

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT502

Course Name : Linear Algebra

Credits : 4 L - 3 T - 1 P - 0

Course Type : Core

Prerequisites : UG Algebra

Course Contents

Review of fields, definition and basic examples. Vector spaces, subspaces, linear combinations, spanning sets, basis and dimension, linear transforms. Rank and nullity of linear transformation. Representation of transforms by matrices. Duality and transpose of a linear transformation. Linear functional dual space.

Inner product spaces. Orthogonality, Gram-Schmidt orthogonalization. Orthogonal projections. Primary decomposition theorem (statement only). Linear functional and adjoints. Unitary and normal operators.

Eigenvalues and Eigenvectors, characteristics polynomials, minimal polynomials. Cayley Hamilton's theorem, triangularization, diagonalization. Spectral Theorem for normal operators. Jordan canonical form.

Recommended Readings

Text book:-

1. Nair M.T., Singh A., *Linear algebra*, Springer, 2018.
2. Axler S., *Linear Algebra Done Right*, Springer UTM, 1997.

Reference book:-

1. Hoffman K. and Kunze R., *Linear Algebra*, Prentice Hall of India, 2005
2. Vineberg E.B., *A course in algebra*, Graduate text in Mathematics, volume 56, AMS, 2003.
3. Rao R.A. and Bhimasankaram P., *Linear Algebra*, Springer, 2000.
4. Strang G., *Linear Algebra and Its Applications*, Pearson, 2005.

Online resources-

1. Linear algebra: NPTEL (<https://nptel.ac.in/courses/111/106/111106051/#>)

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT503

Course Name : Abstract Algebra

Credits : 4 L - 3 T - 1 P - 0

Course Type : Core

Prerequisites : Undergraduate Algebra

Course Contents

Review of basic group theory, Normal subgroups, Quotient groups, homomorphism and isomorphism theorems, Maximal subgroups and Composition series of group, Group actions, Cauchy and Sylow's Theorems for finite groups, Internal and External direct product, P-groups, Nilpotent groups, Solvable groups, Structure theorem of finite Abelian groups.

Rings, Integral domain, Properties of ideals, Prime ideals and maximal ideals, Ring homomorphism and Quotient rings, Chinese remainder theorem, Euclidean domain, Euclidean Algorithm, Principal ideal domain, Unique factorization domain, Polynomial rings.

Field extensions, Basic properties of degree of field extensions.

Recommended Readings

Text Books: -

1. Dummit D. S., Foote R. M., *Abstract Algebra*, 3rd Edition, John Wiley & Sons, NY, 2011.
2. Artin M., *Algebra*, 2nd Edition, Pearson Education, 2011.

Reference books: -

1. Herstein I. N., *Topics in Algebra*, 3rd Edition, John Wiley & Sons, 1996.
2. Fraleigh J., *A First Course in Abstract Algebra*, 8th Edition, Pearson Education, 2020.
3. Gallion J. A., *Contemporary Abstract Algebra*, 9th Edition, Brooks/Cole Cengage Learning, 2017.
4. Hungerford T.A., *Algebra*, Graduate Texts in Mathematics, Springer-Verlag, 1980.
5. Lang S., *Algebra*, 3rd Edition, Addison-Wesley, 1999

Online/E resources: -

<https://nptel.ac.in/courses/111/106/111106113/>

<https://nptel.ac.in/courses/111/106/111106131/>

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT504

Course Name : Ordinary Differential Equation

Credits : 4 L - 3 T - 1 P - 0

Course Type : Core

Prerequisites : Knowledge of linear differential equations with constant/variable coefficients

Course Contents

Series solution. Real analytic solutions, Taylor's Series, Ordinary and singular points. Radius of convergence. Series solution near an ordinary point. Series solution near a regular singular point (Method of Frobenius).

Existence and Uniqueness of Initial Value Problems: Picard's and Peano's Theorems. Boundary Value Problems for Second Order Equations.

Orthogonal functions and orthonormal sets, Oscillations of second order equations, Sturm comparison theorems, Elementary linear oscillations, Eigenvalues and Eigenfunctions. Sturm-Liouville system. Green's functions.

System of simultaneous linear differential equations with constant and variable coefficients. Asymptotic behavior and Stability theory.

Recommended Readings

Text Books:-

1. Ahmad S. and Ambrosetti A., *A Text Book on Ordinary Differential Equations*, Springer, 2015.
2. Nandakumaran A.K., Datti P.S. and George R.K., *Ordinary Differential Equations: Principles and Applications*, Cambridge University Press, 2017.
3. Simmons G.F. and Krantz S.G., *Differential Equations Theory, Techniques and Practice*, McGraw Hill, 2006.

Reference books:-

1. Deo S. G, Raghvendra V., Kar R. and Lakshmikantham V., *Textbook of Ordinary Differential Equations*, McGraw Hill Education, 2018.
2. Braun M., *Differential Equations and Their Applications*, Springer, 1993.
3. Coddington E.A. and Levinson N., *Theory of Ordinary Differential Equations*, McGraw Hill, 2017.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT505

Course Name : Real Analysis

Credits : 4 L - 3 T - 1 P - 0

Course Type : Core

Prerequisites : Undergraduate Calculus

Course Contents

Review of the real number system, definition of a metric space and its examples, convergence of sequences in metric spaces, Subsequences, Cauchy sequences and complete metric spaces, Cantor Intersection Theorem, Baire category theorem.

Limits and Continuity of a function defined on a metric space, uniform continuity, completion of a metric space, contraction mapping, Banach fixed point theorem, connectedness, compactness, Heine Borel theorem.

Monotonic functions, Functions of bounded variation, Partition, Riemann-Stieltjes sum, Riemann-Stieltjes integral, properties, step function as integrator, reduction of RS integral to a finite sum, upper and lower Stieltjes sums, upper and lower integrals, Riemann condition, comparison theorem, mean value theorems, second mean value theorem for RS integrals.

Sequences and series of functions, Pointwise convergence, uniform convergence and its relation to continuity, differentiation and integration of series of functions, Cauchy condition for uniform convergence of series, Power Series, Weierstrass approximation theorem (only statement), equicontinuity, Arzela-Ascoli theorem and applications.

Recommended Readings

Text books-

1. Carothers N.L., *Real Analysis*, Cambridge University Press, Indian Edition, 2009.
2. Shirali S. and Vasudeva H.L., *Metric Spaces*, Springer, South Asian edition, 2019.

Reference books-

1. Ghorpade S.R. and Limaye B.V., *A Course in Calculus and Real Analysis*, Springer, 2006.
2. Royden H.L., *Real Analysis*, McMillan Publication Co. Inc. New York, 1988.
3. Apostol T.M., *Mathematical Analysis*, Narosa Publishing House, 1985.
4. Rudin W., *Principles of Mathematical Analysis*, McGraw Hill, Singapore, 1976.

Online resources-

1. <https://nptel.ac.in/courses/111/106/111106053/> (By Prof. S. H. Kulkarni, IIT Madras)

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT506

Course Name : Multivariable Calculus

Credits : 4 L - 3 T - 1 P - 0

Course Type : Core

Prerequisites : Undergraduate Calculus

Course Contents

Limits and Continuity of functions defined on Euclidean Spaces: Review of vector algebra in R^n . Real-valued functions of several variables. Level sets (level curves, level surfaces, etc.). Vector valued functions of several variables. Sequences in R^n and their limits. Neighborhoods in R^n . Limits and continuity of scalar- and vector-valued functions of several variables.

Differentiation: Partial derivatives. Differentiability of a real-valued function of several variables, the concept of (total) derivative. Gradient and directional derivatives. Chain Rule. Euler's Theorem. Higher order partial derivatives. Mixed Derivative Theorem. Mean Value Theorem and Taylor's Theorem for functions of several variables. Review of quadratic forms. Hessian matrix. Local maxima/minima and saddle points. Constrained maxima and minima of real-valued functions of several variables. Differentiation of vector-valued functions of several variables. Jacobians, Chain Rule. Contraction principle in R^n . Implicit function theorem, Inverse function theorem.

Multiple Integrals: Definition of double (resp: triple) integral of a function defined and bounded on a rectangle (resp: box). Geometric interpretation. Basic properties of double and triple integrals. Iterated integrals, Fubini's Theorem. Integrability and the integral over arbitrary bounded domains. Change of variables formula (Statement only). Polar, cylindrical and spherical coordinates, and integration using these coordinates.

Line Integrals: Paths (parameterized curves) in R^n , Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths. Definition of the line integral of a vector field over a piecewise smooth path. Basic properties of line integrals. First and Second Fundamental Theorems of Calculus for Line Integrals. Green's Theorem (proof only in the case of rectangular domains) and its applications to evaluation of line integrals.

Surface Integrals: Parameterized surfaces. Smoothly equivalent parameterizations. Area of such surfaces. Definition of surface integral. Curl and divergence of a vector field. Stokes' Theorem (proof assuming the general form of Green's Theorem), Gauss' Divergence Theorem (proof only in the case of cubical domains) and their applications.

Recommended Readings

Text books:

1. Apostol T., *Calculus*, Vol. 2, Second Ed., John Wiley, New York, 2002.
2. Ghorpade S.R. and Limaye, B.V., *A Course in Multivariable Calculus and Analysis*, Springer 2010.

Reference books:

1. Edwards C.H., *Advanced calculus of several variables*, Dover Publications Inc., 1995.
2. Apostol T., *Mathematical Analysis*, Second Ed., Narosa, New Delhi, 1974.
3. Courant R. and John F., *Introduction to Calculus and Analysis*, Vol. 2, Springer-Verlag, New York, 1989.
4. Fleming W., *Functions of Several Variables*, Second Ed., Springer-Verlag, New York, 1977.
5. Shifrin T., *Multivariable Mathematics: Linear Algebra, Multivariable Calculus, and Manifolds*, Wiley India Pvt. Ltd., 2018.
6. Marsden J.E. and Tromba A.J., *Vector Calculus*, Fourth Ed., W. H. Freeman and Co., New York, 1996.
7. Widder D.V., *Advanced Calculus*, Second Ed., Dover Pub., New York, 1989.
8. Shirali S. and Vasudeva H.L., *Multivariable analysis*, Springer, New York, 2011.

Online resources-

1. NPTEL course: *Multivariable Calculus* coordinated by IIT Roorkee available at the link: <https://nptel.ac.in/courses/111/107/111107108/> (as on 3rd August 2021).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT507

Course Name : Computer Language

Credits : 1 L - 1 T - 0 P - 0

Course Type : Core

Prerequisites : None

Course Contents

Introduction to C, Algorithms and Flowcharts, Constants, Variables, Data Types, Declarations, Operators and Expressions, Operator Precedence and Associativity, Input and Output Operations, Formatting, Decision Making, Branching, Looping, Arrays, Character Arrays and Strings

Recommended Readings

Text book-

1. Balagurusamy E., *Programming in ANSI C*, McGraw Hill, 8th Edition, 2019.

Reference book-

1. Kernighan B. W. and Ritchie D. M., *The C Programming Language (Ansi C Version)*, PHI Learning, 2015.

Online resources-

1. NPTEL course: Introduction to Programming in C By Dr. SatyadevNandakumar, IIT Kanpur (https://onlinecourses.nptel.ac.in/noc19_cs42/preview)

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAP501

Course Name : Computer Lab

Credits : 2 L - 0 T - 0 P - 4

Course Type : Core

Prerequisites : None

Course Contents

Programming Assignments: Computer Language based theory

Programming Assignment Manual will be prepared and will be the reference for the questions, assignments, evaluation and the laboratory practices.