy as a quadratic function of velocities; equilibrium of conservative holonomic systems; theory of small oscillations in such systems.

Unit-III

Lagrange's equations for potential (conservative) forces; variational principles in mechanics including Hamilton's principle and the principle of least action.
Hamiltonian formulation and canonical equations of motion; basic integral invariants in mechanics. Canonical transformations and their properties; Hamilton–Jacobi equation and its applications.

Unit-IV

Functionals and their variations; Euler–Lagrange equations and their derivation. Variational problems involving one independent and one dependent variable with: (i) first derivative, (ii) higher derivatives (fixed end conditions). Variational problems for functionals involving multiple functions of a single variable, and functionals involving a function and its higher-order derivatives. Functionals depending on functions of several independent variables; variational problems in parametric form.

Natural and transition boundary conditions; invariance of Euler's equation; conditional extremum. Variational problems with moving boundaries.

Classical problems in calculus of variations: shortest path, minimal surface of revolution, Brachistochrone, isoperimetric and geodesic problems.

Reference Books:

1. F. Chorlton, Text Book of Dynamics (2nd Edition), CBS, 2002.
2. F. Gantmacher, Lectures in Analytical Mechanics, Mir Publishers, 1975.
3. F. B. Hilderbrand, Methods of Applied Mathematics, Dover Publications, 1992.
4. A.S. Gupta, Calculus of Variations with Applications, PHI Learning Pvt. Ltd., 1996.
5. H. Goldstein, C.P. Poole and J.L. Safko, Classical Mechanics (3rd Edition), Pearson, 2011.
6. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Dover Publications, 2012.
7. S.K. Sinha, Classical Mechanics, Alpha Science International Limited, 2009.
8. L.N. Hand and J.D. Finch, Analytical Mechanics, Cambridge University Press, 2008.

CLO-PO matrix for the course 241/MAT/CC402 (Classical Mechanics & Calculus of Variations)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/CC402.1	3	3	3	3	3	3	3	3	3	-	3
241/MAT/CC402.2	3	3	3	3	2	3	2	3	3	-	3
241/MAT/CC402.3	3	3	3	3	3	3	2	3	3	-	3
241/MAT/CC402.4	3	3	2	3	3	3	3	3	3	-	3
Average	3	3	2.75	3	2.75	3	2.5	3	3	-	3

CLO-PSO matrix for the course 241/MAT/CC402 (Classical Mechanics & Calculus of Variations)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/CC402.1	3	3	3	3
241/MAT/CC402.2	3	3	3	3
241/MAT/CC402.3	3	2	3	3
241/MAT/CC402.4	3	3	3	3
Average	3	2.75	3	3

M.Sc. MATHEMATICS 4th SEMESTER

Operations Research

DSE-04

Credits: 3(2L+1T)

Max. Time: 2 hrs.

Course ID: 241/MAT/DS401A

Maximum Marks: 75

External Examination: 50

Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Learn about the origin, definition and scope of operations research, formulation and solution of linear programming problems by different methods.

CLO2 Understand the transportation and assignment problems and their solutions by different methods.

CLO3 Knowledge of different queuing models and their solutions by single and multiple servers.

CLO4 Learn about the different inventory control models.

Unit-I

Operations Research: Origin, definition and its scope, Solution of Linear Programming problems by using Simplex methods, Big-M and Two-phase methods. Degeneracy in linear programming. Duality in linear programming.

Unit-II

Transportation Problems: Basic Feasible Solutions, Optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems, trans-shipment problem.

Unit-III

Assignment problems: Solution by Hungarian method, unbalanced problem, case of maximization, travelling salesman and crew assignment problems.

Unit-IV

Introduction to queuing models: Basic components of a queuing system. General birth-death equations in queuing theory.

Steady-state solutions of Markovian queuing models with single and multiple servers: (M/M/1, M/M/C, M/M/1/k, M/M/C/k).

Reference Books:

1. F. Hillier and G.J. Lieberman, Introduction to Operation Research, Holden Day, 1990.
2. H.A. Taha, Operation Research – An Introduction, Prentice Hall of India, 2017.
3. J.K. Sharma, Mathematical Model in Operations Research, Tata McGraw Hill, 1989.
4. K. Swaroop, P.K. Gupta and 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.

CLO-PO matrix for the course 241/MAT/DS401A (Operations Research)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS401A.1	3	3	2	3	3	3	3	3	2	-	3
241/MAT/DS401A.2	3	3	2	3	3	3	3	2	2	-	3
241/MAT/DS401A.3	3	3	3	3	3	3	3	3	3	-	3
241/MAT/DS401A.4	3	3	3	3	3	3	2	3	3	-	3
Average	3	3	2.5	3	3	3	2.75	2.75	2.5	-	3

CLO-PSO matrix for the course 241/MAT/DS401A (Operations Research)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS401A.1	3	3	3	3
241/MAT/DS401A.2	3	3	3	3
241/MAT/DS401A.3	3	3	3	3
241/MAT/DS401A.4	3	3	3	3
Average	3	3	3	3

M.Sc. MATHEMATICS 4th SEMESTER

Fuzzy Set Theory

DSE-04

Credits: 3(2L+1T)

Max. Time: 2 hrs.

Course ID: 241/MAT/DS401B

Maximum Marks: 75

External Examination: 50

Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Using characteristic and membership functions, draw comparisons between crisp and fuzzy set operations.

CLO2 Acquire knowledge about fuzzy sets through language, then use membership functions to express these sets.

CLO3 Describe the mapping of fuzzy sets by a function; concepts related to fuzzy sets: support, normalcy, convexity, and α-level sets.

CLO4 Understand Fuzzy integers, morphisms, fuzzy graphs and relations; extension principle: α-level sets; arithmetic operations on fuzzy numbers.

Unit-I

Fuzzy Sets: Sets, Operation of Sets, Characteristics of Crisp Set, Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set. .

Unit-II

The Operation of Fuzzy Set: Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations In Fuzzy Set, T-norms and T-conorms.

Unit-III

Fuzzy Relation and Composition: Crisp Relation, Properties of Relation on a Single Set, Fuzzy Relation, Extension of Fuzzy Set

Unit-IV

Fuzzy Graph and Relation: Fuzzy Graph, Characteristics of Fuzzy Relation, Classification of Fuzzy Relation, Other Fuzzy Relations.

Reference Books:

1. K.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. J. Yen and R. Langari, *Fuzzy Logic – Intelligence, Control and Information*, Pearson Education, 1999.
4. L. A. Zadeh and G. J. Klir, *Fuzzy Sets, Fuzzy Logic, Theory and Applications* (1st Edition), Prentice Hall, New Jersey, 1995.
5. George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications* (1st Edition), Prentice Hall, New Jersey, 1995.
6. P. K. Maji and R. Biswas, *Fuzzy Sets, Logic and Rough Sets* (1st Edition), Narosa

Publishing House, New Delhi, 2006.

CLO-PO matrix for the course 241/MAT/DS401B (Fuzzy Set Theory)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/DS401B.1	3	3	3	3	2	3	3	3	3	-	3
241/MAT/DS401B.2	3	3	3	3	2	3	3	3	2	-	3
241/MAT/DS401B.3	3	3	2	3	2	3	2	3	2	-	2
241/MAT/DS401B.4	3	3	3	3	2	3	3	3	3	-	3
Average	3	3	2.75	3	2	3	2.75	3	2.5	-	2.75

CLO-PSO matrix for the course 241/MAT/DS401B (Fuzzy Set Theory)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/DS401B.1	3	3	2	3
241/MAT/DS401B.2	3	2	3	3
241/MAT/DS401B.3	3	2	3	3
241/MAT/DS401B.4	3	3	3	3
Average	3	2.5	2.75	3

M.Sc. MATHEMATICS 4th SEMESTER
Seminar

Credits: 6
Course ID: 241/MAT/SM401

Practical External: 100
Practical Internal: 50

Course Learning Outcomes:

CLO1 Identify and choose a topic of personal academic interest while being mindful of ethical responsibilities in scholarly work, demonstrating honesty, fairness, and an inclination toward research-based inquiry.

CLO2 Develop comprehensive knowledge and clear conceptual insight into a selected topic from core or applied areas of Mathematics, enabling systematic analysis and investigation of related problems.

CLO3 Gains the ability to study and interpret mathematical materials from textbooks, research articles, and online academic sources, and present the acquired knowledge effectively through written documentation and oral presentations.

CLO4 Exhibit clarity of understanding, precision in work, and the capability to carry out tasks independently, while nurturing a commitment to continuous and lifelong learning.

Tools

Note: *Each student is required to identify a topic from the emerging areas of Mathematics based on their interest and seek prior permission from the respective group in-charge. After obtaining approval, the student should study the selected topic in detail by referring to suitable academic sources such as textbooks, research journals, and electronic resources available in the library or online. On the basis of this study, the student must prepare a comprehensive seminar report and present the topic before the group. The performance in the seminar will be assessed by the concerned group in-charge according to the specified evaluation criteria.*

i. Depth of understanding and level of proficiency in the subject being presented.

ii. Suitability and academic rigor of the chosen topic, reflecting research interest and awareness of recent developments in the field.

iii. Clarity, structure, and overall quality of the material included in the seminar presentation.

iv. Effectiveness and clarity in conveying ideas during the presentation.

v. Capability to address questions accurately and with confidence during the discussion.

CLO-PO matrix for the course 241/MAT/SM401 (Seminar)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/SM401.1	3	3	2	2	3	3	2	3	3	1	3
241/MAT/SM401.2	3	3	2	3	2	3	2	3	3	1	3
241/MAT/SM401.3	3	2	3	3	3	2	2	2	3	1	3
241/MAT/SM401.4	3	2	3	3	3	3	2	2	3	1	3
Average	3	2.5	2.5	2.75	2.75	2.75	2	2.5	3	1	3

CLO-PSO matrix for the course 241/MAT/SM401 (Seminar)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/SM401.1	3	3	2	3
241/MAT/SM401.2	3	3	3	3
241/MAT/SM401.3	3	3	3	3
241/MAT/SM401.4	3	3	2	3
Average	3	3	2.5	3

M.Sc. MATHEMATICS 1st SEMESTER
Aptitude Reasoning-I

MDC-01
Credits: 3(2L+1T)
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 75
External Examination: 50
Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Develop proficiency in number systems, LCM/HCF, decimal fractions, simplification, roots, and discounts.

CLO2 Acquire skills in applied math: profit/loss, interest, speed/distance, area, height.

CLO3 Analyze data through tables, column graphs, bar graphs, and line charts.

CLO4 Deduce reasoning skills: analogies, blood relations, directions, series, and clocks.

Unit-I

Quantitative Ability (Basic Mathematics): Number Systems, LCM and HCF, Decimal Fractions, Simplification, Square Roots and Cube Roots, Discount.

Unit-II

Quantitative Ability (Applied & Engineering Mathematics): Profit and Loss, Simple and Compound Interest, Time, Speed and Distance, Area, Height and Distance.

Unit-III

Data Interpretation: Data Introduction, Tables, Column Graphs, Bar Graphs, Line Charts.

Unit-IV

Logical Reasoning (Deductive Reasoning): Analogy, Blood Relation, Directional Sense, Number and Letter Series, Clocks.

Reference Books:

1. A Modern Approach to Verbal & Non Verbal Reasoning by R S Agarwal.
2. Analytical and Logical reasoning by Sijwali B S.
3. Quantitative aptitude for Competitive examination by R S Agarwal.
4. Analytical and Logical reasoning for CAT and other management entrance test by Sijwali B S.
5. Quantitative Aptitude by Competitive Examinations by Abhijit Guha 4th edition.

CLO-PO matrix for the course 241/MAT/MD101 (Aptitude Reasoning-I)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/MD101.1	3	3	2	3	2	3	2	2	2	-	2
241/MAT/MD101.2	3	3	3	3	2	3	2	2	2	-	2
241/MAT/MD101.3	3	3	2	3	2	3	2	3	2	-	2
241/MAT/MD101.4	3	3	3	3	2	3	3	3	3	-	2
Average	3	3	2.5	3	2	3	2.25	2.5	2.25	-	2

CLO-PSO matrix for the course 241/MAT/MD101 (Aptitude Reasoning-I)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/MD101.1	3	3	2	2
241/MAT/MD101.2	3	3	2	2
241/MAT/MD101.3	3	3	3	2
241/MAT/MD101.4	3	3	2	3
Average	3	3	2.25	2.25

M.Sc. MATHEMATICS 2nd SEMESTER
Aptitude Reasoning-II

MDC-02
Credits: 3(2L+1T)
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 75
External Examination: 50
Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Acquire quantitative skills in averages, ages, surds, indices, percentages, and number-based problems.

CLO2 Develop skills in logarithms, permutations, combinations, probability, time/work, ratios, mixtures, volumes, and boat/stream problems.

CLO3 Analyze data using interpretation, pie charts, and Venn diagrams.

CLO4 Deduce reasoning through coding-decoding, calendars, Venn diagrams, seating arrangements, syllogism, and mathematical operations.

Unit-I

Quantitative Ability I: Average, Problems on Ages, Surds & Indices, Percentages, Problems on Numbers.

Unit-II

Quantitative Ability II: Logarithm, Permutation and Combinations, Probability, Time & Work, Ratio and Proportion, Mixtures and Allegation, Volume, Problem on boat and stream.

Unit-III

Data Interpretation: Data Interpretation, Pie Chart, Venn Diagrams.

Unit-IV

Logical Reasoning (Deductive Reasoning): Coding – Decoding, Calendars, Venn Diagrams, Seating Arrangement, Syllogism, Mathematical Operations.

Reference Books:

1. A Modern Approach to Verbal & Non Verbal Reasoning by R S Agarwal.
2. Analytical and Logical reasoning by Sijwali B S.
3. Quantitative aptitude for Competitive examination by R S Agarwal.
4. Analytical and Logical reasoning for CAT and other management entrance test by Sijwali B S.
5. Quantitative Aptitude by Competitive Examinations by Abhijit Guha 4th edition.

CLO-PO matrix for the course 241/MAT/MD201 (Aptitude Reasoning-II)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/MD201.1	3	3	2	3	2	3	2	2	2	-	2
241/MAT/MD201.2	3	3	3	3	2	3	2	2	2	-	2
241/MAT/MD201.3	3	3	2	3	2	3	2	3	2	-	2
241/MAT/MD201.4	3	3	3	3	2	3	3	3	3	-	2
Average	3	3	2.5	3	2	3	2.25	2.5	2.25	-	2

CLO-PSO matrix for the course 241/MAT/MD201 (Aptitude Reasoning-II)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/MD201.1	3	3	2	2
241/MAT/MD201.2	3	3	2	2
241/MAT/MD201.3	3	3	3	2
241/MAT/MD201.4	3	3	2	3
Average	3	3	2.25	2.25

M.Sc. MATHEMATICS 3rd SEMESTER

Fundamentals of Mathematics

MDC-03

Credits: 3(2L+1T)

Max. Time: 2 hrs.

Course ID:

Maximum Marks: 75

External Examination: 50

Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand set theory, logic, and functions to solve problems.
CLO2 Solve linear systems using matrices, determinants, rank, and eigenvalues.
CLO3 Apply differentiation and integration techniques to solve problems.
CLO4 Solve first-order differential equations using standard methods.

Unit-I

Sets, subsets, Venn diagrams, operations on sets, Relations and functions, Mathematical logic: propositions, truth tables.

Unit-II

Matrices: types, operations, determinants, inverse, Systems of linear equations, rank,eigenvalues and eigenvectors.

Unit-III

Limits and derivatives, Basics of differentiation, graphical significance of differentiation and its applications. Methods of Integration: integration by parts, integration by partial fractions and their applications

Unit-IV

Linear differential equations and its applications. First order differential equations, separable variables, homogeneous equations, exact differential equations, solution of exact differential equations.

Reference Books:

1. K.H. Rosen, Discrete Mathematics and Its Applications (7th Edition), McGraw-Hill, 2012.
2. S. Lipschutz, Linear Algebra, Schaum's Outline Series, McGraw-Hill, 3rd Edition, 2005.
3. S.L. Ross, Differential Equations (3rd Edition), John Wiley & Sons, 2004.
4. S. Narayan and P.K. Mittal, Integral Calculus (21st Revised Edition), S. Chand & Company Ltd., New Delhi, 2017.

CLO-PO matrix for the course 241/MAT/MD301 (Fundamentals of Mathematics)

CLOs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11
241/MAT/MD301.1	3	3	2	3	2	2	2	2	2	-	2

241/MAT/MD301.2	3	3	3	3	3	2	2	2	2	-	2
241/MAT/MD301.3	3	3	3	3	2	2	2	2	2	-	2
241/MAT/MD301.4	3	3	3	3	2	3	2	2	3	-	2
Average	3	3	2.75	3	2.25	2.25	2	2	2.25	-	2

CLO-PSO matrix for the course 241/MAT/MD301 (Fundamentals of Mathematics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/MD301.1	3	3	2	2
241/MAT/MD301.2	3	3	3	2
241/MAT/MD301.3	3	3	3	2
241/MAT/MD301.4	3	3	3	3
Average	3	3	2.75	2.25

M.Sc. MATHEMATICS 4th SEMESTER

Fundamentals of Statistics

MDC-04

Credits: 3(2L+1T)

Max. Time: 2 hrs.

Course ID:

Maximum Marks: 75

External Examination: 50

Internal Assessment: 25

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of five short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Summarize and interpret data using measures of central tendency, dispersion, and graphical tools.

CLO2 Understand apply probability concepts and distributions to model and analyze random phenomena.

CLO3 To learn about discrete probability distributions, continuous probability distributions.

CLO4 To learn about large sample theory and statistical inference.

Unit -I

Measures of central tendency: Mean, median, mode, Measures of dispersion: Range, variance, standard deviation, and interquartile range, Moments, skewness and kurtosis, Graphical representation of data: Histogram, bar chart, pie chart, and boxplot, Exploratory data analysis.

Unit –II

Basic concepts of probability, Conditional probability and independence, Bayes' theorem and its applications, Random variables: Discrete Random variables, Continuous Random variables and probability distributions. Karl Pearson's coefficients of Correlation, Linear regression.

Unit -III

Discrete probability distributions: Binomial, Poisson, and geometric distributions, Continuous probability distributions: Normal, exponential, and uniform distributions, Moment-generating functions, Central Limit Theorem and its significance, Applications in real-world scenarios.

Unit –IV

Concept of Population and Sample, Sampling Techniques, Concept of estimation, Properties of good estimators, Hypothesis testing: Null and alternative hypotheses, Types of errors, Significance level and power of a test, Z-test, t-test, Chi-square Test.

Reference Books:

1. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Amerind Publishing Co. Pvt. Ltd., New Delhi, 1972.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2014.

3. W.J. Freund, Mathematical Statistics (5th Edition), Prentice-Hall, Inc., Englewood Cliffs, N.J., 1994
4. S.M. Ross, Introductory Statistics, Elsevier, 2010.
5. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2019.
6. W. Feller, An Introduction to Probability Theory and its Applications, Vol. I and Wiley, New York, 1968–1971.

CLO-PO matrix for the course 241/MAT/MD401 (Fundamentals of Statistics)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/MD401.1	3	3	2	3	3	2	2	3	2	-	2
241/MAT/MD401.2	3	3	3	3	3	2	2	3	2	-	2
241/MAT/MD401.3	3	3	3	3	3	2	2	3	2	-	2
241/MAT/MD401.4	3	3	3	3	3	3	2	3	3	-	2
Average	3	3	2.75	3	3	2.25	2	3	2.25	-	2

CLO-PSO matrix for the course 241/MAT/MD401 (Fundamentals of Statistics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/MD401.1	3	3	2	2
241/MAT/MD401.2	3	3	3	2
241/MAT/MD401.3	3	3	3	2
241/MAT/MD401.4	3	3	3	3
Average	3	3	2.75	2.25

M.Sc. MATHEMATICS 2nd SEMESTER

Computational Techniques Using MATLAB

SEC-01
Credits: 2(1L+1P)

Maximum Marks: 50
Theory External: 20
Theory Internal: 05
Practical External: 20
Practical Internal: 05

Max. Time: 2 hrs.
Course ID:

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of four short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Know the basic concepts of MATLAB software.
CLO2 Understand various elementary Matrix operations and loops.
CLO3 Study symbolic toolbox and programs for solving systems of linear equations,
CLO4 Learn various types of graphs using MATLAB.

Unit-I

Introduction to MATLAB Programming: Basics of MATLAB programming, Variables and assignments, Operators, Working with complex numbers, Mathematical operations, Functions for input and output.

Unit-II

Introduction to Matrices in MATLAB: Defining Matrices, Matrix functions, Matrix operations, Vector functions. Loops: for loops, while loops.

Unit-III

Linear Algebra: Solving a linear system, finding eigenvalues and eigenvectors, Numerical Integration, Introduction of symbolic toolbox, finding roots of polynomial equations.

Unit-IV

Graphs and plots: Basic 2-D plots, Overlay plots, specialized 2-D plots, 3-D plots, Interpolated surface plots, using subplots for multiple graphs, saving and printing graphs.

Practicals:

1. Basic mathematical computation.
2. Program to generate Matrix with addition, subtraction and multiplication of matrices.
3. Solving System of Linear equations with two variables.
4. Program to use inbuilt functions and create new functions.
5. Plotting the graph of function of two variables
6. Program to Differentiate and Integrate.

7. Program to find the root of higher degree equations.
8. To plot Graphs of Various Functions like sin x, cos x, etc.
9. To find Eigenvalues and Eigenvectors of a given matrix.
10. Solving polynomial equations with the method studied.

Reference Books:

1. Amos Gilat, MATLAB: An Introduction with Applications, 5th Edition, Wiley.
2. C. F. Van Loan and K-Y, D. Fan, Insight Through Computing: A MATLAB Introduction to Computational Science and Engineering, SIAM Publication, 2009.
3. Y. Kirani Singh and B. B. Chaudhari, MATLAB Programming, PHI Learning Private Ltd., New Delhi 2010.
4. Krister Ahlersten, An Introduction to MATLAB, Bookboon.com.
5. Rudra Pratap, Getting Started with MATLAB, Oxford University Press.

CLO-PO matrix for the course 241/MAT/SE201 (Computational Techniques using MATLAB)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/SE201.1	3	2	2	2	3	2	2	2	2	-	2
241/MAT/SE201.2	3	3	3	2	3	2	2	2	2	-	2
241/MAT/SE201.3	3	3	3	3	3	2	2	2	2	-	2
241/MAT/SE201.4	2	3	3	3	3	2	2	2	2	-	2
Average	2.75	2.75	2.75	2.5	3	2	2	2	2	-	2

CLO-PSO matrix for the course 241/MAT/SE201 (Computational Techniques using MATLAB)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/SE201.1	3	2	2	2
241/MAT/SE201.2	3	3	3	2
241/MAT/SE201.3	3	3	3	2
241/MAT/SE201.4	2	3	3	3
Average	2.75	2.75	2.75	2.25

M.Sc. MATHEMATICS 3rd SEMESTER
LaTeX

SEC-02
Credits: 2(1L+1P)
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 50
Theory External: 20
Theory Internal: 05
Practical External: 20
Practical Internal: 05

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of four short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Understand the fundamentals of LaTeX and create structured documents with appropriate formatting and organization.

CLO2 Apply packages and features to enhance document layout, footnotes, tables, and navigation tools like table of contents.

CLO3 Typeset complex mathematical expressions, insert figures and plots, and visualize data using LaTeX tools.

CLO4 Compile bibliographies, cite references, use multi-file projects, and prepare professional presentations and reports in LaTeX.

Unit-I

Introduction to LaTeX: Purpose of LaTeX, advantages over word processors, introduction to typesetting systems, setting up LaTeX environments (TeX Live, MiKTeX, Overleaf), writing the first `.tex` document, document structure (preamble, body, compiling), formatting text, font styles and sizes, sections, subsections, and paragraphs.

Unit-II

Structuring and Enhancing Documents: Using LaTeX packages, creating lists (itemized, enumerated, description), inserting footnotes and margin notes, working with headers and footers, setting page margins, generating a table of contents, list of figures and tables, cross-referencing using labels, and designing professional tables.

Unit-III

Mathematics and Graphics in LaTeX: Mathematical typesetting: inline and display math modes, commonly used symbols, equation arrays, `amsmath` package, inserting and positioning images using `graphics`, captions, figure references, plotting graphs using `pgfplots` and `tikz`, creating diagrams and flowcharts.

Unit-IV

Citations, Bibliographies, and Advanced Applications: Creating bibliographies with `bibtex` and `biblatex`, in-text citations, bibliography styles (APA, IEEE, etc.), custom commands and environments, using `beamer` for presentations, writing research articles and theses, exporting to PDF.

Reference books:

1. S. Kottwitz, LaTeX Beginner's Guide, Packt Publishing Ltd., 2011.
2. H. Kopka and P.W. Daly, Guide to LaTeX, Pearson Education, 2003.

3. F. Mittelbach et al., The LaTeX Companion, Addison-Wesley Professional, 2004.
4. D.F. Griffiths and D.J. Higham, Learning LaTeX, Society for Industrial and Applied Mathematics, 2016.

CLO-PO matrix for the course 241/MAT/SE301A (LaTeX)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/SE301A .1	2	2	2	2	3	2	2	2	2	-	2
241/MAT/SE301A .2	2	3	3	2	3	2	2	2	2	-	2
241/MAT/SE301A .3	3	3	3	3	3	2	2	2	2	-	2
241/MAT/SE301A .4	2	3	3	3	3	2	2	3	2	-	3
Average	2.25	2.75	2.75	2.50	3	2	2	2.25	2	-	2.25

CLO-PSO matrix for the course 241/MAT/SE301A (LaTeX)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/SE301A .1	2	2	2	2
241/MAT/SE301A .2	2	3	3	2
241/MAT/SE301A .3	3	3	3	2
241/MAT/SE301A .4	2	3	3	3
Average	2.25	2.75	2.75	2.25

M.Sc. MATHEMATICS 3rd SEMESTER
Python for Statistical Analysis

SEC-02
Credits: 2(1L+1P)
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 50
Theory External: 20
Theory Internal: 05
Practical External: 20
Practical Internal: 05

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of four short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Develop fundamental programming skills in Python, including syntax, control structures, and basic input-output operations.
CLO2 Demonstrate proficiency in analyzing and processing data using Python libraries like NumPy and Pandas.
CLO3 Apply data visualization techniques to represent data insights using Matplotlib and Seaborn.
CLO4 Implement basic statistical analysis using Python, including descriptive statistics, hypothesis testing, and data visualization for statistical insights.

Unit-I

Introduction to Python and Basic Concepts: Installation, IDEs (Jupyter Notebook, VS Code), Basic Syntax: Variables, Data Types, Operators, Control Structures: Conditional Statements (if, else), Loops: for and while loops, Basic Input and Output, Functions: Definition, Calling, Parameters, Return Values, Simple Exercises: Basic calculations, conditional logic.

Unit-II

Data Structures and Manipulation: Lists, Tuples, Sets, and Dictionaries, Accessing, Modifying, and Iterating through data structures, Comprehensions: List and Dictionary Comprehensions, File Handling: Reading from and Writing to Files, Introduction to Libraries: Importing and Using Packages (like NumPy), Basic Data Manipulation with Lists and Dictionaries, Simple Exercises: Reading data from files, basic data processing.

Unit-III

Data Handling and Visualization: Working with Numpy for Numerical Operations, Introduction to Pandas for Data Frames and Data Handling, Data Cleaning and Preprocessing: Handling Missing Values, Basic Data Visualization with Matplotlib and Seaborn, Creating Line, Bar, and Scatter Plots, Simple Exercises: Creating plots from data, basic data analysis.

Unit-IV

Basic Statistical Analysis with Python: Introduction to Statistical Concepts: Mean, Median, Mode, Variance, Standard Deviation, using Python Libraries for Statistical Analysis: Scipy and Statsmodels, Descriptive Statistics with Pandas, Data Visualization for Statistical Insights:

Boxplots, Histograms, Simple Hypothesis Testing: t-test, Chi-Square Test, Practical Examples: Analyzing simple datasets for insights.

Reference Books:

1. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, Inc., 2012.
2. P. Bruce and A. Bruce, Practical Statistics for Data Scientists, O'Reilly Media, Inc., 2020.
3. A.B. Downey, Think Stats: Exploratory Data Analysis in Python, O'Reilly Media, Inc., 2014.
4. J. VanderPlas, Python Data Science Handbook, O'Reilly Media, Inc., 2016.
5. A.C. Müller and S. Guido, Introduction to Machine Learning with Python, O'Reilly Media, Inc., 2016.
6. M. Lutz, Programming Python, O'Reilly Media, Inc., 2001. (Supplementary reference for core Python concepts).

CLO-PO matrix for the course 241/MAT/SE301B (Python for Statistical Analysis)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/SE301B .1	2	2	2	2	3	2	2	2	2	-	2
241/MAT/SE301B .2	2	3	3	2	3	2	2	2	2	-	2
241/MAT/SE301B.3	3	3	3	3	3	2	2	2	2	-	2
241/MAT/SE301B.4	3	3	3	3	3	2	2	3	2	-	3
Average	2.50	2.75	2.75	2.50	3	2	2	2.25	2	-	2.25

CLO-PSO matrix for the course 241/MAT/SE301B (Python for Statistical Analysis)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/SE301B.1	2	2	2	2
241/MAT/SE301B.2	2	3	3	2
241/MAT/SE301B.3	3	3	3	2
241/MAT/SE301B.4	3	3	3	3
Average	2.50	2.75	2.75	2.25

M.Sc. MATHEMATICS 1st SEMESTER
Mathematics in Everyday Life

VAC-01
Credits: 2
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 50
External Examination: 35
Internal Assessment: 15

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Learning Outcomes:

CLO1 Perform basic arithmetic operations and apply them in daily activities.
CLO2 Understand and use algebraic expressions and equations in problem-solving.
CLO3 Apply geometric concepts in real-world contexts.
CLO4 Interpret and analyze statistical data.

Unit-I

Basic Arithmetic and Number Operations: Introduction to numbers and operations, Fractions, decimals, percentages, Ratios and proportions.
Interest calculations: Simple and Compound interest, Loans and EMIs

Unit-II

Algebra in Daily Life: Basic algebraic expressions and equations, solving linear equations, understanding functions and graphs.

Unit-III

Geometry in the Real World: Basic geometric shapes and properties, Basics of differentiation and integration, T-ratios and practical applications.

Unit-IV

Introduction to Statistics: Basic statistical concepts, mean, median, mode, Data collection and representation (charts, graphs, tables), Probability and basic concepts.

Reference Books:

1. "Mathematics for Everyday Life" by David E. Newton
2. "Basic Mathematics" by Serge Lang
3. Online resources and educational platforms (Khan Academy, Coursera)
4. Practical Mathematics Workbooks and Case Studies

CLO-PO matrix for the course 241/MAT/VA101 (Mathematics in Everyday Life)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/VA101 .1	3	2	2	2	2	2	2	2	2	-	2
241/MAT/VA101 .2	3	3	2	2	2	2	2	2	2	-	2
241/MAT/VA101.3	3	2	2	2	2	2	2	2	2	-	2
241/MAT/VA101 .4	3	3	2	3	2	2	2	2	2	-	2
Average	3	2.5	2	2.75	2	2	2	2	2	-	2

CLO-PSO matrix for the course 241/MAT/VA101 (Mathematics in Everyday Life)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/VA101.1	2	2	2	2
241/MAT/VA101.2	2	2	2	2
241/MAT/VA101.3	2	2	2	2
241/MAT/VA101.4	2	3	2	2
Average	2	2.25	2	2

M.Sc. MATHEMATICS 3rd SEMESTER
Vedic Mathematics

VAC-02
Credits: 2(2L)
Max. Time: 2 hrs.
Course ID:

Maximum Marks: 50
External Examination: 35
Internal Assessment: 15

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.

Course Learning Outcomes:

CLO1 Understand the basic concepts, history, and features of Vedic Mathematics.
CLO2 Apply major Vedic Sutras for efficient arithmetic and algebraic computations.
CLO3 Use Vedic methods to compute squares, cubes, roots, divisibility, and division.
CLO4 Solve equations and perform factorization using Vedic techniques.

Unit I

Introduction & History of Vedic Mathematics, Introduction to Father of Vedic Mathematics "Jagatguru Bharti Krishan Tirthji" Multiplications-using Sutras- Ekanyunena Purvena, Ekadhikena Purvena, Nikhilam Navatahcarmam Dastah, Vertically & Crosswise, Sum of Products, Difference of products, Sum and difference of Products in arithmetic and algebra. Cross digit sum to check the answers of addition, multiplication and subtraction.

Unit II

Square using Sutras- Ekadhikena Purvena, Nikhilam Navatahcarmam Dastah, Duplex in arithmetic and Algebra, Sum of squared numbers, difference of squared numbers, Sum and difference of squared Numbers, Cube using Sutras-Nikhilam and Anurupyena.

Unit III

Square root using Vilokanam and Duplex, Cube root upto 9 digits, divisibility by denominator ending digits 1, 3, 7 & 9, Division by Sutras-Paravartya, Ekadhikena, Nikhilam Navatahcarmam Dastah, Dhwajank having divisor upto 3 digits, Division of Algebraic Expressions having divisor linear and quadratic.

Unit IV

Solution of Simple equations, Solutions of simultaneous linear equations in two variables, factorization in arithmetic, factorization of quadratic and cubic expressions, Highest Common Factors in arithmetic and algebraic expressions.

Reference Books:

1. A. Gupta, The Power of Vedic Maths (2nd Revised & Updated Edition), Jaico Publishing House, 2004.
2. V.E. Stevens, Pebble Maths: A New and Successful Way to Teach Vedic Math to Beginner Learners of All Ages and Abilities, Pebble Maths Publishing House.
3. R.K. Thakur, The Essentials of Vedic Mathematics (1st Edition), Rupa Publications, India, 2013.

CLO-PO matrix for the course 241/MAT/VA301 (Vedic Mathematics)

CLOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
241/MAT/VA301.1	3	2	2	2	2	2	2	2	2	-	2
241/MAT/VA301.2	3	3	2	2	2	2	2	2	2	-	2
241/MAT/VA301.3	3	3	2	2	2	2	2	2	2	-	2
241/MAT/VA301.4	3	3	3	2	2	2	2	2	2	-	2
Average	3	2.75	2.25	2	2	2	2	2	2	-	2

CLO-PSO matrix for the course 241/MAT/VA301 (Vedic Mathematics)

CLOs	PSO1	PSO2	PSO3	PSO4
241/MAT/VA301.1	2	2	2	2
241/MAT/VA301.2	3	2	2	2
241/MAT/VA301.3	3	2	2	2
241/MAT/VA301.4	3	3	2	2
Average	2.75	2.25	2	2