



**COURSE STRUCTURE AND SYLLABUS  
4-YEAR UG PROGRAM IN MATHEMATICS**



Department of Mathematical Sciences  
TEZPUR UNIVERSITY

**Tezpur University**  
**Department of Mathematical Sciences**

**Course Structure and Syllabus of 4-year UG program in Mathematics**  
*(2023 entry batch onwards)*

Minimum credit requirement : 40+80+120+160  
Program duration : 1+1+1+1 years (8 semesters)

**COURSE STRUCTURE**

**Semester I**

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN101	Mathematics I (Core I)	3-1-0	4	4	Also offered as Minor
	Minor-I			4	
	Minor-II			4	
	MDC-I			3	
	AEC-I			2	
	SEC-I			3	
	VAC-I			2	
<b>Total credits</b>				<b>22</b>	

**Semester II**

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN102	Mathematics II (Core II)	3-1-0	4	4	Also offered as Minor
	Minor-III			4	
	Minor-IV			4	
	MDC-II			3	
	AEC-II			2	
	SEC-II			3	
	VAC-II			2	
<b>Total credits</b>				<b>22</b>	

MDC: Multidisciplinary Course, AEC: Ability Enhancement Course  
SEC: Skills Enhancement Course, VAC: Value Added Course

### Semester III

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN201	Introductory Statistics & Probability	2-1-0	3	3	Also offered as Minor
MSIN202	Foundation of Mathematics	2-1-0	3	3	
MSIN203	Analysis-I	2-1-0	3	3	
MSIN204	Group Theory	2-1-0	3	3	
	Minor-V			3	
	MDC-III			3	
	AEC-III			2	
	VAC-III			2	
<b>Total credits</b>				<b>22</b>	

### Semester IV

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN205	Coordinate Geometry	2-1-0	3	3	
MSIN206	Introductory Linear Algebra	2-1-0	3	3	Also offered as Minor
MSIN207	Introductory Topology	2-1-0	3	3	
MSIN208	Programming, Algorithm and Mathematical Software	2-0-1	4	3	
	Minor-VI			3	
	AEC-IV			2	
	SEC-III			3	
<b>Total credits</b>				<b>20</b>	

MDC: Multidisciplinary Course, AEC: Ability Enhancement Course  
SEC: Skills Enhancement Course, VAC: Value Added Course

## Semester V

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN301	Introductory Differential Equations	2-1-0	3	3	Also offered as Minor
MSIN302	Statics and Dynamics	2-1-0	3	3	
MSIN303	Numerical Methods	2-1-0	3	3	
MSIN304	Elementary Complex Analysis	2-1-0	3	3	Also offered as Minor
MSIN305	Combinatorics	2-1-0	3	3	
	Minor-VII			3	
	Summer Internship			2	
<b>Total credits</b>				<b>20</b>	

## Semester VI

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN306	Introduction to Optimization	2-1-0	3	3	Also offered as Minor
MSIN307	Ring Theory	2-1-0	3	3	Also offered as Minor
MSIN308	Elementary Number Theory	3-1-0	4	4	
MSIN309	Analysis-II	3-1-0	4	4	
MSIN310	Elementary Integral Transforms and Special Functions	3-1-0	4	4	
	Minor-VIII			3	
<b>Total credits</b>				<b>21</b>	

## Semester VII

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN401	Abstract Algebra	3-1-0	4	4	
MSIN402	Linear Algebra	3-1-0	4	4	
MSIN403	Analysis-III	3-1-0	4	4	
MSIN404	Computer Programming+	3-1-0	4	4	
MSIN405	Lebesgue Measure and Integration	3-1-0	4	4	
MSIN406	Computer Lab	0-0-1	2	1	
	Minor-IX			3	
Total credits				<b>24</b>	

*+Course for which there is a separate practical unit assigned as Computer Lab*

**For a 4-year bachelor's degree (Honours with Research), a student has to opt for a minimum 16 credits from courses listed for Semester VII (MSIN401-MSIN406) together with research project of 3 credits.**

## Semester VIII

Course Code	Course Name	L-T-P	CH	CR	Remark
MSIN407	Complex Analysis	3-1-0	4	4	
MSIN408	Theory of Ordinary Differential Equations	3-1-0	4	4	
MSIN409	Topology	3-1-0	4	4	
MSIN410	Numerical Analysis+	3-1-0	4	4	
MSIN411	Computer Lab	0-0-1	2	1	
	Minor-X			3	
Total credits				<b>20</b>	

*+Course for which there is a separate practical unit assigned as Computer Lab*

**For a 4-year bachelor's degree (Honours with Research), a student has to opt for a minimum of 8 credits from courses listed for Semester VIII (MSIN407-MSIN411) together with research project of 9 credits.**

# Detailed Syllabus

## MSIN101: Mathematics I (Core I)

[L3-T1-P0-CH4-CR4]

### Unit-1

Applications of differentiation: Rates of Change in the Natural and Social Sciences, Maximum and Minimum Values, Mean Value Theorems and their applications, Derivatives and the Shapes of Graphs, Indeterminate Forms and L'Hospital's Rule, Curve Sketching, Graphing with Calculus and Calculators.

### Unit-2

Applications of integration: Approximate Integration, Improper Integrals, Areas Between Curves, Volumes, Volumes by Cylindrical Shells, Arc Length, Area of a Surface of Revolution. Improper integrals, Beta and Gamma functions.

### Unit-3

Functions of Several Variables: Limits and Continuity, Partial Derivatives, Tangent Planes and Linear Approximations, The Chain Rule, Directional Derivatives and the Gradient Vector, Maximum and Minimum Values, Lagrange Multipliers.

### Unit-4

Ordinary Differential Equations:

First-Order ODEs: Basic Concepts, Geometric Meaning of  $dy/dx=f(x, y)$ . Direction Fields, Euler's Method, Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation.

Second-Order Linear ODEs: Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients. Non-homogeneous ODEs.

### Textbooks:

1. Ghorpade, S. R. and Limaye. B. V. *A course in Multivariable Calculus and Analysis*. Springer India, 2012.
2. Stewart, J. *Calculus*. Cengage Learning, Metric Edition, 2014.
3. Kreyszig, E. *Advanced Engineering Mathematics. 10<sup>th</sup> Edition*, JOHN WILEY & SONS, INC.

### Reference books:

4. Thomas, G. B. and Finney, R. L. *Calculus and Analytic Geometry*. Narosa Publishing House, 1998.
5. Apostol, T. M. *Calculus, Vol I & II*. John Wiley and Sons, 2<sup>nd</sup> (Indian) Edition, 2022.
6. Braun, M. *Differential equations and Their Applications: An Introduction to Applied Mathematics*. Springer, 2013.
7. Boyce, W. E. and DiPrima, R. C. *Elementary Differential Equations*. John Wiley, Indian Edition, 2000.

## **MSIN102: Mathematics II (Core II)** **[L3-T1-P0-CH4-CR4]**

### **Unit-1**

Systems of linear equations: Solutions and elementary operations, Gaussian elimination, Homogeneous equations, Applications to Network flow, Electrical networks, Chemical reactions.

### **Unit-2**

Matrix algebra: Matrix addition, Scalar multiplication, Transposition, Multiplication, Inverses, Elementary matrices, Linear Transformations, LU factorization, Applications.

### **Unit-3**

Determinants: The cofactor expansion, Determinants and matrix inverses, Diagonalization and Eigen values, Application to Linear recurrences and Differential equations, Proof of cofactor expansion theorem.

### **Unit-4**

Multiple Integrals: Double integrals, Areas, moments and centers of mass, Double integral in polar form, Triple integral in rectangular coordinates, Masses and moments in three dimensions, Triple integral in cylindrical and spherical coordinates, Substitutions in multiple integrals.

### **Unit-5**

Vector Integration: Line integrals, Vector fields, Work, Circulations and Flux, Path independence, Potential function and Conservative fields, Green's theorem in the plane, Surface area and surface integrals, Parametrized surfaces, Stokes's theorem, The divergence theorem and a unified theory.

### **Textbooks:**

1. Nicholson, W. K. *Linear Algebra and Applications*, Open Edition, Lyryx Learning, 2018.
2. Spiegel, M. R. *Vector Analysis*. Schaum's outline series, McGraw-Hill, 2<sup>nd</sup> Edition 2017.
3. Thomas, G. B. and Finney, R. L. *Calculus and Analytic Geometry*. Narosa Publishing House, 1998.

### **Reference books:**

4. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics*. 5<sup>th</sup> Edition, Narosa Publishing House, 2017.
5. Ramana, B. V. *Higher Engineering Mathematics*. McGraw Hill, India 2017.
6. Apostol, T. M. *Calculus, Vol I & II*. John Wiley and Sons, 2<sup>nd</sup> (Indian) Edition, 2022.

## **MSIN201: Introductory Statistics & Probability (L2-T1 -P0 -CH3 -R3)**

### **Unit-1**

Definitions of Statistics, population, sample, data and characteristics of data. Measures of central tendency, dispersion. Histogram, frequency curve and boxplot.

### **Unit-2**

Skewness and its measures. Normal and student's-t curves. Kurtosis and its measures. Effects of change of origin and scale. Definition of Probability and some properties of the probability function.

### **Unit-3**

Random variable, Probability distribution and distribution function. Discrete and continuous distribution. Some important discrete and continuous distributions.

### **Unit-4**

Random sampling and sampling fluctuation, Simple random sampling, variance of sample mean under SRS WOR, Estimation of population size (capture-release- capture method), Correlation and simple linear regression. Rank correlation.

### **Textbooks:**

1. Medhi, J. *Statistical Methods: An introductory Text*. New Age International(P)Ltd, 2005.
2. Wasserman, L. *All of Statistics: A Concise Course in Statistical Inference*. Springer Texts in Statistics, 2004.
3. Cochran, W. G. *Sampling Techniques*. John Wiley & Sons, 3<sup>rd</sup> Edition, 1977.

### **Reference books:**

4. Feller, W. *An Introduction to Probability Theory and Its Applications. Vol. I*. Wiley, 2008.
5. Feller, W. *An Introduction to Probability Theory and Its Applications. Vol. II*. Wiley, 2008.



## **MSIN202: Foundation of Mathematics**

**(L2 -T1 -P0 -CH3 -CR 3)**

### **Unit-1**

Statements, quantifiers, negation, compound statements (conjunction, disjunction, conditional and bi-conditional), contra-positive statement, proofs in Mathematics. Set, subset, superset, operations viz. union, intersection, difference etc. of sets; powerset, cartesian product.

### **Unit-2**

Equivalence relations, equivalence classes, partition, fundamental theorem of equivalence relation. Functions, injection, surjection and bijection; image and pre-image of set under function, composition of functions, invertible function.

### **Unit-3**

Partial order relation, poset, chain, upper & lower bounds in poset, greatest & least elements, maximal & minimal elements, supremum & infimum, Zorn's lemma, introduction to lattice theory.

### **Unit-4**

Principle of mathematical induction, well ordering principle, axiom of choice. Finite and infinite sets, countable and uncountable sets, Schroeder Bernstein Theorem, Continuum hypothesis. Ordinal Numbers.

### **Textbooks:**

1. Kumar, A., Kumaresan, S. and Sarma, B. K. *A foundation course in Mathematics*. Alpha Science International, 2018.
2. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*. John Wiley and Sons, 3<sup>rd</sup> Edition, 2005 (reprint, Wiley India, 2011).

### **Reference Books:**

3. Hrbacek, K. and Jech, T. *Introduction to Set Theory*. Taylor & Francis, 3rd edition, 1999.
4. Halmos, P. R. *Naive Set Theory*. Springer, 2009.

## **MSIN203: Analysis-I (L2-T1-P0-CH3-CR3)**

### **Unit-1**

Real Numbers: algebraic and ordered properties, Upper and Lower bounds, LUB property and its applications viz. Archimedean property, greatest integer function, density property and existence of  $n^{\text{th}}$  root of a positive real number. Intervals, Nested interval theorem. Absolute value and triangle inequality. Decimal representations.

### **Unit 2**

Revisit to sequences and their convergence. Sequences defined recursively. Limit supremum and Limit infimum. Sequential definition of continuous functions,  $\epsilon - \delta$  definition of continuity, Thomae's function, Intermediate value theorem, Fixed point theorem, Weierstrass theorem, Extreme value theorem, Monotone functions.

### **Unit 3**

Uniform continuity, Continuous extensions, Differentiability of functions, Caratheodory's theorem, Rolle's theorem, Lagrange's form of mean value theorem, Darboux's theorem, Inverse function theorem, Cauchy's form of mean value theorem. Applications of mean value theorems.

### **Unit 4**

Higher order derivatives, Leibniz formula, Taylor's Theorem, Lagrange's and Cauchy's form of remainder, relative extrema. The relation between integration and differentiation: Derivative of an indefinite integral, the first fundamental theorem of calculus, Primitive functions and the second fundamental theorem of calculus. The Leibniz notation for primitives.

### **Textbooks:**

1. Kumar, A. and Kumaresan, S. *A Basic Course in Real Analysis*. CRC Press, 2014.
2. Bartle, R. G. and Sherbert, D. R. *Introduction to Real Analysis*. John Wiley and Sons, New Delhi, 4<sup>th</sup> Edition, 2021.
3. Apostol, T. M. *Calculus, Vol I*. John Wiley and Sons, 2<sup>nd</sup> (Indian) Edition, 2002.

## **MSIN204: Group Theory** **(L2 -T1-P0-CH3-CR 3)**

### **Unit-1**

Group, elementary properties of groups, subgroup, coset, Lagrange's theorem and its applications.

### **Unit-2**

Permutation, cycle notation, even and odd permutation, order of a permutation, symmetric group and alternating group.

### **Unit-3**

Cyclic subgroups, order of an element, properties of cyclic groups, fundamental theorem of cyclic group, Subgroup generated by a set.

### **Unit-24**

Conjugacy class, normal subgroups and quotient groups.

### **Unit-5**

Homomorphism and isomorphism of groups, isomorphism theorems, Cayley's theorem.

### **Unit-6**

Direct product of groups, properties of direct products.

### **Textbooks:**

1. Gallian, J. A. *Contemporary Abstract Algebra*. CRC Press, Taylor & Francis Group, 10<sup>th</sup> Edition 2021.
2. Fraleigh, J. B. *A First Course in Abstract Algebra*. Pearson Education India, New Delhi, 7<sup>th</sup> Edition, 2020.

### **Reference books:**

3. Dummit, D. S. and Foote, R. M. *Abstract Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 3<sup>rd</sup> Edition 2011.
4. Herstein, I. N. *Topics in Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 2<sup>nd</sup> Edition, 2006.

## **MSIN205: Coordinate Geometry** **(L2-T1 -P0 -CH3 -CR 3)**

### **Unit-1**

Transformation of co-ordinate axes. Pair of straight lines. General equation of second degree and the conditions for representing a pair of straight lines, a parabola, an ellipse, a hyperbola, and a circle.

### **Unit-2**

Reduction to standard forms: The centre of a conic, Reduction of the equation of a central and non-central conic, Equation of the axes and length of the axes.

The equation of tangent, Condition of tangency of line, Equation of normal, Pair of tangents and director circle, Chord of contact, Pole and polar, Chord in terms of middle points, Diameter and conjugate diameters, Asymptotes.

### **Unit-3**

Polar equation of a conic, tangent and normal, properties. Circle and its parametric form, Orthogonal circle, condition of orthogonality of circles.

### **Unit-4**

Plane, straight line, Sphere, Cone and Cylinder.

### **Unit-5**

Central Conicoids: Ellipsoid, Hyperboloid of one and two sheets. Intersection of a conicoid and a line: Tangent line, tangent plane, condition of tangency, Director sphere. Normal: Equation of the normal, number of normals from a given point, cubic curve through the feet of the normal, cone through six normal. Polar plane and polar lines, Enveloping cone, Enveloping cylinder, Diameters and diametral planes, conjugate diameters and diametral planes.

### **Textbooks:**

1. Jain, P. K. and Ahmad, K. *Textbook of Analytical Geometry of two & three Dimensions*. New Age Publications, 2014.
2. Das, B. *Analytical Geometry and Vector Analysis*. Orient Book Company, 1995.

### **Reference books:**

3. Khan, R. M. *Analytical Geometry & Vector Analysis*. New Central Book Agency Pvt. Ltd., 2012.
4. Askwith, E. H. *A Course of Pure Geometry*. Creative Media Partners, LLC, 2022.
5. Spain, B. *Analytical Conics*. Dover, 2007.
6. McCrea, W. H. *Analytical Geometry of Three Dimensions*. Dover, 2006.

## **MSIN206: Introductory Linear Algebra (L2-T1-P0-CH3-CR3)**

### **Unit-1**

Vector spaces and Subspaces, Direct sum of subspaces, Quotient space.

Linear combination and Span, Linear Independence, Exchange lemma, Basis of a vector space and Dimension.

### **Unit-2**

Linear transformations and Linearly Independent Sets, Matrix representation of linear transformations, Transition matrix and similar matrices, Rank of a linear Transformation and Rank of a matrix.

### **Unit-3**

Eigen values and eigen vectors, Characteristic polynomial, Cayley-Hamilton Theorem. Diagonalizability.

### **Unit-4**

Inner Product in  $\mathbb{R}^n$  and spectral theorem for symmetric matrices.

### **Textbooks:**

1. Stephen, H. F., Arnold J. I. and Lawrence, E. S. *Linear Algebra*. Prentice Hall, 4<sup>th</sup> Edition, 2003.
2. Hoffman, K. and Kunze, R. *Linear Algebra*. Pearson India, 2015.

### **Reference books:**

3. Halmos, P. R. *Finite dimensional vector spaces*. Dover Publications, 2<sup>nd</sup> Edition, 2017.
4. Poole, D. *Linear Algebra: A modern introduction*. Cengage Learning, 4<sup>th</sup> Edition, 2014.

## **MSIN207: Introductory Topology** **(L2-T1 -P0 -CH3 -CR 3)**

### **Unit-1**

Definition and examples of metric spaces, Open ball, Neighborhoods, Limit points, Interior and boundary points, Open and closed sets, Closure and interior of a set, Equivalent metrics.

Subspaces, Cauchy sequences, Completeness, Cantor's intersection theorem, Baire's category theorem.

### **Unit-2**

Continuous functions, Uniform continuity, Isometry.

### **Unit-3**

Topological spaces, examples, basis and sub-basis, subspaces, closure, interior, exterior and boundary.

### **Unit-4**

Continuity, open functions, homeomorphisms, embeddings, strong and weak topologies.

### **Textbooks:**

1. O'Searcoid, M. *Metric Spaces*, Springer, 2007.
2. Shirali, S. and Vasudeva, H. L. *Metric Spaces*. Springer (India), 2009.
3. Munkres, J. R. *Topology: A first course (2/e)*, Pearson Education, 2018.

### **Reference Books:**

4. Kumersan, S. *Topology of Metric Spaces*, Narosa, 2011.
5. Simmons, G. F. *Introduction to Topology and Modern Analysis*. Mc-Graw Hill Education, 2017.

## **MSIN208: Programming, Algorithm and Mathematical Software (L2-T0-P1-CH4-CR3)**

### **Unit-1**

Algorithms and flowcharts. Divide and conquer strategy.

### **Unit-2**

Fundamentals of C: Data types in C, variables in C, input output statements, constant declaration, arithmetic operators in C, arithmetic expressions, assignment statements, arithmetic assignment operators, increment and decrement operators, type conversions, operator precedence.

### **Unit-3**

Basic techniques: sum of numbers, swapping contents of variables, computing area, simple interest etc. Decision making: if statement, if...else statement, the break statement, the continue statement, the go-to statement.

Looping techniques: for loop, while loop, do...while loop.

### **Unit-4**

Basic operations through Matlab, Input through keyboard and its illustration, Flow Control statements.

### **Unit -5**

Iterative Method for Solving Non-linear Equation, Numerical Integration, Numerical Solution of 1st order IVP. Numerical Differentiation and BVP.

### **Textbooks:**

1. Rajaraman, V. *Fundamentals of Computers*. PHI, 2004.
2. Venkateshmurthy, M. G. *Programming Techniques through C-A Beginner's Companion*, Pearson Education, 2011.
3. Pratap, R. *Getting Started with MATLAB : A Quick Introduction for Scientists and Engineers*. Oxford University Press, USA, 2010.
4. Otto, S. R. and Denier, J. P. *An Introduction to Programming and Numerical Methods in MATLAB*. Springer, 2009.

### **Reference books:**

5. Hunt, B. R., Lipsman, R. L., Osborn, John E. and Rosenberg, J. *Differential Equations with Matlab*. John Wiley & Sons, 3<sup>rd</sup> Edition, 2012.

## **MSIN301: Introductory Differential Equations** **(L2-T1 -P0-CH3 -CR3)**

### **Unit-1**

Reviews of first order ODE. Applications of first order ODE: Orthogonal and oblique trajectories, rate problems.

### **Unit-2**

Second order ODE: Wronskian. Statements and proofs of theorems on second order homogeneous linear equations. Applications of second order ODE: Free, undamped, damped, forced motion and resonance.

### **Unit-3**

Series Solutions for ODE, Types of singularity, Solution at an Ordinary Point, Solution at a Singular Point. Method of Frobenius.

### **Unit-4**

Laplace Transforms: Laplace Transforms and its application in solution of ordinary differential equations.

### **Unit-5**

Introduction, Origins of First order PDE, Cauchy Problem for First order equations, Linear equations of first order, Lagrange equation, Integral Surface passing through a given curve, surface orthogonal to a given system of surfaces.

### **Unit-6**

Nonlinear PDE of first order, Compatible systems of first order equation, Charpit's Method, special types of first order equations, solution satisfying given conditions.

### **Textbooks:**

1. Ross, S. L. *Differential Equations*. Wiley, 3<sup>rd</sup> edition, 2016.
2. Sneddon, I. *Elements of Partial Differential Equations*, Dover, 2006.
3. Pinchover, P. and Rubinstein, J. *An Introduction to Partial Differential Equations*. Cambridge University Press, 2005.



## **MSIN302: Statics and Dynamics** **(L2-T1-P0-CH 3-CR3)**

### **Unit-1**

Resolution and composition of forces, Coplanar forces, Moment of force and Couple. Centre of Mass, Centre of gravity of a plane area, arc and sector of a curve. Centre of gravity of solids and surface of revolution.

### **Unit-2**

Friction, laws of friction, limiting friction, equilibrium of a particle in rough inclined plane. System of pulleys. Stable and unstable equilibrium.

### **Unit-3**

Velocity and acceleration, Newton's laws of motion, velocity and acceleration in curvilinear coordinates, tangential and normal components of velocity, acceleration, momentum, force etc. Two-dimensional motion, motion of a projectile.

### **Unit-4**

Central force, reduced mass, angular momentum; motion under central force, inverse square law of motion, polar equation of orbit, Kepler's laws of motion.

### **Unit-5**

Periodic motion; Simple harmonic motion, Differential equation of simple harmonic motion and solution, Kinetic and Potential energies of Simple harmonic motion, Compound pendulum.

### **Textbooks:**

1. Whittaker, E. T. and McCrea, W. *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies: with an Introduction to the Problem of Three Bodies*. Kessinger Pub Co (30 October 2007).
2. Loney, S. L. *Elements of Statics & Dynamics, Part I, Statics* Fifth Edition (Twenty First Impressions), Alpha Edition (14 September 2020).

### **Reference books:**

3. Spiegel, M. R. *Schaum's Outline of Theory and Problems of Theoretical Mechanics: with an Introduction to Lagrange's Equations and Hamiltonian Theory*. McGraw-Hill, 2007.
4. Ramsey, A. T. *Dynamics*. The University Press, 2<sup>nd</sup> Edition, 2007.
5. Chorlton, F. *Textbook of Dynamics*. CBS; 2<sup>nd</sup> edition (1 January 2002).
6. Loney, S. L. *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. AITBS Publishers, 2016.
7. Rao, S. *Engineering Mechanics -Statics and Dynamics*. Pearson Education, 2005.

## **MSIN303: Numerical Methods** **(L2-T1 -P0 -CH3 -CR 3)**

### **Unit-1**

Finite Difference operators and their operations on functions of a single variable. Existence and uniqueness of interpolating polynomial, Lagrange interpolation, Newton divided difference, forward and backward interpolation, central difference interpolation and associated error terms. Extrapolation and inverse interpolation. Properties of divided differences.

### **Unit-2**

Roots of algebraic and transcendental equations: Bisection method, Secant method, Regula-Falsi method, Newton-Raphson method, their geometrical interpretation and derivation.

### **Unit-3**

Numerical differentiation, Richardson's extrapolation. Numerical integration: Newton-Cotes quadrature formula, Trapezoidal rule, Simpson's 1/3rd and 3/8th rule of integration. Use, interpretation and derivation. Composite Trapezoidal and Simpson's rules. Double integration.

### **Unit-4**

Solution of system of linear algebraic equations: Direct methods- Gauss elimination, pivoting and Gauss-Jordan methods. LU-factorization.

### **Textbooks:**

1. Atkinson, K. E. *An introduction to Numerical Analysis*. John Wiley and Sons, 2<sup>nd</sup> Edition, 2008.
2. Burden, R. L. and Faires, J. D. *Numerical analysis theory and applications*. Cengage Learning, 2015.
3. Jain, R. K. and Iyenger, S. R. K. *Advanced Engineering Mathematics*, Alpha Science International Ltd; 5th edition 2016.

### **Reference Books:**

4. Jain, M. K., Iyengar, S. R. K. and Jain R. K. *Numerical methods for Scientific and Engineering Computation*, New Age International (P) Ltd., New Delhi, 8<sup>th</sup> Edition 2022.
5. Sastry, S. S. *Introductory methods of Numerical Analysis*. Prentice Hall of India, 5<sup>th</sup> Edition, New Delhi, 2012.

## **MSIN304: Elementary Complex Analysis** (L2 -T1 -P0 -CH3 -CR 3)

### **Unit-1**

Complex numbers as ordered pairs, Geometric representation of complex numbers, Riemann sphere and Stereo graphic Projection.

### **Unit-2**

Continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations, harmonic functions.

### **Unit-3**

Elementary analytic functions (exponential function, trigonometric functions and logarithm function) and their mapping properties.

### **Unit-4**

Complex integration, Cauchy-Goursat theorem, Cauchy's integral formula.

### **Unit-5**

Cauchy's integral formula for derivatives, Cauchy's inequality and Liouville's theorem, the fundamental theorem of algebra, Maximum-modulus theorem, Morera's theorem.

### **Textbooks:**

1. Churchill R. V. and Brown, J. W. *Complex variables and applications*. McGraw-Hill Education (India) 9<sup>th</sup> Edition, 2021.
2. Mathews, J. H. and Howell, R. W. *Complex Analysis for Mathematics and Engineering*. Laxmi Publications, 6<sup>th</sup> Edition, 2011.
3. Ponnusamy, S. *Foundations of Complex Analysis*. Narosa Book Distributors Pvt Ltd., 2<sup>nd</sup> Edition, 2011.

### **Reference Books:**

4. Saff, E. B. and Snider, A. D. *Fundamentals of Complex Analysis with applications to Engineering and Science*, Pearson, 3<sup>rd</sup> Edition, 2019.

## **MSIN305: Combinatorics**

**(L2 -T1 -P0 -CH3 -CR 3)**

### **Unit-1**

Basic counting rules, Permutations: Allocation Problem, Circular and Ring Permutations, Generalized Permutations, Combinations: Allocation Problem, Pascal's formula, Generalized combinations, The Multinomial Theorem, Properties of Binomial Coefficients.

### **Unit-2**

Partitioning of a set, The Pigeonhole Principle: simple form, strong form, the inclusion-Exclusion principle, Calculating in two ways: Fubini's Principle, Derangements.

### **Unit-3**

Generating Functions: Ordinary generating Functions, Exponential generating Function.

### **Unit-4**

Recurrence Relations: Homogeneous Recurrence Relations, Inhomogeneous Recurrence Relation.

### **TextBooks:**

1. Balakrishnan, V. K. *Introductory Discrete Mathematics*. Dover Publications, New Edition, 2000.
2. Brualdi, R. A. *Introductory Combinatorics*. Pearson, 5<sup>th</sup> Edition, 2010.

### **Reference Books:**

3. K.H.Rosen, K. H. *Discrete Mathematics & its Applications*. Tata McGraw-Hill, 8<sup>th</sup> Edition, 2021.
4. S.Lipschutz, S. and Lipson, M. *Theory and Problems of Discrete Mathematics*. Schaum's Outline Series, McGraw-Hill, 3<sup>rd</sup> Edition.

## **MSIN306: Introduction to Optimization** **(L2 -T1 -P0 -CH3 -CR 3)**

### **Unit-1**

General linear programming problems, Standard form of L.P.P., Graphical method for L.P.P.

### **Unit-2**

Geometry of linear programming: Polyhedra and Convex sets, Extreme point, vertices and basic solutions, basic feasible solutions, convex function, Convex hull of a set, Convex polyhedrons, Existence of extreme points, optimality of extreme points.

### **Unit-3**

Supporting hyperplanes and extreme points, Development of Simplex method, Applications of Simplex Technique, Column geometry and the simplex method, Solution of Simultaneous Equations, Inverse of a Matrix by Simplex Method, Problem of Degeneracy. Revised simplex method.

### **Unit-4**

The dual Problem, duality theorem, comparison of solutions of primal and its dual. Standard form problems and the dual simplex method along with its limitations, Farkas' lemma and linear in equalities, Separating hyper plane and duality General linear programming duality.

### **Textbooks:**

1. Hadley, G. *Linear Programming*. Narosa Publishing House, New Delhi, 1987.
2. Swarup, K., Gupta, P. K. and Man Mohan, *Operation Research*. Sultan Chand & Sons, New Delhi, 13<sup>th</sup> Edition, 2007.
3. Bertsimas, D. and Tsitsiklis, J. N. *Introduction to linear Optimization*. Athena Scientific, 1997.

### **Reference Books:**

4. Taha, H. A. *Operation Research: An Introduction*. MacMillan, New York, 9<sup>th</sup> Edition 2014.
5. Kambo, N. S. *Mathematical Programming Techniques*. Affiliated East West Press, New Delhi, 2008.
6. Chong, E. K.P. and Zak, S. H. *An Introduction to Optimization*. Willey, 2013.

## **MSIN307: Ring Theory** **(L2 -T1-P0-CH3 -CR3)**

### **Unit-1**

Ring, properties of rings, subring, ideal and quotient ring.

### **Unit-2**

Integral domain, division ring, field, characteristic of ring.

### **Unit-3**

Ideal generated by a set, principal ideals, prime ideals, maximal ideals.

### **Unit-4**

Homomorphism, isomorphism and isomorphism theorems.

### **Unit-5**

Polynomial rings, Division algorithm and consequences, factorization of polynomials, reducibility and irreducibility tests.

### **Textbooks:**

1. Gallian, J. A. *Contemporary Abstract Algebra*. Narosa Publishing house, New Delhi, 9<sup>th</sup> Edition, 2019.
2. Dummit, D. S. and Foote, R. M. *Abstract Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 3<sup>rd</sup> Edition, 2011.
3. Musili, C. *Introduction to rings and modules*. Narosa, 2<sup>nd</sup> revised edition 2010.

### **Reference Books:**

4. Fraleigh, J. B. *A First Course in Abstract Algebra*. Pearson Education India, New Delhi, 7<sup>th</sup> Edition, 2013.
5. Herstein, I. N. *Topics in Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 2<sup>nd</sup> Edition, 2006.

## **MSIN308: Elementary Number Theory**

**(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit-1**

Divisibility, greatest common divisor, least Common multiple, Euclidean Algorithm.

Prime numbers, factorization in prime numbers, fundamental theorem of arithmetic.

### **Unit-2**

Divisor functions, perfect numbers, Mersenne numbers, Fermat numbers.

Greatest integer function (Gauss function), Mobius function, Euler function.

### **Unit-3**

Concept of congruences and its elementary properties, congruences in one unknown, complete residue system, reduced residue system.

### **Unit-4**

Diophantine equations, linear Diophantine equations, Pythagoras equation, sum of two squares.

### **Unit-5**

Order of an integer modulo  $n$ , Primitive roots, necessary and sufficient condition for the existence of primitive roots, construction of reduced residue system.

Quadratic residues and congruences of second degree in one unknown, Legendre symbol, Jacobi symbol, congruences of second degree with prime modulus and with composite modulus.

### **Unit-6**

Continued fractions, simple continued fractions, approximation of irrational numbers by continued fractions, solution of Pell's equation.

### **Textbooks:**

1. Burton, D. M. *Elementary Number Theory*. Tata McGraw-Hill, New Delhi, 7<sup>th</sup> Edition, 2017.
2. Niven, I. and Zuckerman, H. *An Introduction to the Theory of Numbers*. Wiley Eastern, New Delhi, 5<sup>th</sup> Edition, 2008.

### **Reference Books:**

3. Hardy, G. H. and Wright, E. M. *An Introduction to the Theory of Numbers*. Oxford University Press, 6<sup>th</sup> Edition, 2008.
4. Andrews, G. E. *Number Theory*, Dover Publications Inc.; New edition, 1994.
5. Telang, S. G. *Number Theory*. Tata McGraw-Hill, New Delhi, 2001.
6. Hsiung, Y. *Elementary Theory of Numbers*. World Scientific, 1992; First Indian Reprint, Allied Publishers Limited, 1995.

## **MSIN309: Analysis-II**

### **(L3-T1-P0-CH4-CR4)**

#### **Topic 1: Riemann Integration and series of functions**

##### **Unit-1**

Definition of Riemann integral using upper and lower Darboux sums; Definition of Riemann integration using Riemann sums; equivalence of the two definitions; Riemann integrability of monotone and continuous functions; Properties of the Riemann integral; Definition and integrability of piecewise continuous functions; Intermediate value theorem for integrals; Fundamental theorems of calculus.

##### **Unit-2**

Pointwise and uniform convergence of sequence of functions; Theorems on continuity, derivability and integrability of the sum function of a series of functions; Uniform Cauchy criterion for series; Power series and radius of convergence; Differentiation and integration of power series; Uniqueness of power series representation; Behavior of power series at the end points of its interval of convergence; Abel's theorem.

#### **Topic 2: Normed linear spaces**

##### **Unit-3**

Definition and properties of a norm; Discussion on the interplay between linear structure and metric structure of a normed space; Norms on  $R^n$  and  $C^n$ ; Complete and incomplete norms; The sequence spaces  $l^p$  ( $1 \leq p \leq \infty$ ); Norms on  $C[a, b]$ ; Definition of equivalent norms; Finite dimensional normed linear spaces and their properties.

##### **Unit-4**

Banach spaces and Schauder basis; Properties of Banach spaces; Hilbert spaces and orthonormal basis; Bounded linear operators and functionals on normed linear spaces; Dual space.

#### **Textbooks:**

1. Denlinger, C. G. *Elements of Real Analysis*. Jones & Bartlett India Pvt. Ltd. Student Edition, 2011(Reprinted 2015).
2. Kreyszig E. *Introductory Functional Analysis with Applications*. Wiley Student Edition, 2007.
3. Ross, K. A. *Elementary Analysis: The Theory of Calculus*. Undergraduate Texts in Mathematics, Springer, 2<sup>nd</sup> Edition (Indian Reprint), 2013.

#### **Reference Books:**

4. Bilodeau, G. G., Thie, P. R. and Keough, G. E. *An Introduction to Analysis*. Jones & Bartlett India Pvt. Ltd. Student Edition, 2<sup>nd</sup> Edition, 2010 (Reprinted 2015).
5. Ghorpade, S. R. and Limaye, B. V. (2006). *A Course in Calculus and Real Analysis*. Undergraduate Texts in Mathematics, Springer (SIE), 2<sup>nd</sup> Edition 2008.
6. Nair, M. T. *Functional Analysis: A First Course*. Prentice Hall of India, New Delhi. 2002.



# **MSIN310: Elementary Integral Transforms and Special Functions**

**(L3-T1 -P0-CH4 -CR4)**

## **Unit-1**

Bessel function and recurrence relations, Orthogonal sets of Bessel functions, Modified Bessel functions, Applications.

## **Unit-2**

Orthogonal polynomials: Legendre polynomials, Associated Legendre polynomials, Hermite polynomials, Laguerre polynomials, Chebyshev polynomial.

## **Unit-3**

Fourier Series, Generalized Fourier series, Fourier Cosine series, Fourier Sine series, Fourier integrals.

## **Unit-4**

Definition of Fourier Transform and Examples, Basic Properties of Fourier Transforms. Fourier sine Transform, Fourier cosine Transform. Linearity, Change of scale property, Shifting property, modulation theorem. Convolution Theorem for Fourier transform, Parseval's Identity. Finite Fourier Sine Transform, Finite Fourier Cosine Transform, Inversion formula for sine and cosine Transforms only statement and related problems.

## **Unit-5**

Mellin transform, Hankel transform, Z-transform

## **Textbooks:**

1. Whittaker E. T. and Watson G. N. *A course of Modern Analysis*. Merchant Books, Revised Edition 2008.
2. Andrews, L. C. and Shivamoggi, B. K. *Integral Transform for Engineers*. PHI, 2003.
3. Debnath, L. and Bhatta, D. *Integral transforms and their applications*. CRC Press, 3<sup>rd</sup> Edition, 2014.

## **Reference Books**

4. Wazwaz, A. M. *Linear and Nonlinear Integral Equations Methods and Applications*. Springer, 2011.

## **MSIN401: Abstract Algebra**

**(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit-1**

External direct product of groups, properties of external direct products, internal direct products, fundamental theorem of finite abelian groups and applications.

### **Unit-2**

Group action, properties of group action, class equation of finite groups, Sylow's theorems, applications of Sylow's theorems.

### **Unit-3**

Subnormal, normal series, derived group, solvable groups, composition series, Nilpotent groups, Jordan-Holder theorem.

### **Unit-4**

Word, reduced word, free group, rank of a free group, fundamental theorem of free groups, presentation of groups.

### **Unit-5**

Polynomial rings, rings of formal power series, embedding theorems, field of fractions.

### **Unit-6**

Factorization theory in integral domains, PID, UFD and Euclidean domains.

### **Unit-7**

Field extensions, algebraic and transcendental elements, geometrical constructions, splitting field, finite fields, structure of finite fields, normal, separable and inseparable extension of fields.

### **Textbooks:**

1. Gallian, J. A. *Contemporary Abstract Algebra*. Cengage India, 9<sup>th</sup> Edition, 2019.
2. Dummit, D. S. and Foote, R. M. *Abstract Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 3<sup>rd</sup> Edition, 2011.
3. Herstein, I. N., *Topics in Algebra*. John Wiley & Sons, Indian reprint, New Delhi, 2<sup>nd</sup> Edition, 2006.

### **Reference books:**

4. Fraleigh, J. B. *A First Course in Abstract Algebra*. Pearson Education India, New Delhi, 7<sup>th</sup> Edition, 2008.
5. Lang, S. *Algebra*. Springer India, New Delhi, 3<sup>rd</sup> Edition, 2006.

## **MSIN402: Linear Algebra**

**(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit-1**

Matrix representation of a linear transformation, Annihilating polynomial of a linear transformation; Elementary Canonical forms: diagonalization and triangulation of linear operators. Gerschgorin's disk theorem.

### **Unit-2**

Primary Decomposition theorem; rational and Jordan forms.

### **Unit-3**

Inner product spaces: inner product, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalization process.

### **Unit-4**

Linear functionals and adjoints; self-adjoint, positive definite, normal and unitary operators; orthogonal projections; spectral theorem for normal operators on a finite dimensional vector space, Singular value decomposition.

### **Unit- 6**

Bilinear forms, Matrices of bilinear forms, Symmetric bilinear forms, Diagonalization of symmetric matrices, positive and quadratic forms, Sylvester's law of inertia.

### **Textbooks:**

1. Stephen H. F., Arnold J. I. and Lawrence E. S., *Linear Algebra*. Prentice Hall, 4<sup>th</sup> Edition, 2003.
2. Halmos, P. R., *Finite dimensional vector spaces*. Springer Verlag, New York, 1987.
3. Hoffman, K. and Kunze, R. *Linear Algebra*. Prentice Hall, 2<sup>nd</sup> Edition, 2015.

### **Reference Books:**

4. Halmos, P. R. *Linear Algebra Problem Book*. The Mathematical Association of America (MAA), USA, 1995.
5. Williams, G., *Linear Algebra with Applications*. Jones and Burlet Publishers, 9<sup>th</sup> Edition, 2017.

## **MSIN403: Analysis-III** **(L3-T1-P0-CH4-CR4)**

### **Unit-1**

Sequence of functions, pointwise and uniform convergence, interchange of limits.  
Functions of bounded variation. Riemann Stieltjes integral. Integration by parts.

### **Unit-2**

Compactness, Sequential compactness, Bolzano-Weierstrass Property, Totally bounded spaces, compactness and completeness, finite intersection property. Continuous functions on compact spaces. Characterization of complete metric spaces. Arzela Ascoli Theorem.

### **Unit-3**

Connectedness, intermediate value theorem, Completeness, Bolzano Weierstrass Theorem, nested set theorem. Fixed point theorem. Completion.

### **Unit-4**

Functions of several variables, directional derivatives, differentiability and total derivative. Jacobians, chain rule, higher order partial derivatives, Taylor's theorem. Inverse function theorem, Implicit function theorem, extremum problem with constraints, Lagrange's method of multiplier.

### **Textbooks:**

1. Carothers, N. L. *Real Analysis*. Cambridge University Press, 2006.
2. Fleming, W. *Functions of several variables*. Springer, 2012.

### **Reference Books:**

3. Apostol, T. M. *Mathematical Analysis*. Narosa Publishing House, 2<sup>nd</sup> Edition, 2002.
4. Simmons, G. F. *Introduction to Topology and Modern Analysis*. Tata McGrawHill Book Co. Ltd., 2017.

## **MSIN404: Computer Programming+** **(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit-1**

Revision of fundamentals of C: Data types in C, variables in C, input output statements, constant declaration, arithmetic operators in C, arithmetic expressions, assignment statements, arithmetic assignment operators, increment and decrement operators, type conversions, operator precedence. for loop, while loop, do...while loop, if statement, if...else statement, switch statement, conditional operators. The break statement, the continue statement, the go-to statement.

### **Unit-2**

Arrays: Arrays, declaration of one-dimensional arrays, two dimensional arrays.  
Structures and Unions: User defined data types, structures, array of structures, unions, enumerated data type.

### **Unit-3**

Searching and Sorting: Bubble sort, selection sort, insertion sort, linear search and binarysearch.

### **Unit-4**

Function in C: Simple functions, passing arguments to functions with return value, call byvalue, call by reference, overloaded functions, inline functions, default arguments.

### **Unit-5**

Pointers: Introduction; accessing address of a variable; pointer declaration, initialization, accessing variable through pointer, chain of pointers; pointer expressions, increment and scale factor. Pointers and Arrays. Array of pointers. Pointers as function arguments.

### **Unit-6**

Files in C: Defining and opening a file, closing a file. Input/Output operations on files.

### **Unit-7**

Dynamic Memory Allocation and Linked list: Dynamic memory allocation, Malloc, Calloc, Free, Realloc. Concepts of linked list, advantages of linked list, types of linked list. Creating a linked list.

### **Textbooks:**

1. Rajaraman, V. *Fundamentals of Computers*. Prentice Hall of India, New Delhi, 6<sup>th</sup> Edition, 2014.
2. Balaguruswamy, E. *Programming in ANSI C*. Tata McGraw-Hill, 8<sup>th</sup> Edition, 2019.

### **Reference books:**

3. Kanetkar, Y. P. *Let us C*. BPB Publication, 15<sup>th</sup> Edition, 2016.
4. Venkateshmurthy, M. G. *Programming Techniques through C*. Pearson Education, 2002.

## **MSIN405: Lebesgue Measure and Integration** (L3 -T1 -P0 -CH4 -CR 4)

### **Unit-1**

Algebra of sets, Borel sets, Extended real numbers.

### **Unit-2**

Lebesgue measure on the Real Line: Lebesgue outer measure, Lebesgue Measurable sets and Lebesgue measure, Non-measurable sets.

### **Unit-3**

Lebesgue Measurable functions, Simple functions, Littlewood's principles.

### **Unit-4**

Lebesgue integral of simple functions, Lebesgue integral of bounded functions, Bounded convergence theorem, Comparison of Riemann and Lebesgue integral.

### **Unit-5**

Lebesgue integral of non-negative functions, Fatou's Lemma, Monotone convergence theorem, Lebesgue general integral, Lebesgue dominated convergence theorem.

### **Unit-6**

Convex function and Jensen's inequality,  $L_p$  spaces, Young, Holder and Minkowski inequalities, Completeness of  $L_p$  spaces, Bounded linear functionals on  $L_p$  spaces.

### **Textbooks:**

1. Royden, H. L. and Fitzpatrick, P. M. *Real Analysis*. Pearson, 4<sup>th</sup> Edition, 2015.
2. Barra, G. D. *Measure Theory and Integration*. New Age International(P) Ltd., New Delhi, 2<sup>nd</sup> Edition, 2013.

### **Reference books:**

3. Rana, I. K. *An Introduction to Measure and Integration*, Narosa Publishing House India, 2<sup>nd</sup> Edition, 2007.
4. Halmos, P. R. *Measure Theory*. Springer, 2008.
5. Jain, P. K., Gupta, V. P. and P. Jain. *Lebesgue Measure and Integration*, New Age International (P) Limited, New Delhi, 3<sup>rd</sup> Edition, 2019.

**MSIN406 Computer Laboratory**  
**(L0-T0-P1 -CH2 -CR 1)**

*Practical unit for the course MSIN404 Computer Programming.*

## **MSIN407: Complex Analysis**

**(L3-T1-P0-CH-CR 4)**

### **Unit-1**

Convergence of sequences and series, Absolute and uniform convergence of power series, Integration and differentiation of power series, uniqueness of series representations.

### **Unit-2**

Taylor series, Zeros of analytic functions, Limit points of Zeros, Singularities and their classification, Behaviour of the function in a neighbourhood of isolated singularities, Laurent's series, Residues, Cauchy Residue Theorem.

### **Unit-3**

Evaluation of improper integrals and definite integrals involving sines and cosines, integration through a branch cut.

### **Unit-4**

The winding number, Logarithmic residues and Rouché's theorem, the Argument Principle.

### **Unit-5**

Mapping by elementary functions, Linear fractional transformations, cross ratios, mappings of the half planes and circles, conformal mapping, Statement of Riemann Mapping Theorem.

### **Unit-6**

Schwarz Reflection Principle, Analytic continuation, Riemann Surfaces.

### **Textbooks:**

1. Conway, J. B. *Functions of One Complex Variable*. Springer, 2<sup>nd</sup> Edition, 1994.
2. Churchill, R. V. and Brown, J. W. *Complex Variables and Applications*, McGraw-Hill Education (India) Edition, 9<sup>th</sup> Edition, 2021.

### **Reference book(s)**

3. Ahlfors, L. V. *Complex Analysis*. McGraw-Hill Education (Indian) Edition, 3<sup>rd</sup> Edition, 2017.
4. Priestly, H. A. *Introduction to Complex Analysis*. Oxford University Press, 2<sup>nd</sup> Edition, 2005.
5. Gamelin, T. W. *Complex Analysis*. UTM, Springer, 2003.
6. Narasimhan, R. and Nievergelt, Y. *Complex Analysis in One Variable*. 2<sup>nd</sup> Edition, Springer (India), New Delhi, 2004.



## **MSIN408: Theory of Ordinary Differential Equations** **(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit -1**

Review of fundamentals of ODEs, Some basic mathematical models, direction fields, classification of differential equation, Solutions of some differential equation. 1<sup>st</sup> order non- linear differential equation.

Existence and Uniqueness problem, Gronwall's inequality, Peano existence theorem, Picard existence and uniqueness theorem, interval of definition.

### **Unit -2**

Second order linear differential equation, General solution for homogeneous equation, superposition of solutions, Methods of solution for non-homogeneous problem: undetermined coefficients, variation of parameters.

### **Unit -3**

n<sup>th</sup> order differential equation, system of equation, homogeneous system of equation, fundamental matrix, Abel-Liouville formula, System of non-homogeneous equations, Stability of linear systems.

### **Unit -4**

Theory of two-point BVP, Greens function, Greens matrix, properties of greens functions, Adjoint and self-adjoint BVP.

### **Unit -5**

Sturm-Liouville's problem, Orthogonal functions, eigen values & eigen functions, Completeness of the Eigen functions.

### **Unit -6**

Orthogonal trajectory of a system of curves on a surface solution of Pfaffian differential equations in three variables.

### **Unit -7**

Stability of linear and non-linear system: Classification of critical points, Lyapunov stability.

### **Textbooks:**

1. Boyce, W. E. and DiPrima, R. C. *Elementary Differential Equation and Boundary Value Problems*. John Wiley & Sons (Asia), 9<sup>th</sup> Edition, 2009.
2. Ross, S. L. *Differential Equations*. Wiley, 3<sup>rd</sup> edition, 2007.

### **Reference books:**

3. Simmons, G. F. *Differential Equations with Applications and Historical Note*. McGraw Hill, 2<sup>nd</sup> Edition, 2017.
4. Coddington, E. A. *An Introduction to Ordinary Differential Equations*. Dover Publications, 1989.
5. Farlow, S. J. *An Introduction to Differential Equations and Their Applications*. Dover Publications, 2006.

**MSIN409: Topology**  
(L3 -T1 -P0 -CH4 -CR 4)

**Unit-1**

Metric topology, Product and Box topology, Order topology, Quotient spaces.

**Unit-2**

Countability axioms: First countable spaces, Second countable spaces, separable spaces, Lindelof spaces.

**Unit-3**

Separation axioms: Hausdorff, Regular and Normal spaces, Urysohn's characterization of normality, Urysohn's metrization theorem, Tietze's extension theorem, Completely Regular spaces.

**Unit-4**

Compactness, limit point compactness, local compactness, one-point compactification

**Unit-5**

Tychonoff's product theorem, Stone-Cech compactification, Baire Spaces, Baire Category Theorem.

**Unit-6**

Connectedness, Local connectedness, Path connectedness, Components, Products of connected spaces.

**Textbooks:**

1. Munkres, J. R. *Topology*, Pearson Education India, 2<sup>nd</sup> Edition, 2015.
2. Willard, S. *General Topology*. Dover Publications, 2004.

**Reference Books:**

3. Joshi, K. D. *Introduction to General Topology*. New Age International Publishers, 2<sup>nd</sup> Edition, 2017.
4. Kelley, J. L. *General Topology*. Springer India, 2008.
5. Adams C. and Franzosa, R. *Introduction to Topology: Pure and Applied*. Pearson, 2009.

## **MSIN410: Numerical Analysis +** **(L3 -T1 -P0 -CH4 -CR 4)**

### **Unit-1**

Definition and sources of errors, Propagation of errors, Error analysis, Sensitivity and conditioning, Stability and accuracy, Floating-point arithmetic and rounding errors.

### **Unit-2**

Solution of system of linear algebraic equations: Iterative methods- Jacobi, Gauss-Seidel, Successive over-relaxation (SOR), symmetric SOR (SSOR). Numerical solution of non-linear simultaneous equations, Newton's method, General iteration method.

### **Unit-3**

Review of interpolation, Hermite interpolation. Spline interpolation, B-splines. Special emphasis on cubic spline.

### **Unit-4**

Approximation of function: The Weierstrass and Taylor theorem, Minimax and least square approximations, Orthogonal polynomials.

### **Unit-5**

Numerical solution of algebraic and transcendental equations: Methods based on first and second degree equations, rate of convergence. Theory of one-point iterative methods and its convergence analysis, multipoint iterative methods. Numerical evaluation of multiple roots.

### **Unit-6**

Overview of Newton-Cotes method. Composite integration. Gaussian quadrature, one point, two point and three point formulae. Orthogonal polynomials, Gauss-Legendre, Gauss-Hermite and Gauss-Laguerre quadrature formulae. Romberg integration.

### **Unit-7**

Solution of ordinary differential equations. Picard method, Euler method, backward Euler method, modified Euler method, Runge-Kutta class of methods.

### **Unit-8**

Solving problems with C codes.

### **Textbooks:**

1. Atkinson, K. E. *Introduction to Numerical Analysis*. Wiley India, 2<sup>nd</sup> Edition, 2008.
2. Jain, M. K., Iyengar, S. R. K. and Jain R. K. *Numerical methods for Scientific and Engineering Computation*. New Age International (P) Ltd., New Delhi, 6<sup>th</sup> edition, 2012.

### **Reference books:**

3. Sastry, S. S. *Introductory methods of Numerical Analysis*. Prentice Hall India, New Delhi, 5<sup>th</sup> Edition, 2012.
4. Hilderbrand, F. B. *Introduction to Numerical Analysis*. Dover Publications, 2<sup>nd</sup> Edition, 2003.
5. Conte, S. D. and Boor, Carl de. *Elementary Numerical Analysis - An Algorithmic Approach Updated with MATLAB*, SIAM, 2017.

## **MSIN411: Computer Laboratory**

**(L0 -T0 -P1-CH2 -CR 1)**

*Practical unit for the course MSIN416 Numerical Analysis.*