MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT OF MATHEMATICS

CURRICULUM WORKSHOP

3rd and 4th September 2021

B. Tech. Courses

PROPOSED SYLLABUS

September 2021

List of Open Electives B. Tech. courses

S No	Course Code	Name of the course	L	T	P	Cr
1	MAT101	Mathematics I	3	1	-	4
2	MAT102	Mathematics II	3	1	-	4
3	MAT-402	Complex Analysis	3	-	-	3
4	MAT-403	Abstract Algebra	3	-	-	3
5	MAT-404	Numerical Methods	3	-	-	3
6	MAT-405	Probability and Statistics	3	-	-	3
7	MAT-406	Operation Research	3	-	-	3
8	MAT-408	Linear Algebra	3	-	-	3
9	MAT-409	Integral and Discrete Transforms	3	-	-	3
10	MAT-410	Discrete Mathematical Structures	3	-	-	3
11	MAT-413	Knowledge of Number Theory	3	-	-	3
12	MAT-415	Random Variables & Stochastic Process	3	-	-	3

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : **Department of Mathematics**
Course Code : **MAT-101**
Course Name : **Mathematics I**
Credits : 4 **L -** 3 **T -** 1 **P -** 0
Course Type : Core
Prerequisites : Single Variable Calculus

Course Contents

Real sequences, convergence, basic algebraic properties, monotonic sequences, Infinite series, convergence and absolute convergence, Convergence tests: n^{th}–term test, geometric series test, comparison test, Ratio test, root test, p-test and alternating-series test (without proof). Taylor's theorem, Power series and Taylor series.

Functions of Several Variables, Definitions of Limit, Continuity and Partial Differentiation, Gradient and Directional derivative, chain rule, Total differential, Differentiability, Taylor's series for functions of two variables, Maxima and Minima of Functions of two Variables, Lagrange's method of multipliers.

Improper Integral, Gamma and Beta functions and their properties, applications of definite integrals (arc length, volume and surface of solid of revolution). Double and Triple integrals, change of order of integration, Jacobians and Change of variables with applications to polar, cylindrical and spherical coordinates.

Vector fields, divergence and curl, Parameterization of curves and surfaces, Line integrals, Scalar Potential, surface integral, Green's, Gauss and Stokes' theorems and related applications.

Recommended Readings

Text Books:

1. Weir M.D., Hass J. and Giordano F.R., *Thomas' Calculus*, 11th edition, Pearson Education, 2008.
2. Stewart J., *Calculus*, 8th edition, Cengage Learning, 2014.

Reference Books:

1. Jain R.K. and Iyanger S.R.K., *Advanced Engineering Mathematics*,5th edition, Narosa Publication, 2015.
2. Zill D.G. and Wright W.S., *Advanced Engineering Mathematics*, 9th edition, Jones & Bartlett, 2011.
3. Larson R. and Edwards B. H., *Multivariable Calculus*, 9th edition, Cengage Learning, 2009.
4. Thomas G.B. and Finney R.L., *Calculus and Analytic Geometry*, Addison-Wesley, 1988.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics
Course Code : MAT-102
Course Name : Mathematics II
Credits : 4 L - 3 T - 1 P - 0
Course Type : Core
Prerequisites : Mathematics I

Course Contents

Basic Matrix Operations, transpose and Adjoint, symmetric, skew-symmetric, Hermitian, skew-Hermitian, normal, orthogonal and unitary matrices, elementary row operations, row reduced echelon form, determinant and trace, inverse of a matrix, linear independence and dependence, rank of a matrix, solvability of linear equations, Gauss-Jordan elimination subspaces of R^n and C^n, span of vectors, basis and dimensions, matrix as a linear transformation, eigen values and eigen vectors, characteristic polynomial, Cayley-Hamilton Theorem (Without proof), diagonalization.

Exact equations, Integrating factors (of the form $F(x)$ and $F(y)$), Existence and uniqueness theorem (without proof), examples on non-uniqueness. Second and Higher order linear ODEs with constant coefficients, Wronskian, Method of undetermined coefficients, Method of variation of parameters, Cauchy-Euler equation. Solution of system of ODEs using matrix method. Power series solution about an ordinary point.

Formulation and classification of PDEs, Lagrange's Method, Fourier Series and method of Fourier to solve second order homogeneous PDEs: Solutions of Wave, Heat, and Laplace equations.

Recommended Readings

Text books:

1. Kreyszig E., *Advanced Engineering Mathematics*, 10th Edition, Wiley, 2011.
2. Singh A., *Introduction to Matrix Theory*, Springer, 2021.

Reference books:

1. Jain R.K. and Iyanger S.R.K., *Advanced Engineering Mathematics*, 5th edition, Narosa Publication, 2015.
2. Strang G., *Introduction to Linear Algebra*, 4th Edition, Cengage Learning (RS), 2005.
3. Simmons G.F., *Differential Equations with applications and historic notes*, 2nd edition, McGraw hill education, 2017.
4. Jeffrey A., *Advanced Engineering Mathematics*, Elsevier Academic Press, 2002.
5. Greenberg M.D., *Advanced Engineering Mathematics*, 2nd Edition, Pearson Education Inc., 2002.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : MAT-402

Course Name : Complex Analysis

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

Course Type : Elective

Prerequisites : MAT-101 and MAT-102

Course Contents

Metric Properties of Complex Plane: Usual metric on complex plane, open sets, closed sets, accumulation point, connectedness and path connectedness.

Analytic Functions: Complex valued functions of the form f(t), functions of a complex variable, limits and continuity, differentiability, Cauchy – Riemann equations, analytic function, harmonic functions, conjugate functions. Mappings or transformations, conformal mapping, necessary and sufficient conditions for $w = f(z)$ to represent conformal mapping, bilinear transformations.

Complex Integration: Line integral of functions of the form f(t), Contour integrals, Antiderivative, Cauchy fundamental theorem, Cauchy-Goursat theorem, Cauchy integral formula and its extension, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle.

Expansion of analytic function: Taylor and Laurent series, zeros and poles, isolated and essential singularities.

Calculus of Residues: Residue at simple pole, residue at a pole of order greater than unity, the Cauchy's residue theorem, evaluation of real definite integrals.

Recommended Readings

Text books-

1. Churchill R. V. and Brown J. S., *Complex Variables & Applications* –Tata McGraw Hill Eduction, 2009.
2. Kreyszig E., *Advanced Engineering Mathematics*, John Wiley, 10th edition, 2015.

Reference books-

1. Ahlfors L., *Complex Analysis*, McGraw Hill, 3 edition, 1979.
2. Ponnusamy S., *Foundations of Complex Analysis*, Alpha Science Intl Ltd; 2nd edition, 2006.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : MAT-403

Course Name : Abstract Algebra

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

Course Type : Elective

Prerequisites :

Course Contents

Group theory: Groups, semi groups and monoids, subgroups and cosets, Lagrange's theorem, normal subgroups, homomorphisms and factor groups. Structure of cyclic groups, permutation groups, dihedral groups, Sylow's theorems (statement only). Structure of finite abelian groups (statement only) and examples.

Rings: Rings, subrings, homomorphisms of rings, divisibility in rings, ideal and quotient rings, integral domains, primal and maximal ideals, examples of rings including polynomial rings and rings of matrices.

Recommended Readings

Text book:

1. Gallian J., *Contemporary Abstract Algebra*, 8th edition, Cengage Learning, 2013.
2. Fraleigh J., *A First Course in Abstract Algebra*, 8th edition, Pearson Education, 2020.

Reference books:

1. Artin M., *Algebra*, 2nd Edition, Pearson Education, 2011.
2. Beachy J.A. and Blair W. D., *Abstract Algebra*, 3rd edition, Waveland Press, 2006.
3. Beachy J.A., *Abstract Algebra II*, Cambridge University Press, 1999.
4. Herstein I.N., *Topics in Algebra*, 2nd Edition, John-Wiley, Cengage Pub. 1975.
5. Sharma R.K., Shah S.K. and Shankar G., *Algebra I*, Pearson, 2011.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : MAT-404

Course Name : Numerical Methods

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

Course Type : Elective

Prerequisites : MAT101: Mathematics - I and MAT102: Mathematics – II

Course Contents

Error analysis: Representation of numbers in computers and their accuracy, floating point arithmetic, concept of zero, errors in computations, types of errors, propagation of errors, computational methods for error estimation, general error formulae, approximations of functions and series.

Roots of algebraic and transcendental equations: Bisection method, Regula-falsi method, fixed-point iteration, Newton-Raphson method.

Solution of simultaneous algebraic equations: Gauss elimination method, Gauss Jordan method, decomposition method, Jacobi and Gauss-Seidel iteration methods.

Interpolation and finite differences: Forward, backward and central differences, relations between the operators, Newton's forward and backward differences interpolation formulae, Stirling, Bessel and Gauss formulae for central difference, numerical differentiation, Lagrange's and Newton's divided difference interpolation formulae for unequal interval.

Numerical Integration: Gaussian-Legendre quadrature formula, Trapezoidal, Simpson's one-third, Simpson's three-eighth quadrature formula, Weddle's rule.

Ordinary Differential Equations: Taylor's series method, Picard's method, Euler's and modified Euler's methods, Runge-Kutta fourth-order method, Milne's Predictor-Corrector method.

Recommended Readings

Textbooks:

1. Jain M.K., Iyengar S.R.K., and Jain R.K., *Numerical Methods for Scientific and Engineering Computation*, Wiley Eastern Limited, 2012.
2. Burden R. L. and Faires J. D., *Numerical Analysis*, 9th Edition, Cengage learning, 2011.

Reference books:

1. Gerald C.F and Wheatly P.O., *Applied numerical analysis*, Seventh Edition, Pearson Addison-Wesley Pub. Co, 1985.
2. Sastry S.S., *Introductory Methods of Numerical Analysis*, Prentice Hall of India, 2012.
3. Sharma J.N., *Numerical methods for Engineers and Scientists*, 2nd edition, Narosa Publishing House, New Delhi, 2008.

Online resources:

NPTEL course *Numerical Methods*, coordinated by IIT Roorkee available at the link: https://nptel.ac.in/courses/111/107/111107105/ (as on 04.09.2021).

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre	**:**	**Department of Mathematics**
Course Code	**:**	**MAT-405**
Course Name	**:**	**Probability and Statistics**
Credits	**:**	3 **L -** 3 **T -** 0 **P -** 0
Course Type	**:**	Elective
Prerequisites	**:**	**Mathematics-I and II**

Course Contents

Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems. Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quantiles.

Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, beta, normal, lognormal, inverse Gaussian distributions, reliability and hazard rate, reliability of series and parallel systems, problems, Function of a random variable.

Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems. Transformations: functions of random vectors, distributions of order statistics, distributions of sums of random variables, problems.

Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems.

Descriptive Statistics: Graphical representation, measures of locations and variability,

Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, testing of hypothesis.

Recommended Readings

Text books:

1. Ravichandran J., *Probability and statistics for Engineers*, Wiley India, 2019
2. Ross S.M., *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier Third Edition Academic Press 2008.

Reference books:

1. Gupta S. C. and Kapoor V. K., *Fundamentals of Mathematical Statistics* , Sultan Chand & Sons (1 January 2014)
2. Shanker Rao G., *Probability and statistics for Science and Engineering*, Universities Press, 2011.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics
Course Code : MAT-406

Course Name : Operations Research
Credits : 3 L - 3 T - 0 P - 0
Course Type : Elective
Prerequisites : Mathematics-I and II

Course Contents

An overview of optimization problem, some examples of optimum design problem. Concepts and terms related to optimization problem, necessary and sufficient conditions for a multivariable function. Effects of scaling or adding a constant to an objective function and understanding constrained and unconstrained optimization problems. Concept of Lagrange multipliers and its application to unconstrained optimization problem.

Linear programming: Introduction, general structure of linear programming (LP) models, methods of solving: graphical method, simplex method. Duality in LP, Assignment problem, Game theory. Transportation Problem: Mathematical statement of transportation problem, methods of finding basic feasible solution (BFS), test of optimality, MODI'S method for optimal solution, variation in transportation problem.

Convex sets, convex and concave functions, properties of convex function, definiteness of a matrix and test for concavity of function. Problem statement of convex optimization, quadratic optimization, quadratically constrained quadratic optimization, local and global optima.

Quadratic programming: Wolfe's and Beale's method. Network Analysis: Project planning and control with PERT-CPM.

Recommended Readings

Text books:

1. Taha H.A., *Operations Research - An Introduction*, Pearson Education Limited, 2017.

Reference Books:

1. Hillier F.S. and Liebraman G.J., *Introduction to Operations Research*, McGraw Hill, 2014.
2. Arora J.S, *Introduction to optimum design*, Elsevier, 2016.
3. Rao S.S, *Engineering Optimization: Theory and Practice*, Wiley, 2009.
4. Ravindran A, Ragsdell K.M and Reklaitis G.V, *Engineering optimization: Methods and Applications*, John Wiley &Sons, 2006.
5. Deb K, *Optimization for Engineering Design: Algorithms and Examples*, PHI Learning,2012.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code	**:**	**MAT-408**
Course Name	**:**	**Linear Algebra and Its Applications**
Credits	**:**	**3 L - 3 T - 0 P - 0**
Course Type	**:**	**Elective**
Prerequisites	**:**	**MAT-102 (Mathematics-II)**

Course Contents

Vector space and subspaces, Linear independence and dependence, Spanning set, Basis, linear transformations, matrix representation, change of basis.

Inner product spaces, Gram-Schmidt orthogonalization, QR-factorization, best approximation, least square approximation. Adjoint of an operator, hermitian, unitary and normal operators.

Diagonalizability of linear operators of finite dimensional vector space. The primary decomposition theorem, generalized eigenvectors, Jordan form. Singular Value Decomposition and its applications. Introduction of bilinear and quadratic forms.

Recommended Readings

Text books-

1. Strang G., *Linear Algebra and Its Applications*, 4th edition Cengage Learning, 2006.
2. Anton H., Rorres C., *Elementary Linear Algebra: Applications*, 11th edition, Wiley, 2013.

Reference books-

1. Hoffman K. and Kunze R., *Linear Algebra*, 2nd edition, PHI Learning, 2009.
2. Artin M., Algebra, 2nd Edition, Pearson education, 2011.
3. Kumaresan S., *Linear Algebra: A Geometric Approach*, PHI Learning, 2000.
4. Lewis D. W., *Matrix Theory*, World Scientific, 1991.
5. Lang S., *Introduction to Linear Algebra*, 2nd Edition, Springer India, 2005.

Online resources-

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : MAT-409

Course Name : Integral and Discrete Transforms

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

Course Type : Elective

Prerequisites : Differential and Integral Calculus,

Course Contents

Laplace Transforms: Laplace Transforms of elementary functions, inverse Laplace transformations, Heavisides' unit step function, Dirac delta function, first and second shifting theorems, transforms of derivatives and integrals, convolution theorem, solution of ordinary differential equation with constant coefficients and partial differential equations with special reference to heat equation, wave equation, Laplace and Poisson equation.

Fourier Transforms: Fourier integral formula, exponential Fourier transform, inverse Fourier transform, Fourier sine and cosine transforms, applications to integral equations.

Z- Transforms: Linearity, Z -Transform of elementary functions, shifting theorems, initial and final value theorems, Convolution theorem, inversion of Z-Transform, solution of difference equations using Z- Transform.

Mellin Transforms: Definition and properties of Mellin transform, shifting and scaling properties, Mellin transforms of derivatives and integrals, Applications of Mellin transform.

Hankel Transforms: Basic properties of Hankel transform, Hankel transform of derivatives, Application of Hankel Transform to PDEs.

Recommended Readings

Text books

1. Debnath L. and Bhatta D., *Integral transforms and their Applications*, CRC Press/Chapman and Hall, 3rd Edition, 2015.
2. Patra B., *An Introduction of Integral Transform*, Taylor & Francis/CRC, 2018
3. Drof R.C., *Transform and Applications*, Taylor & Francis/CRC, 3rd Edition, 2010

Reference books:-

1. Andrews L.C. and Shivamoggi B.K., *Integral Transform for Engineers*, SPIE Optical Engineering Press, 1999.
2. Sneddon I.N., *The use of Integral Transform*, McGraw Hill, 2nd Edition, 1972.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics
Course Code : MAT-410

Course Name : Discrete Mathematical Structures
Credits : 3 L - 3 T - 0 P - 0
Course Type : Elective
Prerequisites : none; [preferred – understanding of basic mathematics]

Course Contents

Set Theory: Review of basic set operations, cardinality of a set. Countable and uncountable sets. Relations, Types of relations, operations of relations and applications, Poset, Congruence arithmetic.
Logic: Propositional Logic, language of propositional logic, truth table, natural deduction, predicate logic: language of predicate logic, Logical inference with Quantifiers. Proof techniques: Introduction to different standard proof techniques.
Combinatorics: Counting techniques: Pigeon Hole principle, inclusion exclusion principle, recurrence relation and generating function.
Graphs: Complete graphs, regular graphs, bipartite graphs, Vertex degree, subgraphs, paths and cycles, Hamiltonian graphs, Planar graphs, the matrix representation of graphs, trees, Graph coloring, shortest path problems.

Recommended Readings

Text books-

1. Rosen K. H., *Discrete Mathematics and its Applications with Combinatorics and Graph Theory*, 7th Edition, Tata McGraw-Hill Edu. 2012.
2. Liu C. L. and Mohapatra D., *Elements of Discrete Mathematical*, 4th Ed., Tata McGraw-Hill, 2012.

Reference books-

1. Kolman B., Busby R. and Ross S. C., *Discrete mathematical structures*, 4th edition. Prentice Hall of India, 2002.
2. Bondy J. A. and Murty U. S. R., *Graph Theory*, Springer, 2008.
3. Mott J.L., Kandel A. and Baker T.P., *Discrete Mathematics for Computer Scientists and Engineers*, 2nd Ed. PHI, 2003.

Online resources-https://nptel.ac.in/courses/106/108/106108227/

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics
Course Code : MAT-413

Course Name : Number Theory
Credits : 3 L - 3 T - 0 P - 0
Course Type : Elective
Prerequisites : Knowledge of number system

Course Contents

Divisibility: basic definition, properties, prime numbers, some results on distribution of primes.

Congruences: Basic definitions and properties, complete and reduced residue systems, theorems of Fermat, Euler & Wilson, application to RSA cryptosystem. Linear congruences and Chinese remainder theorem, Euler's functions, quadratic congruences, Quadratic Reciprocity law.

Arithmetical functions: τ and σ functions with some properties and their rate of growth, Möbius-Inversion formula.

Diophantine Approximation: Continued fractions and their connection with Diophantine approximations, applications to Pell's equations.

Diophantine Equations: Linear equations, Binary quadratic forms, Solutions of some quadratic and higher degree Diophantine equations.

Partitions: Partitions of a number, Some basic properties and results.

Recommended Readings

Text books-

1. Jones G.A. and Jones J.M., *Elementary Number Theory*, Springer UTM, 2007.
2. Burton D., *Elementary Number Theory*, McGraw Hill Edu. 2006.

Reference books-

1. Baker A., *A concise introduction to the theory of numbers*, Cambridge Univ. Press, 1984.
2. Hardy G. H. and Wright E. M., *An introduction to the theory of numbers*, 4 th Editions, Oxford, Univ. Press, 1960.
3. Ireland K.F. and Rosen M.I., *A Classical Introduction to Modern Number Theory*, Springer, 1990.
4. Niven I., Zuckerman H. S. and Montgomery H. L., *An introduction to the theory of numbers*, 5e, Wiley, 1991.

Online resources-

1. https://nptel.ac.in/courses/111/103/111103020/

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Mathematics

Course Code : MAT-415

Course Name : Random Variables and Stochastic process

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

Course Type : Elective

Prerequisites : **Mathematics-I and II**

Course Contents

Experiments, Models and Probabilities: Set Theory, Applying Set theory to Probability, Probability Axioms, Some consequences of the Axioms, Conditional Probability, Independence, Independent Trials.

Discrete Random Variables: Probability Mass Function (PMF), Families of discrete Random Variables, Cumulative Distribution Function, Averages, Functions of Random Variables, Expected values of derived Random variables, Variance and Standard Deviation, Conditional Probability Mass Function.

Continuous Random Variables: Cumulative Distribution Function, Probability Density Function, Expected Values, Families of Continuous Random Variables, Gaussian Random Variables, Mixed Random Variables, Probability models of derived Random Variables, Conditioning a continuous Random Variables.

Pairs of Random Variables: Joint Cumulative Distribution Function, Joint Probability Mass Function, Marginal PMF, Joint Probability Density Function, Marginal PDF, Functions of two random variables, expected values, Conditioning by an event, conditioning by a Random Variables.

Stochastic Process: Types of Stochastic Processes, Random Variables from Random Processes, The Poisson Process and properties, The Brownian motion process, Expected value and Correlation.

Recommended Readings

Text Books:-

1. Papoulis A and Pillai S.U., *Probability, Random Variables and Stochastic Processes*, 4th edition, McGraw-Hill, 2002.

Reference Books:-

1. Chung K.L. and AitSahlia F., *Elementary Probability theory: With Stochastic Processes and an Introduction to Mathematical Finance,* Springer**,** 2010
2. Ross S.M., *Introduction to Probability and Statistics for Engineers and Scientists*, Academic Press, 2014.