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 adjoins. 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 orthonormalsets, 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.

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Reference books:-

1. Deo S. G, Raghvendra V., Kar R. and Lakshmikantham V., *Textbook ofOrdinary Differential Equations*, McGraw Hill Education, 2018.
2. Braun M., *Differential Equations and Their Applications*, Springer, 1993.
3. Coddington E.A. and Levison 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

Reviewof 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. ShifrinT., *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.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT508

Course Name : General Topology

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

Course Type : Core

Prerequisites : Real Analysis

Course Contents

Definition of a topological space, open and closed sets, metric space as an example of a topological space, neighbourhoods, bases and subbases, limit points, closures, interiors, convergence of sequences in topological space, insufficiency of sequences and first countability, subspace topology, hereditary properties.

Continuous maps, open and closed maps, homeomorphisms, separable spaces, second countability, quotient topology, weak topology, product topology, metrizable spaces, completely metrizable spaces and function spaces.

T_1-axiom, Hausdorff spaces, regularity, complete regularity, normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze's Extension Theorem.

Directed sets**,** Nets, Connectedness, path connectedness, component and path components, locally connected spaces, Lindelöf spaces, compact spaces and various types of compactness: countably compact, sequentially compact, pseudocompact spaces and their relationships, Tychonoff Theorem, One point Compactification.

Recommended Readings

Text book-

1. Patty C.W., *Foundation in General Topology*, Jones and Bartlett, 2010.
2. Munkres J. R., *Topology*, 2nd Edition, Pearson Education (India), 2001.
3. Armstrong M.A., *Basic Topology*, Springer (India), 2004.

Reference book-

1. Joshi K.D., *Introduction to General Topology*, New Age International, 2000.
2. Simmons G.F., *Introduction to Topology and Modern Analysis,* McGraw-Hill, 1963.
3. Kelley J.L., *General Topology*, Springer, Van Nostrand, 1955.
4. Willard S., *General Topology*, Addison-Wesley Publishing Co., Reading, Mass.-London-Don Mills, Ont., 1970.

Online resources-

1. https://nptel.ac.in/courses/111/106/111106054/

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT509

Course Name : Complex Analysis

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

Course Type : Core

Prerequisites : None

Course Contents

Topology of Complex number, Stereographic projection, Function of complex variable, Limits, Continuity, Uniform Continuity and Differentiability of function of complex variable, Exponential function, Trigonometric and inverse trigonometric functions, Logarithm function, Cauchy Riemann equation, Harmonic function, Harmonic conjugate.

Analytic function, Construction of analytic function, Entire function, Bilinear transformation, Problems on cross ratio, Fixed point, Normal form of bilinear transformation.

Zeros and singularities of analytic function, types of singularities: isolated or non-isolated singularity, classification of singularities: removable singularity, poles, essential and non-isolated essential, Power series, circle of convergence, radius of convergence, Abel's formula, Cauchy Hadmard formula.

Curve, Jordan curve, Smooth curve, Winding number, Complex integration, Cauchy integral theorem, Cauchy Goursat theorem, Cauchy's integral formulas, ML inequality, derivative of analytic function, Morera's theorem, Lucca theorem.

Liouville's theorem, Fundamental theorem of algebra, Identity theorem, Extension of Liouville's theorem, Taylor's Expansion, Laurent's series, Residue at a pole and at infinity, Cauchy's Residue theorem, Residue and Contour integration.

Meromorphic function, Rational function, Picard's little theorem, Argument principle, Maximum modulus and minimum modulus principle, Rouche's theorem, Conformal Mapping, Fundamental transformation, Schwarz lemma.

Recommended Readings

Text book-

1. Ponnusamy S., Silverman H., *Complex Variable with Application*s, Birkhauser, 2006.
2. Kasana H.S., *Complex Variables: Theory and Application*, PHI Intl Ltd, 2nd Edition, 2017.

Reference book-

1. Churchill R.V., Brown J.W., *Complex Variable & Applications*, Tata McGraw HillEducation, 2009.
2. Conway J.B, *Function of One Variable*, Narosa Distributors Pvt. Ltd., 1973.
3. Ahlfors L.V., *Complex Analysis*, McGraw Hill, 3rd Edition, 1979.
4. Zill D.G., Patrick D.S., *A First Course in Complex Analysis with Application*, Jones & Bartlett publications, 2013.
5. Daniel A., *A Complex Analysis Problem Book*, Birkhauser, 2010.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT510

Course Name : Introduction to Numerical Analysis

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

Course Type : Core

Prerequisites : Basic linear algebra and ordinary differential equations

Course Contents

Numerical Computations and Errors: Preliminaries of computing. Floating-point approximation of a number, Loss of significance and error propagation, Stability in numerical computation. Norms of vectors and matrices. Review of Taylor's series.

Linear Systems: Gaussian elimination with pivoting strategies, Gauss Jordan elimination. Iterative methods (Jacobi and Gauss-Seidal method) with convergence analysis.

Nonlinear Equations: Bisection method, Regula-falsi method, Secant method, Fixed-point iteration, Newton-Raphson method. Rate of convergence through error analysis. Solution of a system of nonlinear equations by fixed-point iteration and Newton's method.

Interpolation: Interpolation and Error.Finite difference operators. Newton's forward and backward difference interpolation formulae, Central difference formulae. Lagrange's interpolation, Newton's divided difference formulae for unequal interval. Spline interpolation.

Numerical Differentiation and Integration: Numerical differentiation, error estimates, Maxima/minima of tabulated functions. Newton-Cotes formulae with associated errors. Gaussian quadrature. Richardson extrapolation.

Numerical Solution of ODEs: Taylor's series method, Picard's method, Euler's and modified Euler's methods, Runge-Kutta methods. Solution of simultaneous and higher order equations. Predictor-Corrector methods. Single step and Multi-step methods: order, consistency, stability and convergence analysis. Two-point BVPs: Shooting and Finite difference method.

Recommended Readings

Text books:

1. Atkinson K.E., *An Introduction to Numerical Analysis*, 2nd Edition, Wiley-India, 1989.
2. Burden R.L. and Faires J.D., *Numerical Analysis,* 9th Edition, Cengage learning, 2011.

Reference books:

1. Jain M.K., Iyengar S.R.K. and Jain R.K., *Numerical Methods for Scientific and Engineering Computation,* Wiley Eastern Limited, 2012.
2. Conte S.D. and Boor C., *Elementary Numerical Analysis - An Algorithmic Approach,* 3rd Edition, McGraw-Hill, 1981.
3. Gerald C.F. and Wheatly P.O., *Applied numerical analysis,* Seventh Edition, Pearson Addison-Wesley Pub. Co, 1985.

4. Sastry S. S., *Introductory Methods of Numerical Analysis,* Prentice Hall of India, 2012.
5. Sharma J.N., *Numerical methods for Engineers and Scientists,* 2nd edition, Narosa Publishing House New Delhi, 2008.

Online resources-

1. NPTEL course: *Numerical Analysis* coordinated by IIT Madras available at the link: https://nptel.ac.in/courses/111/106/111106101/ (as on 3rd August 2021.)

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department : Department of Mathematics
Course Code : 21MAT511

Course Name : Partial Differential Equations

Credits : 4 L - 3 T - 1 P - 0
Course Type : Core
Prerequisites : Basic Multivariable Calculus and ODEs

COURSE CONTENTS

Classification of first order PDE, Method of characteristics, Cauchy problem, Cauchy-Kowalewsky theorem, Holmgren's Uniqueness Theorem, Integral surfaces passing through a given curve, Nonlinear first-order PDEs, Compatible systems, Classification and Canonical forms of second order PDE, Charpit's method, Jacobi's method for nonlinear PDEs.

Laplace equation: Fundamental solution, Construction of Green's function for Dirichlet problem posed on special domains. Poisson's formula, Solution of Dirichlet problem on a rectangle by method of separation of variables, Mean value property, Maximum principles, Dirichlet principle

Heat equation: Fundamental solution, Solution of initial-boundary value problem by separation of variables method, Maximum principle.

Wave equation: D'Alembert's formula, Solution of wave equation on bounded domains by separation of variables method, Duhamel's principle, Solutions by spherical means, Non-Homogeneous Problems, Duhamel's principle, Energy Methods.

Recommended Readings

Text Books:

1. Evans L.C., *Partial Differential Equations*, AMS (1998).
2. McOwen R.C., *Partial Differential Equations – Method and Applications*, Pearson Education, second Edition (2005).

Reference books:

1. Myint-U T. and Debnath L., *Linear Partial Differential Equations for Scientists and Engineers*, Birkhauser, Boston, 2007.
2. Nandakumaran A.K. and Datti P.S., *Partial Differential Equations-Classical Theory with a Modern Touch*, Cambridge (2020) (Cambridge-IISc Series).
3. Pinchover Y. and Rubinstein J., *An Introduction to Partial Differential Equations*, Cambridge, 2005.
4. Fritz J., *Partial Differential Equations,* Applied Mathematical Sciences, 1. Springer-Verlag, New York, 1982.
5. Farlow S.J., *Partial Differential Equations for Scientists and Engineers*, Birkhauser, New York, 1993.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT512

Course Name : Probability and Statistics

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

Course Type : Core

Prerequisites : none; [preferred – understanding of basic statistics]

Course Contents

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 and Bonferroni's Inequalities, Conditional Probability, Multiplication Theorem, Independence of Events ,Total probability, Baye's Theorem.

Random variables, Discrete and Continuous random variables and their expected value, mean, Variance and moment generating function. Specific discrete and continuous distributions, e.g. Binomial, Poisson, Geometric, Pascal, Hypergeometric, Uniform, Exponential, Weibull, Beta, Gamma, Erlang and Normal distributions.

Sampling from a distribution: random sample, concept of derived distribution of functions of random variables, concept of a statistic and its sampling distribution. Point and interval estimation, concept of bias and standard error of an estimate, standard error of sample mean, sample proportion and sample variance. Sampling distribution: χ-square -distribution, t-distribution and F-distribution and their properties. Test of significance: null and alternative hypothesis, errors in sampling (Type I and Type II), critical region, level of significance, Z-test, t-test, χ- -test, F-test. χ-Square test as a test of goodness of fit.

Recommended Reading

Text books-

1. Ravichandran J., *Probability and Statistics for Engineers*, Wiley India, 2019.
2. Shanker R.G., *Probability and Statistics for Science and Engineering*, Universities Press, 2011.

Reference books-

1. Feller W., *An Introduction to Probability Theory and its Applications*, Vol. I and II. New York, NY: Wiley, 1968-1971.
2. Jonson R.A , Miller and Freund's *Probability and Statistics for Engineers***,** PHI, India Learning Private Limited; 8th edition (1 January 2011).
3. Ross S.M., *A first course in Probability*, Pearson, 2006.

4. Gupta S.C. and Kapoor V.K.,*Fundamentals of Mathematical Statistics* , Sultan Chand & Sons (1 January 2014).
5. Freund W.J., *Mathematical Statistics*, 5th Ed., Prentice-Hall, Inc., Englewood Cliffs, N.J., 1994.
6. Hogg R.V., McKean J.W., and Allen T. Craig: *Introduction to Mathematical Statistics*, 7th Edition, Pearson Education, Asia, 2014.
7. Ross S.M., *Introductory Statistics*, Elsevier,2010.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : 21MAT602

CourseName : Functional Analysis

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

Course Type : Core

Prerequisites : Real analysis, Linear algebra

Course Contents

Normed linear spaces and Banach spaces, Finite dimensional normed spaces, Riesz Lemma, compactness of closed unit disk, equivalence of norms, Schauder basis and separablilty. Bounded linear operators, continuous linear functionals, normed spaces of bounded linear operators, dual space, reflexive space and canonical mapping, weak and weak* topologies.

Hahn-Banach extension theorem, Uniform boundedness principle, open mapping theorem, closed graph theorem and their applications.

Inner product and Hilbert Spaces, orthogonal complements, Orthonormal sets, Total orthonormal sets, Bessel's Inequality, Parseval's relation, Riesz representation theorem. Adjoint operators in Hilbert Spaces, sesquilinear form, Compact Operators and Spectral Theorem, normal operator, unitary operators, Projections and orthogonal projections in Hilbert spaces, Best approximations in Hilbert Spaces.

Recommended Readings

Text books-

1. Nair M.T., *Functional Analysis: A first course*, PHI, 2002.
2. Kreyszig E., *Introductory functional analysis with applications*, Wiley publications, 1989.

Reference books-

1. Limaye, B.V., *Functional Analysis*, Wiley Publication, 1996.
2. Brown, A.L. and Page A., *Functional Analysis*, Van Nostrand Reinhold, 1970.
3. Kesavan S., *Functional Analysis*, Hindustan Book Agency, 2014.

Online resources-

1. NPTEL Course- https://nptel.ac.in/courses/111/105/111105037/
2. MITCourse- https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring-2009/