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ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಗಣಿತಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗ

ಅಧ್ಯಕ್ಷರ ಕಾರ್ಯಾಲಯ, ಮೊದಲನೇ ಮಹಡಿ, ಎಂ. ಬಿ. ಎ. ಕಟ್ಟಡ, ಶಿವಗಂಗೋತ್ರಿ, ದಾವಣಗೆರೆ -577 007
ದೂರವಾಣಿ: 80959 07689, ಇ-ಮೇಲ್: dudvgmaths@gmail.com, prakashadg@gmail.com

ಸಂಖ್ಯೆ:ದಾವಿವಿ:ಗಅ.:2024-25/232 ದಿನಾಂಕ:20-09-2024

ಗೆ,
ಕುಲಸಚಿವರು (ಆಡಳಿತ)
ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಶಿವಗಂಗೋತ್ರಿ,
ದಾವಣಗೆರೆ - 577007.

ಮಾನ್ಯರೆ.

ವಿಷಯ: ಗಣಿತಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗದ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನ PG-BOS ಸಭೆಯ ನಡಾವಳಿಯನ್ನು ಕಳುಹಿಸುತ್ತಿರುವ ಕುರಿತು.

ಮೇಲ್ಕಂಡ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಗಣಿತಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗದ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನ PG BOS ಮಂಡಳಿ ಸಭೆಯ ನಡಾವಳಿಯನ್ನು ರಚನೆ ಮಾಡಿ ತಮ್ಮ ಮುಂದಿನ ಸೂಕ್ತ ಕ್ರಮಕ್ಕೆ ಕಳುಹಿಸಲಾಗಿದೆ.

ವಂದನೆಗಳೊಂದಿಗೆ,

ತಮ್ಮ ವಿಶ್ವಾಸಿ

[signature] 20/9

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ಅಡಕ:1. PG Syllabus copy
ph. D. Course work Syllabus copy.

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NO: DU: Math/2024-25 Date: 20/09/2024

Proceedings of the Board of Studies meeting in PG Mathematics

The meeting of Board of Studies in P G (Post Graduate) Mathematics was held in the Department of Mathematics, Davangere University, Davangere on 20th September, 2024 (Friday) at 11.30AM through Google meet with the link: https://meet.googl;e.com/jxn-sxro-tvs

The following members were present:

Chairman and Members in the Board of Studies	
Dr. H. S. Ramane, Senior Professor, Karnatak University, Dharwad.	External Member (PG-BOS)
Dr. U. S. Mahabaleshwar, Professor, Davangere University, Davangere.	Internal Member (PG-BOS)
Dr. B. C. Prasannakumara, Professor, Davangere University, Davangere.	Internal Member (PG-BOS)
Dr. Chetana Gali, Asst. Professor, Davangere University, Davangere.	Internal Member (PG-BOS)
Dr. Mahesh Barki, Asst. Professor, Davangere University, Davangere.	Member (Co-Opt.)
Dr. Raghunatha K. R., Asst. Professor, Davangere University, Davangere.	Member (Co-Opt.)
Dr. Ashwini Yalnaik, Asst. Professor, Davangere University, Davangere.	Member (Co-Opt.)
Dr. Prakasha D. G. Professor, Davangere University, Davanagre	Chairman (PG-BOS)

Member Absent: Dr.V. S. Shegihalli, Senior Professor, Rani Channamma University, Belagavi.

The meeting was started with the welcoming the members by Chairman and then discussed the following:

Item No. 1: To Read and Confirm the minutes of the last meeting.

Resolution No. 1: Read and confirmed the minutes of the last meeting.

20/09
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Item No. 2: Preparation and Approval of Syllabus for the P G Programme in Mathematics for the academic year 2024-25 and onwards.

Resolution No. 2: Board thoroughly gone through the regulations of UGC and Davangere University along with syllabus of various universities. Further, prepared the syllabus on par with UGC/CSIR NET syllabus for PG programme in Mathematics. Finally, it is resolved to approve and recommend the prepared syllabus to Davangere University for implementation from the academic year 2024-25 for M.Sc. Mathematics programme. (See, Appendix - I).

Item No. 3: Preparation and Approval of Syllabus for the Ph. D. Course Work in Mathematics.

Resolution No. 2: Dr. Mahesh Barki, Asst. Professor of Mathematics has been recently recognized as Research Guide in Mathematics to guide Ph. D. students. In this connection, he has submitted a syllabus (Paper – III; Area of Research Specialization) for seeking approval to include in Ph. D. course work syllabus, for those who are working under his guidance. The Board has thoroughly gone through the syllabus and resolved to approve the syllabus of the **Paper: III-Area of Research Specialization: NEVANLINNA THEORY** for the Ph. D. Course work students those who are registered under his guidance. (See, Appendix - II).

Item No. 4: Up-gradation of panel of Examiners for PG Mathematics Examinations of 2024-25 & onwards.

Resolution No. 4: Board has revisited the panel of examiners and prepared the fresh list of panel of examiners for PG Mathematics examination of 2024-25 & onwards. And, resolved to approve and recommend the same to the University (See, Appendix - II).

Item No. 5: Any other matter with the permission of the Chair.
Resolution No. 5: No matter.

Dr. Prakasha D. G.
CHAIRMAN
(PG-BOS in Mathematics)
Davangere University
Davangere-7.

BoS-Chairman,
Department of Mathematics
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DAVANGERE UNIVERSITY

SHIVAGANGOTHRI – 577 007, DAVANGERE, INDIA.

SYLLABUS

FOR

MASTER OF SCIENCE (M. SC.)

SEMESTER SCHEME – CBCS

(W.E.F. 2024-25 & ONWARDS)

MATHEMATICS

SEPTEMBER-2024

Dr. U.S. MAHABALESHWAR
M.Sc., M.Phil., Ph.D
Professor & Dean, Science & Technology
Davangere University, Shivagangotri
Davangere-577007, Karnataka, India

Registrar
Davangere University
Shivagangotri, Davangere

BoS-Chairman,
Department of Mathematics
Davangere University
Shivagangotri, Davangere-577007

PROGRAM OBJECTIVE

The M.Sc. program in Mathematics aims at developing mathematical ability in students with acute and abstract reasoning. The course will enable students to cultivate a mathematician's habit of thought and reasoning and will enlighten students with mathematical ideas relevant for oneself and for the program itself.

PROGRAMME OUTCOMES (POs)

POs describe what students are expected to know or be able to do by the time of graduation. After completion of the programme, the student will be able to

- acquire sound analytical and practical knowledge to formulate and solve challenging problems.
- take jobs in schools and colleges as mathematic teachers and professors, software industries, research and development organizations.
- pursue higher studies in mathematical and computing sciences and to clear competitive exams like SET/ NET/ TET etc.
- learn and apply mathematics in real life situations aiming at service to the society.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

The students at the time of graduation are enabled to

- provide strong foundation and inculcate ample knowledge on topics in pure and applied mathematics, empowering the students to pursue higher degrees at reputed academic institutions.
- provide scope for interaction with international researchers and developing collaborations.
- provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

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Master of Science (M. Sc.) Semester Scheme - CBCS
Subject: MATHEMATICS
Course Structure, Scheme of Teaching and Evaluation (2024-25 & onwards)

	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
SEMESTER - I		**THEORY PAPERS**						
	MT1.1	Algebra - I	4	70	30	100	4	3
	MT1.2	Real Analysis - I	4	70	30	100	4	3
	MT1.3	Linear Algebra - I	4	70	30	100	4	3
	MT 1.4	Mathematical Methods	4	70	30	100	4	3
	MT1.5	Ordinary Differential Equations	4	70	30	100	4	3
		PRACTICAL PAPERS						
	MP 1.6	Programming Lab - I	4	40	10	50	2	3
	MP 1.7	Programming Lab - II	4	40	10	50	2	3
	Mandatory Credits: English Language Communication Skill		2	---	---	---	2	---
SEMESTER - II		**THEORY PAPERS**						
	MT 2.1	Algebra - II	4	70	30	100	4	3
	MT 2.2	Real Analysis - II	4	70	30	100	4	3
	MT 2.3	Linear Algebra - II	4	70	30	100	4	3
	MT 2.4	Complex Analysis-I	4	70	30	100	4	3
	MT 2.5	Partial Differential Equations	4	70	30	100	4	3
		PRACTICAL PAPERS						
	MP 2.6	Programming Lab - III	4	40	10	50	2	3
	MP 2.7	Programming Lab - IV	4	40	10	50	2	3
	Mandatory Credits: Computer Skill		2	---	---	---	---	
SEMESTER - III		**THEORY PAPERS**						
	MT 3.1	Topology	4	70	30	100	4	3
	MT 3.2	Complex Analysis - II	4	70	30	100	4	3
	MT 3.3	Numerical Methods - I	4	70	30	100	4	3
	MT 3.4	Classical and Continuum Mechanics	4	70	30	100	4	3
	MT 3.5	(a) Graph Theory (b) Fractional Calculus	4	70	30	100	4	3
	MT 3.6	Foundations of Mathematics (Interdisciplinary-Elective Paper)	2	40	10	50	2	2
		PRACTICAL PAPERS						
	MP 3.7	Programming Lab- V	4	40	10	50	2	3
SEMESTER - IV		**THEORY PAPERS**						
	MT 4.1	Functional Analysis	4	70	30	100	4	3
	MT 4.2	Measure Theory and Integration	4	70	30	100	4	3
	MT 4.3	Numerical Methods - II	4	70	30	100	4	3
	MT 4.4	Differential Geometry	4	70	30	100	4	3
	MT 4.5	(a) Value Distribution Theory (b) Magnetohydrodynamics	4	70	30	100	4	3
		Project Work/ Report Writing						
	MT 4.6	Project	6	70	30	100	6	3
	Mandatory Credits: Personality Development		2	---	---	---	2	---
	Total Credits for the Course		114	---	---	2400	104	---

Dr. U.S. MAHABALESHWAR
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Professor & Dean, Science & Technology
Davangere University, Shivagangotri,
Davangere-577 007, Karnataka, India.

Registrar
Davangere University
Shivagangotri, Davangere

BoS-Chairman,
Department of Mathematics
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SEMESTER - I

MT1.1: Algebra - I

Unit I: Permutations, Combinations, Pigeon-hole Principle, Inclusion-Exclusion Principle, Derangements.

Unit II: Fundamental Theorem of arithmetic, divisibility in Z, Congruences, Chinese remainder theorem, Euler's ϕ- function, primitive roots.

Unit III: Groups, subgroups, normal subgroups, cyclic groups, permutation groups, symmetric groups, quotient groups, homomorphisms, types of homomorphisms, isomorphism theorems and its related problems, automorphisms, inner automorphisms, groups of automorphisms and inner automorphisms and their relation with centre of a group, Cayley's theorem, class equations.

Unit IV: Sylow's groups and subgroups, Sylow's theorems for a finite group, applications and examples of p-Sylow subgroups.

Textbooks:

1. D. M. Burton: Elementary Number Theory, Tata McGraw-Hill, New Delhi, 6th Ed.,
2. I.N. Herstein: Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976.
3. J.B. Fraleigh: A first course in Algebra, 3rd Edition, Narosa, 1996.
4. I. Niven, H. S. Zuckerman and H. L. Montgomery: An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.

Reference books:

1. M. Artin: Algebra, Prentice Hall of India, 1991.
2. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons, 1999.
3. J. A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4th Ed.
4. N. Jacobson: Basic Algebra-I, HPC, 1984.

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MT1.2: Real Analysis - I

Unit I: Elementary set theory, finite, countable and uncountable sets, real number system as complete ordered field, Archimedean property, supremum, infimum, metric spaces, interior points and limit points of subset, open sets and closed sets and their properties, compactness, connectedness, perfect sets, topology of R^n, k-cell and its compactness, Heine-Borel theorem, Bolzano Weirstrass theorem.

Unit II: Convergent sequences, subsequence, Cauchy sequences, limsup, liminf, tests for convergence of sequences, series, series of non-negative series, summation by parts, tests for convergence of series, absolute convergence, addition and multiplication of series, rearrangement.

Unit III: Limits of function, continuous function, uniform continuity, continuity and compactness, continuity and connectedness, discontinuity, monotonic functions, infinite limits and limits at infinity.

Unit IV: The derivative of real function, mean value theorems, the continuity of derivatives, derivatives of higher order, Taylor's theorem.

Textbooks:

1. W. Rudin: Principles of Mathematical Analysis, McGraw-Hill, 1983.
2. S. C. Malik and Savita Arora: Mathematical Analysis, 2nd ed., New Age Intn. (P) Ltd., 1992
3. N. P. Bali: Real analysis, New Age International Private Limited, second edition

Reference books:

1. T. M Apostol: Mathematical Analysis, 2nd ed. Narosa, 1988
2. S. Goldberg: Methods of Real Analysis, OUP, 1970

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MT1.3: Linear Algebra – I

Unit I: Definition and examples of vector spaces, subspaces, sum and direct sum of subspaces, linear span, linear dependence, independence and their basic properties, basis, finite dimensional vector spaces, existence theorem for bases, invariance of number of elements of a basis set, existence of complementary subspace of a subspace of a finite dimensional vector space, dimension of sums of subspaces, quotient space and its dimension.

Unit II: Linear transformations and their representation as matrices, the algebra of linear transformations, the rank nullity theorem, change of basis, solutions of homogeneous and non-homogeneous systems of linear equations, dual space, bidual space and natural isomorphism, adjoint of a linear transformation.

Unit III: Eigen values characteristic roots, Eigen vectors and Eigen spaces, Cayley Hamilton theorem and minimum polynomial, annihilating polynomials, annihilator of a subspace, invariant subspaces, simultaneous triangulation, simultaneous diagonalization.

Unit IV: Direct sum decompositions, invariant direct sums, the primary decomposition theorem, cyclic subspaces and annihilators, cyclic decompositions.

Textbooks:

1. S. Friedberg, A. Insel, and L. Spence: Linear Algebra, Fourth Edition, PHI, 2009.
2. Jimmie Gilbert and Linda Gilbert: Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.
3. I. N. Herstein: Topics in Algebra, Vikas Pub. House, New Delhi.

Reference books:

1. Hoffman and Kunze: Linear Algebra, 2ND Ed. Prentice-Hall of India, 1978.
2. P. R. Halmos: Finite Dimensional Vector Space, D. Van Nostrand, 1958.
3. S. Kumeresan: Linear Algebra- A Geometric approach, Prentice Hall India, 2000.
4. V. K. Khanna and S. K. Bhambri: A Course in Abstract Algebra, 3rd Ed., Vikas Pub., 2008.

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MT1.4: Mathematical Methods

Unit I: Integral equations, definitions and types of integral equations, Volterra integral equations of first kind, second kind and third kind, homogeneous volterra integral equation, special kinds of kernel (symmetric, separable or degenerate), characteristic numbers and eigenfunctions, solution by separable kernel, resolvent kernel, conversion of multiple integral into a single ordinary integral, method of converting IVP into a volterra integral equation.

Unit II: Fredholm integral equations of first kind, second kind and third kind, homogeneous Fredholm integral equation, special kinds of kernel (symmetric, separable or degenerate), characteristic numbers and eigenfunctions, solution by separable kernel, resolvent kernel, method of converting boundary value problem into a Fredholm integral equation. Green's function approach for converting a boundary value problem with homogeneous and non- homogeneous boundary condtions into an integral equation.

Unit III: Variation of a functional, Euler-Lagrange equation and its particular forms with examples, Necessary and sufficient conditions for extrema, standard problems like geodesics, minimal surface of revolutions, hanging chain, Brachistochrone problem, isoperimetric problems, variational methods for boundary value problems in ordinary and partial differential equations.

Unit IV: Linear Programming, Introduction, Formulation of LPP, General mathematical model of LPP. Slack and Surplus variables, canonical and standard form of LPP, Graphical method, standard LPP and basic solution, fundamental theorem of LPP, Simplex Algorithm, Big-M method.

Textbooks:

1. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, Ny, 1971.
2. C.M. Bender and S.A. Orszag: Advanced Mathematical Methods for Scientists and Engineers, McGraw- Hill, New York, 1978.

Reference books:

1. H.T. Davis: Introduction to nonlinear differential and integral equations, Dover Pub.1962.
2. A.H. Nayfeh: Perturbation Methods, John Wiley &Sons New York, 1973.
3. Don Hong, J. Wang and R. Gardner. Real analysis with Introduction to Wavelets and Applications, Academic Press, Elsevier, 2006.
4. R.V. Churchill: Operational Mathematics, Mc. Graw Hill, New York, 1958.
5. I.N. Sneddon – The Use of Integral Transforms, Tata McGraw Hill, New Delhi, 1974.

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MT1.5: Ordinary Differential Equations

Unit I: Linear differential equations of nth order, fundamental sets of solutions, Wronskian, Abel's identity, theorems on linear dependence of solutions, adjoint, self - adjoint linear operator, adjoint equations, the nth order nonhomogeneous linear equations, variation of parameters, method of undetermined coefficients, zeros of solutions, comparison and separation theorems.

Unit II: Fundamental existence and uniqueness theorem, dependence of solutions on initial conditions, existence and uniqueness theorem for higher order and system of differential equations, Eigenvalue problems, Sturm-Liouville problems, orthogonality of Eigenfunctions.

Unit III: Oscillatory and non-oscillatory differential equations and some theorems, power series solution of linear differential equations, ordinary and singular points of differential equations, classification into regular and irregular singular point, series solution of differential equations about an ordinary point (power series method) and a regular singular point (Frobenius method).

Unit IV: Linear system of homogeneous and non-homogeneous equations (matrix method), linear and non-linear autonomous system of equations, phase plane, critical points, stability, Liapunov direct method, limit cycle and periodic solutions, bifurcation of plane autonomous systems.

Text books:

1. G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential equations (3rd edition), John Wiley & Sons, New York, 1984.

Reference books:

1. E.D. Rainville and P.E. Bedient: Elementary Differential Equations, McGraw Hill, NewYork, 1969.
2. E.A. Coddington and N. Levinson: Theory of ordinary differential equations, McGraw Hill, 1955.
3. A.C. King, J. Billingham& S.R. Otto: Differential equations, Cambridge University Press, 2006.

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MP 1.6: Programming Lab - I

Problems from M.M. 1.1 (Theory) and MT 1.3 (Theory) may be solved with the help of FOSS.

MP 1.7: Programming Lab – II

Problems from MT 1.4 (Theory) and MT 1.5 (Theory) may be solved with the help of FOSS.

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SEMESTER - II

MT2.1: Algebra-II

Unit I: Rings, some special classes of rings (integral domain, division ring, field), ideals and quotient rings, homomorphisms of rings, kernel and image of homomorphisms of rings, isomorphism of rings, fundamental theorem of homomorphism of rings.

Unit II: Theorems on principle, maximal and prime ideals, field of quotients of an integral domain, imbedding of rings. Euclidean rings, prime and relatively prime elements of a Euclidean ring, unique factorization theorem, Fermat's theorem, polynomial rings, the division algorithm.

Unit III: Polynomials over the rational field, primitive polynomial, content of a polynomial. Gauss lemma, irreducibility criterion, mod p irreducibility test, Eisenstein criteria, polynomial rings over commutative rings, unique factorization domains.

Unit IV: Extension fields, finite and algebraic extensions, degree of extension, algebraic elements and algebraic extensions, adjunction of an element of a field, roots of a polynomial, splitting fields, more about roots (characteristic of a field), simple and separable extensions, finite field, elements of Galois theory, fixed fields, normal extension.

Textbooks:

1. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley and Sons, 1999
2. J. A. Gallian: Contemporary Abstract Algebra, Narosa Pub., 4th Ed.,
3. I. N.Herstein: Topics in Algebra, 2nd Edition, Vikas Pub., 1976.
4. V. K. Khanna and S. K. Bhambri: A Course in Abstract Algebra, 3rd Ed., Vikas Pub., 2008.

Reference books:

1. M. Artin: Algebra, Prentice Hall of India, 1991.
2. Joseph Rotman: Galois Theory, Universitext, Springer, 1998.
3. J. B. Fraleigh: A first course in Algebra, 3rd Ed., Narosa Pub.

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MT2.2: Real Analysis - II

Unit I: Riemann-Stieltjes integral, its existence and linearity, the integral as a limit of sum, change of variables, mean value theorems on R-S integrals, the fundamental theorem of calculus, functions of bounded variation.

Unit II: Improper integrals, convergence and absolute convergence of improper integrals. Comparison tests for convergence of integrals, Abel's and Dirichlet's theorems on the convergence of the integrals of the product of two integrands, integrals involving parameters.

Unit III: Sequences and series of functions, point wise and uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, equicontinuous families of functions, point wise and uniformly bounded, equicontinuous family of functions, the Stone-Weierstrass theorem.

Unit IV: Linear transformations, invertible linear operators, functions of several variables (real valued and vector valued functions of several variables), directional derivative, partial derivatives, differentiation, chain rule, continuously differentiable functions, the contraction principle, the inverse function theorem, implicit function theorem with examples, Jacobians.

Textbooks:

1. W. Rudin: Principles of Mathematical Analysis, McGraw-Hill, 1983.
2. S. C. Malik and SavitaArora: Mathematatcal Analysis, 2nd ed., New Age Intn. (P) Ltd., 1992
3. N. P. Bali: Real analysis, New Age International Private Limited, second edition.

Reference books:

1. T. M Apostol: Mathematical Analysis, 2nd ed. Narosa, 1988
2. S. Goldberg: Methods of Real Analysis, OUP, 1970.

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MT2.3: Linear Algebra - II

Unit I: Canonical forms, diagonal forms, triangular canonical form, nilpotent transformations, Jordan canonical form, the rational canonical form.

Unit II: Inner product spaces, orthogonality, orthogonal basis and orthonormal basis, orhtogonal complement, Gram-Schmidt orthonormalization process.

Unit III: Positive definite matrices, maxima, minima and saddle points, tests for positive definiteness, singular value decomposition and its applications.

Unit IV: Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, rank and signature, Sylvester's law of inertia.

Textbooks:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. Prentice-Hall of India, 1991.
2. I. N. Herstein, Topics in Algebra, 2nd Ed., John Wiley & Sons, 2006
3. S. Freidberg. AInsel, and L Spence: Linear Algebra, Fourth Edition, PHI, 2009.
4. J. Gilbert and L. Gilbert, Linear Algebra and Matrix theory, Academic Press, 1995.

Reference books:

1. S. Lang, Linear Algebra, Springer-Verlag, New York, 1989.
2. M. Artin, Algebra, Prentice Hall of India, 1994.
3. G. Strang: Linear Algebra and its Applications, Brooks/Cole Ltd., New Delhi, Third Edition, 2003.
4. L. Hogben, Handbook of Linear Algebra-Chapman and Hall-CRC (2006).

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MT2.4: Complex Analysis - I

Unit I: Complex plane its algebra and topology. Holomorphic maps. Analytic functions. Harmonic functions. Hormonic conjugate function; their relation to analytic functions, Cauchy-Riemann equations.

Unit II: Power series. Radius of convergence. uniform convergence of power series, power series representation of analytic functions, integration and differentiation of power series. Uniqueness of series representation. Relation between power series and analytic functions: trigonometric, exponential and logarithmic functions.

Unit III: Complex integration, contour integrals, antiderivatives, Cauchy-Goursat theorem for simply and multiply connected domains, winding numbers, Cauchy integral formula, derivatives of analytic functions, Moreva's theorem, Cauchy's inequality, Liouville's theorem and fundamental theorem of algebra, maximum modulli of functions, Schwartz lemma, open mapping theorem, Hadmard's Three circle theorem and their applications.

Unit IV: Taylor and Laurent's expansion. residues at poles, zeros and poles of order m, conditions under which $f(z)\equiv 0$, behaviour of $f(z)$ at infinity, analytic continuation, Classification of singularities using Laurent's expansion. Behaviour of analytic function in the neighborhood of singularities. Principle of analytic continuation, Residue theorem and contour integrals. Argument principle, Rouche's theorem its applications.

Textbooks:

1. J. W Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 1996.
2. H. S. Kasana, Complex Variables: Theory and Applications, PHI, 2000.
3. J. B Conway, Functions of one Complex Variable, Narosa, 1987.

Reference books:

1. L. V. Ahlfors, Complex analysis, McGraw Hill, 1966.
2. S. Ponnusamy, Functions of Complex Variables, Narosa Pub.
3. S. Lang, complex Analysis, 3rd ed. Springer, 1993.

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MT2.5: Partial Differential Equations

Unit I: First Order Partial Differential Equations: Basic definitions, Origin of PDEs, Classification, Geometrical interpretation. The Cauchy problem, the method of characteristics for Semi linear, quasi linear and Non-linear equations, complete integrals, Examples of equations to analytical dynamics, discontinuous solution and shockwaves.

Unit II: Second Order Partial Differential Equations: Definitions of Linear and Non-Linear equations, Linear Superposition principle, Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms, solution of linear Homogeneous and non-homogeneous with constant coefficients, Variable coefficients, Monge's method.

Unit III: Wave equation: Solution by the method of separation of variables and integral transforms The Cauchy problem, Wave equation in cylindrical and spherical polar coordinates. Laplace equation: Solution by the method of separation of variables and transforms. Dirichlet's, Neumann's and Churchills problems, Dirichlet's problem for a rectangle, half-plane and circle, Solution of Laplace equation in cylindrical and spherical polar coordinates.

Unit IV: Diffusion equation: Fundamental solution by the method of variables and integral transforms, Duhamel's principle, Solution of the equation in cylindrical and spherical polar coordinates. Solution of boundary value problems: Green's function method for Hyperbolic, Parabolic and Elliptic equations.

Textbooks:

1. I. N. Sneddon, Elements of PDE's, McGraw Hill Book company Inc., 2006.
2. L Debnath, Nonlinear PDE's for Scientists and Engineers, Birkhauser, Boston, 2007.
3. F. John, Partial differential equations, Springer, 1971.

Reference books:

1. F. Treves: Basic linear partial differential equations, Academic Press, 1975.
2. M.G. Smith: Introduction to the theory of partial differential equations, Van Nostrand, 1967.
3. Shankar Rao: Partial Differential Equations, PHI, 2006.

MP 2.6: Programming Lab - III

Problems from MT 2.3 (Theory) & MT 2.5 (Theory) may be solved with the help of FOSS.

MP 2.7: Programming Lab - IV

LaTeX & LaTeX Beamer

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SEMESTER - III

MT3.1: Topology

Unit I: Definition and examples of topological spaces, basis and sub basis, order topology, dense sets, subspace topology, continuity and related concepts, product topology, quotient topology, countability axioms, Lindelof spaces and separable spaces.

Unit II: Connected spaces, generation of connected sets, component, path component, local connectedness, local path-connectedness.

Unit III: Compact spaces, limit point compact and sequentially compact spaces, locally compact spaces, one point compactification, finite product of compact spaces, statement of Tychonoff's theorem (proof of finite product only).

Unit IV: Separation axioms, Urysohn's lemma, Tietze's extension theorem, Urysohn's embedding lemma and Urysohn'smetrization theorem for second countable spaces.

Textbooks:

1. Munkres, J. R. (2000) *Topology: a First Course*, Prentice-Hall of India Ltd., New Delhi.

Reference books:

1. J.Dugundji (1990) *General Topology*, Universal Book Stall, New Delhi.
2. Pervin, W. J. (1964) *Foundations of General Topology*, Academic Press, New York.
3. Willard, S. (1970) *General Topology*, Addison-Wesley Publishing Company, Massachusetts.
4. Armstrong, M. A. (2005) *Basic Topology*, Springer International Ed.
5. Kelley, J. L. (1990) *General Topology*, Springer Verlag, New York.
6. Joshi, K. D. (2002) *An Introduction to General Topology* (2nd edition), Wiley Eastern Ltd., New Delhi.

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MT3.2: Complex analysis II

Unit I: Maximum Modulus Principle. Minimum Modulus Principle. Schwarz's Lemma. Some applications of Schwarz's Lemma. Basic properties of univalent functions.

Unit II: Open Mapping Theorem. Deduction of Maximum Modulus Principle using Open Mapping theorem. Hadamard's Three Circle theorem.

Unit III: Conformal Mapping. Linear transformations. Unit disc transformations. Sequences and series of functions. Normal families.

Unit IV: Weierstrass theorem, Hurwitz's theorem. Montel's theorem. Riemann mapping theorem. Analytic continuation of functions with natural boundaries. Schwarz's reflection principle.

Textbooks:

1. J. W Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 1996
2. H. S. Kasana, Complex Variables: Theory and Applications, PHI, 2000.
3. J. B Conway, Functions of one Complex Variable, Narosa, 1987.

Reference books:

1. L. V. Ahlfors, Complex analysis, McGraw Hill, 1966
2. S. Ponnusamy, Functions of Complex Variables, Narosa Pub.
3. S. Lang, complex Analysis, 3rd ed. Springer, 1993.

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MT3.3: Numerical Methods - I

Unit-I: Errors, different type of errors. Floating-point number and round-off, absolute and relative errors. Solution of nonlinear equation in one variable Fixed point iterative method - convergence and acceleration by Aitken's Δ^2-process. Newton-Raphson methods for multiple roots and their convergence criteria, Ramanujan method, Bairstow's method, Sturm sequence for identifying the number of real roots of the polynomial functions, complex roots-Muller's method. Homotopy and continuation methods.

Unit-II: Solving system of equations Review of matrix algebra. Gauss-elimination with pivotal strategy. Factorization methods (Crout's, Doolittle and Cholesky). Tri-diagonal systems-Thomas algorithm. Iterative methods: Matrix norms, error analysis and ill-conditioned systems-Jacobi and Gauss-Seidel methods, Chebyshev acceleration. Introduction to steepest descent and conjugate gradient methods. Solutions of nonlinear equations: Newton-Raphson method, Quasilinearization (quasi-Newton's) method, successive over relaxation method.

Unit-III: Interpolation Review of interpolations basics, Lagrange, Hermite methods and error analyses, Splines-linear, quadratic and cubic (natural, Not a knot and clamped), Bivariate interpolation, Least-squares, Chebyshev and rational approximations.

Unit-IV: Numerical integration Review of integrations. Newton-Cotes integration methods; Trapezoidal rule, Simpson's 1\3rd rule, Simpson's 3\8th rule and Weddle's rule. Gaussian integration methods and their error analysis. Gauss-Legendre, Gauss-Hermite, Gauss-Laguerre and Gauss-Chebyshev integration methods and their error analysis. Romberg integration, Double integration.

Text books:

1. S.D. Cante & C de Boor: Elementary numerical analysis, Tata-Mc Graw-Hill,1980, 3 edition.
2. R.L. Burden and J.D. Faires: Numerical Analysis, Thomson-Brooks/Cole, 1989, 7 edition.
3. D. Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edition.

References:

1. S. Larsson and V. Thomee: *Partial differential equations with numerical methods*, Springer, 2008.
2. J. W. Thoma: *Numerical partial differential equations: finite difference methods*,2ndedition, pringer, 1998.
3. R. K. Jain, S. R. K. Iyengar and M. K. Jain: *Numerical methods for scientific and Engineering computation*, Wiley Eastern, 2001.
4. S. D. Conte and Carl De Boor: *Elementary Numerical Analysis*, McGraw Hill, 2000.
5. M. K. Jain: *Numerical Solution of Differential Equations*, Wiley Eastern, 1990.
6. G. D. Smith: *Numerical Solution of PDE*, Oxford University Press, 1998.

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MT3.4: Classical and Continuum Mechanics

Unit I: Classical Mechanics: Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

Unit II: Fundamental basic physical laws: Law of conservation of mass - Principles of linear and angular momenta - Balance of energy - Examples.Motion of non-viscous fluids: Stress tensor- Euler equation- Bernoulli's equation- simple consequences- Helmholtz vorticity equation - Permanence of vorticity and circulation - Dimensional analysis - Nondimensional numbers.

Unit III: Motion of Viscous fluids: Stress tensor - Navier-Stokes equation - Energy equation - Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen-Poiseuille flows (ii) Generalized plane Couette flow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems. Diffusion of vorticity - Energy dissipation due to viscosity.

Unit IV: Two-dimensional flows of inviscid fluids: Meaning of two-dimensional flow -Stream function - Complex potential - Line sources and sinks - Line doublets and vortices - Images - Milne Thomson circle theorem and applications - Blasius theorem and applications.

Text books:

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. S. W. Yuan: Foundations of Fluid Mechanics, Prentice Hall, 1976.

Reference books:

1. P. Chadwick: Continuum Mechanics, Allen and Unwin, 1976.
2. L.E. Malvern: Introduction to the Mechanics of a Continuous Media, Prentice Hall, 1969.
3. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977.
4. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, Fluid Mechanics, Fifth Edition, 2010.
5. C.S. Yih: Fluid Mechanics, McGraw-Hill, 1969.

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MT3.5: (a) Graph Theory

Unit I: Graph Theory: Introduction to graph theory, types of graphs, subgraphs, graph isomorphism, graph Operations, connectedness in simple graphs, paths and cycles in graphs. degree sequences, directed graphs, distance in graphs: eccentricity, radius, diameter, center, periphery, weighted graphs, Dijkstra's algorithm to find the shortest distance paths in graphs and digraphs, self-complementary graphs, blocks: cut-points, bridges and blocks, block graphs and cut-point graphs.

Unit II: Line graphs, subdivision graph and total graphs along with some properties
Planarity: Planar graphs, outer planar graphs, Kuratowaski criterion on planarity and Euler polyhedron formula.

Unit III: Colorings, vertex coloring, color class, n-coloring, chromatic index of a graph, chromatic number of standard graphs, bichromatic graphs, colorings in critical graphs, relation between chromatic number and clique number/independence number/maximum degree, edge coloring, edge chromatic number of standard graphs coloring of a plane map, four color problem, five color theorem, uniquely colorable graph, chromatic polynomial. Domination: dominating sets, domination number, domatic number and its bounds, independent domination number of a graph.

Unit IV: Linear algebra in graph theory: Adjacency matrix, incidence matrix. the spectrum of a graph, characteristic polynomials, largest Eigen values-extremal Eigen values of symmetric matrice, largest adjacency eigen value, spectrum of strongly regular graphs, spectral bounds, chromatic number and independence number, isoperimetric constant, edge counting. Groups and Graphs: Automorphism group of a graph, operation on permutation graphs and composition of graphs.

Textbooks:

1. F. Harary: Graph Theory, Addison -Wesley,1969
2. G. Chartrand and P. Zhang: Introduction to Graph Theory. McGraw-Hill Intrn.Ed., 2005.
3. J. A. Bondy and V.S.R. Murthy: Graph Theory with Applications, Macmillan, London.
4. D. Cvetkovic, M. Doob, I. Gutman and A. Torgasev, Recent Results in Theory of Graph Spectra, Annulus of Discrete Mathematics, No.36. Elsevier Science, Pub.BV.1991.
5. BogdamNica, A Brief Introduction to Spectral Graph Theory, European Mathematical Society Publishing House, 2018

Reference books:

1. N. Deo: Graph Theory: PHI Pvt. Ltd. New Delhi, – 1990
2. T.W. Haynes, S.T. Hedetneime and P. J. Slater: Fundamental of Domination in graphs, Marcel Dekker. Inc.New York.1998.
3. J. Gross and J. Yellen: Graph Theory and its application, CRC Press LLC, BR, Florida, 2000.

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MT3.5: (b) Fractional Calculus

Unit I: Brief review of Special Functions of the Fractional Calculus: Gamma Function, Mittag-Leffler Function, Wright Function, Fractional Derivative and Integrals: Grünwald-Letnikov (GL) Fractional Derivatives, Unification of integer order derivatives and integrals, GL Derivatives of arbitrary order, GL fractional derivative of $(t-a)$, Composition of GL derivative with integer order derivatives, Composition of two GL derivatives of different orders.

Unit II: Riemann-Liouville (RL) fractional derivatives- Unification of integer order derivatives and integrals, Integrals of arbitrary order, RL derivatives of arbitrary order, RL fractional derivative of $(t-a)$, Composition of RL derivative with integer order derivatives and fractional derivatives, Link of RL derivative to Grünwald-Letnikov approach, Caputo's fractional derivative, generalized functions approach, Left and right fractional derivatives.

Unit III: Properties of fractional derivatives: Linearity, The Leibnitz rule for fractional derivatives, Fractional derivative for composite function Riemann-Liouville fractional differentiation of an integral depending on a parameter, Behaviour near the lower terminal, Behaviour far from the lower terminal, Laplace transform of the Riemann-Liouville fractional derivative, Caputo derivative and Grünwald-Letnikov fractional derivative, Fourier transforms of fractional integrals and derivatives.

Unit IV: Mellin transforms of the Riemann-Liouville fractional integrals and fractional derivative, Mellin transforms of Caputo derivative. Methods of solving FDE's: The Laplace transform method: Ordinary fractional differential equations, Partial fractional differential equations, The Mellin transform method, Power series method: One term equation, Equation with non-constant coefficients, Two-term nonlinear equation.

Text Books:

1. Igor Podlubny, Fractional Differential Equations. San Diego: Academic Press; 1999.
2. L. Debnath, D. Bhatta, Integral Transforms and Their Applications, CRC Press, 2010.

Reference Books:

1. A. Kilbas, H.M. Srivastava, J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, 2006.
2. Kai Diethelm, The Analysis of Fractional Differential Equations, Springer, 2010.
3. K. S. Miller, B. Ross An Introduction to the Fractional Calculus and Differential Equations, Wiley, New York, 1993.
4. S. G. Samko, A. A. Kilbas, O. I. Marichev, Fractional Integrals and Derivatives, Theory and Applications, Gordon and Breach, New York, 1993.

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MT3.6: Foundations of Mathematics

(Open Elective)

Unit I: Set Theory: Union, intersection, Complementation, cross product of sets, relations, functions, properties functions, Equivalence relation.

Unit-II: Mathematical Logic, Logical connectives, two valued & three valued logics, Applications.Mathematical Induction, Permutations and Combinations, Binomial Theorem.

Unit-III: Quantitative Aptitude: Arithmetic ability, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Numbers GCD & LCM, Time and Work, Simple and Compound Interest, Volume surface and area,

Unit-IV: Mental / logic ability and data interpretation –Races & Games of skills, Stocks and Shares, Bankers Discount, Heights and distance, odd man out series, Tabulation, Bar graph, Pie graph, Line graphs.

Text books:

1. R. S. Agarawal, *Quantitative Aptitude*, S. Chand & Co.

References:

1. N. D. Vohra, *Quantitative Techniques in Management*, Tata McGraw Hill.

MP 3.7: Programming Lab - V

Problems from MT 3.3 (Theory) may be solved with the help of FOSS.

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SEMESTER IV

MT4.1: Functional Analysis

Unit I: Normed linear spaces, Banach Spaces, Definition and examples, quotient Spaces. convexity of the closed unit sphere of a Banach Space, examples of normed linear spaces which are not Banach, Holder's inequality, Minkowski's inequality, linear transformations on a normed linear space and characterization of continuity of such transformations.
The set B (N, N′) of all bounded linear transformations of a normed linear space N into normed linear space N′. Linear functionals, The conjugate space N*. The natural imbedding of N into N**. Reflexive spaces.

Unit II: Hahn-Banach theorem and its consequences, Projections on a Banach Space. The open mapping theorem and the closed graph theorem. The uniform boundedness theorem. The conjugate of an operator, properties of conjugate operator.

Unit III: Inner product spaces, Hilbert Spaces: Definition and Examples, Schwarz's inequality. Parallelogram Law, polarization identity. Convex sets, a closed convex subset of a Hilbert Space contains a unique vector of the smallest norm.
Orthogonal sets in a Hilbert space. Bessel's inequality. orthogonal complements, complete orthonormal sets, Orthogonal decomposition of a Hilbert space. Characterization of complete orthonormal set. Gram-Schmidt orthogonalization process.

Unit IV: The conjugate space H* of a Hilbert space H. Representation of a functional f as $f(x) = (x, y)$ with y unique. The Hilbert space H*. Interpretation of T* as an operator on H. The adjoint operator T* on B (H). Self-adjoint operators, Positive operators. Normal operators. Unitary operators and their properties.
Projections on a Hilbert space. Invariant subspace. Orthogonality of projections. Eigen values and eigenspace of an operator on a Hilbert Space.Spectrum of an operator on a finite dimensional Hilbert Space. Finite dimensional spectral theorem.

Textbooks:

1. G.F. Simmons: Introduction to Topology & Modern Analysis (McGraw-Hill Intl. Edition), 1998.
2. G. Backman and L. Narici: Functional Analysis (Academic), 2006.

Reference books:

1. B. V. Limaye: Functional Analysis (Wiley Eastern), 1998.
2. P. R. Halmos: Finite dimensional vector paces, Van Nostrand, 1958.
3. E. Kreyszig: Introduction to Functional Analysis with Applications, John Wiley & Sons, 2000.

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MT4.2: Measure Theory and Integration

Unit I: Lebesgue Measure and measurable functions: Lebesgue Measure -Introduction, uter measure, measurable sets and Lebesgue measure, translation invariant, algebra of measurable sets, countable subadditivity, countable additively and continuity of measure, Borel sets, a non-measurable set. Measurable Function -Examples: Characteristic function, constant function and continuous function, Sums, products and compositions, Sequential point wise limits, Simple functions.

Unit II: Lebesgue Integral of Bounded Functions: The Riemann integral, integral of simple functions, integral of bounded functions over a set of finite measure, bounded convergence theorem.

Unit III: The General Lebesgue Integral: Lebesgue integral of measurable nonnegative functions, Fatou's lemma, Monotone convergence theorem, the general Lebesgue integral, integrable functions, linearity and monotonicity of integration, additivity over the domains of integration. Lebesgue dominated convergence theorem.

Unit IV: Differentiation and Integration: Differentiation of monotone functions, Vitali covering lemma, Dini derivatives, Lebesgue differentiation theorem, functions of bounded variation, Jordan's theorem, differentiation of an integral, indefinite integral, absolute continuity.

Text books:

1. H. L. Royden: Real Analysis, 3d Edition, MacMillan, New York, 1963.
2. C. Goffman: Real Functions, Holt, Rinehart and Winston Inc. New York, 1953.
3. P. K. Jain and V. P. Gupta: Lebesgue Measure and Integration, Wiley Eastern Ltd., 1986.

References:

1. I. K. Rana: An introduction to Measure and Integration, Narosa Publishing House, 1997.
2. G. DeBarra: Measure and Integration, Wiley Eastern Ltd., UK, 1981.
3. I. K. Rana : An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 1997.
4. P. R. Halmos: Measure Theory, Springer-Verlag, New York, 1974.
5. W. Rudin: Real & Complex Analysis, McGraw Hill, New York, 1987.

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MT4.3: Numerical Methods - II

Unit I: Examples from ODE where analytical solutions are difficult or impossible. Examples from PDE where analytical solution are difficult or impossible.
Numerical solution of ordinary differential equations: Initial value problems: Picard's and Taylor series methods. Euler's and Modified Euler's methods, Runge-Kutta methods of second and fourth order, Runge-Kutta-Gill method, Runge-Kutta-Fehlberg methods.

Unit II: Multistep methods - the Adams-Bashforth and Adams-Moulton predictor-corrector methods. Local and global errors, stability analyses for the above methods. Methods for systems and higher order ordinary differential equations. Boundary value problems: finite difference methods, Shooting methods and cubic spline methods.

Unit III: Numerical solution of partial differential equations: Elliptic equations: Difference schemes for Laplace and Poisson's equations. Parabolic equations: Difference methods for one-dimension– methods of Schmidt, Laasonen, Dufort-Frankel and Crank-Nicolson. Alternating direction implicit method for two-dimensional equation.

Unit IV: Hyperbolic equations: Difference methods for one-dimension- explicit and implicit schemes, D'Yakonov split and Lees alternating direction implicit methods for two-dimensional equations. Stability and convergence analyses for the above equations.

Text books:

1. S.D. Cante & C de Boor: Elementary numerical analysis, Tata-Mc Graw-Hill,1980 3 edition.
2. R.L. Burden and J.D. Faires: Numerical Analysis, Thomson-Brooks/Cole, 1989, 7 edition.
3. D. Kincade and W Cheney: Numerical analysis, American Mathematical Society, 2002, 3 edition.

References:

1. S. Larsson and V. Thomee: *Partial differential equations with numerical methods*, Springer, 2008.
2. J. W. Thoma: *Numerical partial differential equations: finite difference methods*,2nd edition, pringer, 1998.
3. R. K. Jain, S. R. K. Iyengar and M. K. Jain: *Numerical methods for scientific and Engineering computation*, Wiley Eastern, 2001.
4. S. D. Conte and Carl De Boor: *Elementary Numerical Analysis*, McGraw Hill, 2000.
5. M. K. Jain: *Numerical Solution of Differential Equations*, Wiley Eastern, 1990.
6. G. D. Smith: *Numerical Solution of PDE*, Oxford University Press, 1998.

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MT4.4: Differential Geometry

Unit I: Introduction, Euclidean space, Tangent vectors, Vector fields, Directional derivatives, curves in E^3, 1 – Forms, differential forms, Mappings on Euclidean spaces, derivative map, dot product in E^3, dot product of tangent vectors, Frame at a point.

Unit II: Cross product of tangent vectors, curves in E^3, arc length, reparameterization, The Frenet formulas, Frenet frame field, curvature and torsion of a unit speed curve. Arbitrary speed curves, Frenet formulas for arbitrary speed curve, Covariant derivatives, Frame field on E^3, connection forms of a frame field, Cartan'sstructural equations.

Unit III: Isometry in E^3, Derivative map of isometry in E^3, Calculus on a surface, co-ordinate patch, proper patch, surface in E^3, Monge patch, Patch computations, parametrization of a cylinder, Differentiable functions and tangent vectors, tangent to a surface, tangent plane, Vector-field, tangent and normal vector-fields on a surface.

Unit-IV: Mapping of surfaces, topological properties of surfaces, manifolds. Shape operators, normal curvature, Gaussian curvature, computational techniques, special curves in surfaces.

Text books:

1. Barrett. O. Neill, *Elementary Differential Geometry,* Academic Press, New York (1998)
2. T.J.Willmore, *An introduction to Differential Geometry*, Oxford University Press (1999)

References:

1. N.J.Hicks, *Notes on Differential Geometry*, Van Nostrand, Princeton (2000)
2. NirmalaPrakash, *Differential Geometry - An integrated approach*, Tata McGraw Hill Pub. Co. New Delhi (2001).
3. M. P. Do Carmo, *Differential Geometry of Curves and Surfaces,* Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1976.
4. J. A. Thorpe, *Elementary Topics in Differential Geometry*, Springer (Undergraduate Texts in Mathematics), 1979.
5. L. P. Eisenhart, *A Treatise on the Differential Geometry of Curves and Surfaces*, Ginn and Company, Boston, 1909.
6. A. Gray, *Differential Geometry of Curves and Surfaces*, CRC Press, 1998.

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MT4.5: (a) Value Distribution Theory

Unit I : Basic Properties of Entire Functions. Order and Type of an Entire Function.Relationship between the order of an entire function and its derivative. Poisson Integral Formula. Poisson-Jenson Theorem. Exponent of Convergence of Zeros of an Entire function. Picard and Borel's Theorems for Entire Functions.

Unit II: Asymptotic values and Asymptotic Curve. Connection between Asymptotic and various Exponential Values.

Unit III: Meromorphic functions. Nevanlinna's Characteristic function. Cartan's Identity and Convexity theorems. Nevanlinna's First and second fundamental theorems.Order and type of meromorphic function.Order of a meromorphic function and its derivative.Relationship between $T(r, f)$ and $log\ log\ M(r, f)$ for an Entire Function. Basic Properties of $T(r, f)$.

Unit IV: Deficient Values and Relation between the Various Exponential Values. Fundamental Inequality of Deficient Values. Some Applications of Nevanlinna's Second Fundamental Theorem. Functions taking the same values at the same points. Fix-points of Integral Functions.

Textbooks:

1. A. I. Markushevich: Theory of Functions of Complex Variable, Vol. –II, Prentice – Hall (1965).

References:

1. A. S. B. Holland: Introduction to the theory of Entire Functions, Academic Press, New York (1973).
2. C. L. Siegel: Nine Introductions in Complex Analysis, North Holland (1981)
3. W. K. Hayman: Meromorphic Functions, Oxford University Press (1964)
4. Yang Lo: Value Distribution theory, Springer Verlag, Scientific Press (1964)
5. I. Laine: Nevanlinna Theory and Complex Differential Equations, Walter De Gruyter, Berlin (1993).

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MT4.5: (b) Magnetohydrodynamics

Unit I: Electrodynamics: Electrostatics, Coulomb's law, derivation of Gauss's law, electric potential, dielectrics, polarization, bound charges, Gauss law in the presence of dielectrics, magneto statics, Faraday's law, Ampere's law, vector potential, conservation of charges, electromagnetic units.

Unit II: Basic equations of MHD, equation conservation of mass, equation of conservation of momentum, conservation of energy, Magnetic induction equation, Lorentz force, MHD approximations, non-dimensional numbers, some useful dimensionless number, Reynold's number, magnetic Reynold's number, Prandtl number, magnetic Prandtl number, boundary conditions on velocity and boundary conditions on temperature.

Unit III: Exact solutions: Hartmann flow, velocity distributions in Hartmann flow, hydromagnetic plane Couette flow, temperature distributions in Hartmann flow, Hagen-Poiseuille flow, Temperature distribution for these flows, concepts in classical MHD.

Unit IV: Applications: Classical MHD, Alfven waves, Alfven theorem, Kelvin's circulation theorem, analog of Helmholtz vorticity equation in MHD, Bernoulli's equation MHD, Chandrasekhar's theorem, Ferraro's law of isorotation, physical interpretation of Lorentz force, derivation of classical Alfven wave equation.

Text Books:

1. P A Davidson , An Introduction to Magnetohydrodynamics, Cambridge University Press, 2016.
2. V.C. A Ferraro and Plumpton: Introduction to Magnetofluidmechanics, Clarendon Press, 1966.
3. David J Griffiths: Introduction to electrodynamics, PHI,1997.
4. Allen Jeffrey: Magneto hydrodynamics.

Reference books:

1. Sutton and Sherman: Magneto hydrodynamics, McGraw Hill, 1965.
2. Roger J. Hosking • Robert L. Dewar, Fundamental Fluid Mechanics and Magnetohydrodynamics, Springer Science+Business Media Singapore Pte Ltd. is part of Springer Science+Business Media, 2015.

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QUESTION PAPER PATTERN

Paper Name: ALGEBRA - I

Paper Code: MT1.1

Time: 3 Hours **Max. Marks: 70**

PART – A

1. Answer **any five** of the following: **(2×5 = 10)**

a)

b)

c)

d)

e)

f)

g)

h)

PART –B

Answer **any Four** of the following: **(5x4=20)**

2.

3.

4.

5.

6.

7.

PART –C

Answer **any Four** of the following: **(10x4=40)**

8.

9.

10.

11.

12.

13.

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