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.