NATIONAL EDUCATION POLICY-2020

Syllabus of Mathematics

Degree with Research

(Graduation: VII and VIII Semester)

and

Post-Graduation

Sridev Suman Uttarakhand University

Badshahi Thaul (Tehri Garhwal) Uttarakhand -249199

(State University of Uttarakhand)

2023

Syllabus of Mathematics

Degree with Research

(Graduation: VII &VIII Semester)

and

Post-Graduation

(Board of Studies on July 11, 2023)

Curriculum Design Committee, Uttarakhand

S. No.	Name & Designation	
1.	Prof. N.K. Joshi Vice-Chancellor, Sridev Suman Uttarakhand University, Badshahi Thaul, Tehri Garhwal, Uttarakhand	**Chairman**
2.	Prof. Manmohan Singh Chauhan Vice-Chancellor, Kumaon University, Nainital,Uttarakhand	**Member**
3.	Prof. O.P.S. Negi Vice-Chancellor, Uttarakhand Open University	**Member**
4.	Prof. Jagat Singh Bisht, Vice-Chancellor, Soban Singh Jeena University, Almora	**Member**
5.	Prof Surekha Dangwal Vice-Chancellor, Doon University, Dehradun	**Member**
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	**Member**
7.	Prof. K.D. Purohit Advisor Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	**Member**

Sridev Suman Uttarakhand University
Badshahi Thaul, Tehri Garhwal (Uttarakhand)

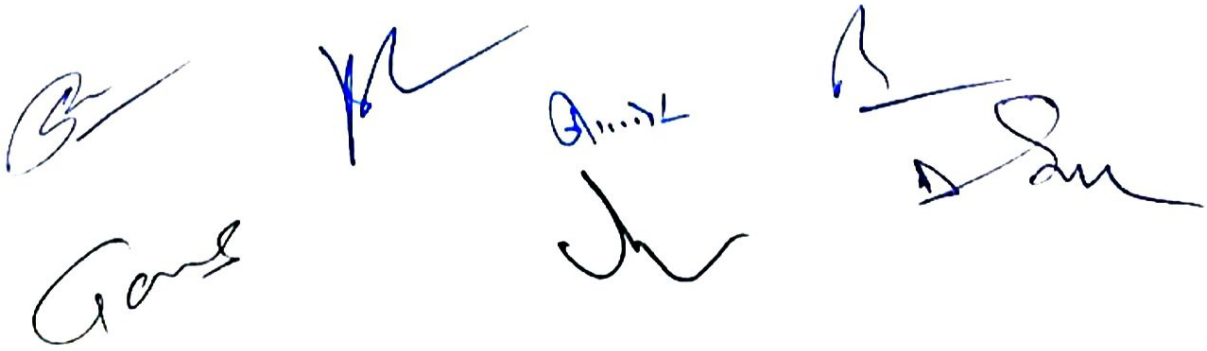
Department of Mathematics

Members of Board of Studies

	Name	Designation	Department	Board of Studies	Signature
1.	Prof. G. K. Dhingra	Dean Faculty of Science Pt. L.M.S. Campus Sridev Suman Uttarakhand University Rishikesh	Faculty of Science	Chairman	
2.	Director	Uttarakhand Science Education and Research Council	USERC	Member	
3.	Prof. K.S. Rawat	Professor and Head Department of Mathematics H.N.B. Garhwal Central University S.R.T. Campus, Tehri Garhwal, Uttarakhand	Mathematics	Member (External Expert)	
4.	Prof. Pushpa Negi	Principal Govt. P.G.College New Tehri	Higher Education	Member	
5.	Prof. Pankaj Pant	Principal, Govt. P.G.College Nagnath Pokhari	Higher Education	Member	11.7.2023
6.	Prof. Kuldeep Singh Negi	Principal, Govt. P.G. College, Khanpur(Haridwar)	Higher Education	Member	11.7.2023
5.	Prof. Anita Tomar	Professor & Head, Department of Mathematics Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh	Mathematics	Member	
6.	Prof. Dipa Sharma	Professor Department of Mathematics Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh	Mathematics	Member	
7.	Dr. Gaurav Varshney	Associate Professor, Department of Mathematics Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh	Mathematics	Member	
8	Dr. Dhirendra Singh	Assistant Professor, Department of Mathematics Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh	Mathematics	Member	11.7.23

Syllabus Preparation Committee

S.No.	Name	Designation	Department	Affiliation
1.	Prof. Anita Tomar	Professor & Head	Mathematics	Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh
2.	Prof. Dipa Sharma	Professor	Mathematics	Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh
3.	Dr. Gaurav Varshney	Associate Professor	Mathematics	Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh
4.	Dr. Dhirendra Singh	Assistant Professor	Mathematics	Pt. L.M.S. Campus, Sridev Suman Uttarakhand University Rishikesh
5.	Dr. Deepak Singh	Assistant Professor	Mathematics	B.L.J. Govt. (P.G.) College Purola, Uttarkashi

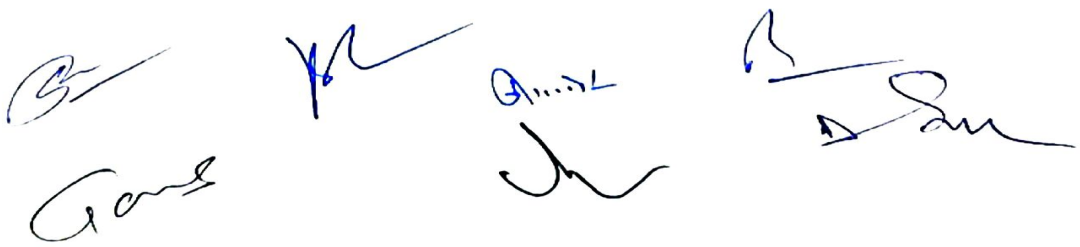


Year	Semester	Paper Title	Course Code	CREDIT (L+P+T)	No. of Lectures
UG-"Fourth Year" / PG-"First Year"	UG-VII / PG-I Sem.	Discrete Mathematics	MTH101	5 (4+0+1)	Theory = 4 Tutorial = 1
		Abstract Algebra	MTH102	5 (4+0+1)	Theory = 4 Tutorial = 1
		Real Analysis	MTH103	5 (4+0+1)	Theory = 4 Tutorial = 1
		Differential Geometry and Tensor Calculus	MTH104	5 (4+0+1)	Theory = 4 Tutorial = 1
		Research Project	MTH105	4 (4+0+0)	
	UG-VIII / PG-II Sem	Linear Algebra	MTH201	5 (4+0+1)	Theory = 4 Tutorial = 1
		Complex Analysis	MTH202	5 (4+0+1)	Theory = 4 Tutorial = 1
		Differential Equations	MTH203	5 (4+0+1)	Theory = 4 Tutorial = 1
		Operations Research-I	MTH204	5 (4+0+1)	Theory = 4 Tutorial = 1
		Research Project	MTH205	4 (4+0+0)	

Year	Semester	Paper Title		CREDIT (L+P+T)	No. of Lectures
"PG- "Second Year"	UG-IX / PG-III Sem	Number Theory	MTH301	5 (4+0+1)	Theory = 4 Tutorial = 1
		Topology	MTH302	5 (4+0+1)	Theory = 4 Tutorial = 1
		Measure Theory	MTH303	5 (4+0+1)	Theory = 4 Tutorial = 1
		Open Elective Course -1	MTH304	5 (4+0+1)	Theory = 4 Tutorial = 1
		Research Project	MTH305	5 (4+0+1)	
	UG-X / PG-IV Sem	Functional Analysis	MTH401	5 (4+0+1)	Theory = 4 Tutorial = 1
		Special Functions	MTH402	5 (4+0+1)	Theory = 4 Tutorial = 1
		Calculus of Variations and Integral Equations	MTH403	5 (4+0+1)	Theory = 4 Tutorial = 1
		Open Elective Course -2	MTH404	5 (4+0+1)	Theory = 4 Tutorial = 1
		Research Project	MTH405	4 (4+0+0)	

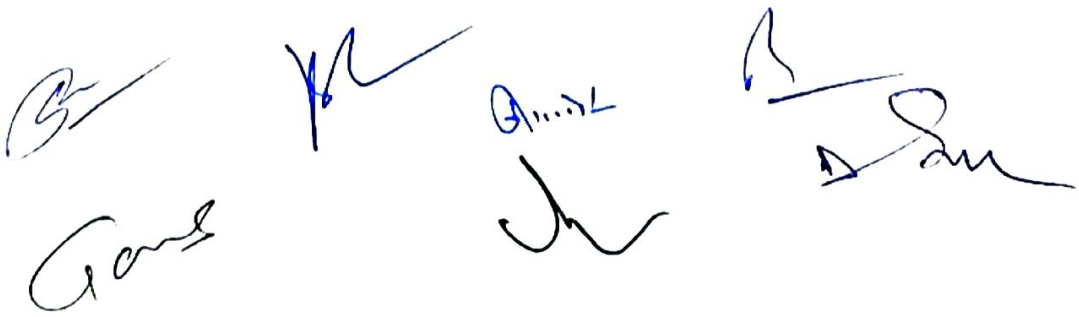
List of Open Elective Courses

Elective Courses	Paper Title		CREDIT (L+P+T)
Open Elective Course -1	Algebraic Topology	MTH304	5 (4+0+1)
	Fluid Mechanics	MTH305	5 (4+0+1)
	Mathematical Statistics	MTH306	5 (4+0+1)
	Combinatorial Mathematics	MTH307	5 (4+0+1)
	Operations Research-II	MTH308	5 (4+0+1)
Open Elective Course -2	Dynamics of Rigid Bodies	MTH404	5 (4+0+1)
	Algebraic Coding Theory	MTH405	5 (4+0+1)
	Algebraic Number Theory	MTH406	5 (4+0+1)
	Fuzzy Set Theory	MTH407	5 (4+0+1)
	Mathematical Modeling	MTH408	5 (4+0+1)
MINOR/ADDITIONAL/INTERDISCIPLINARY / MULTIDISCIPLINARY COURSE IN MATHEMATICS			
UG-FOURTH YEAR/ PG-FIRST YEAR	**VII/ VIII Semester**	Research Methodology	**MEC03**	**4 (3+0+1)**



Examination Pattern

1. The students will be required to take both internal and external examinations. The external examination will carry a weightage of 75 marks while the internal examination will carry a weightage of 25 marks. Passing/qualifying marks are as per university norms.
2. There are no minimum passing marks in the internal examination (i.e., Even if a student gets *0 marks in internal examination* but gets minimum passing marks in total (out of *100 =25 internal +75 external*), then candidate is considered pass/qualified).
3. There will be ***no grace marks***.

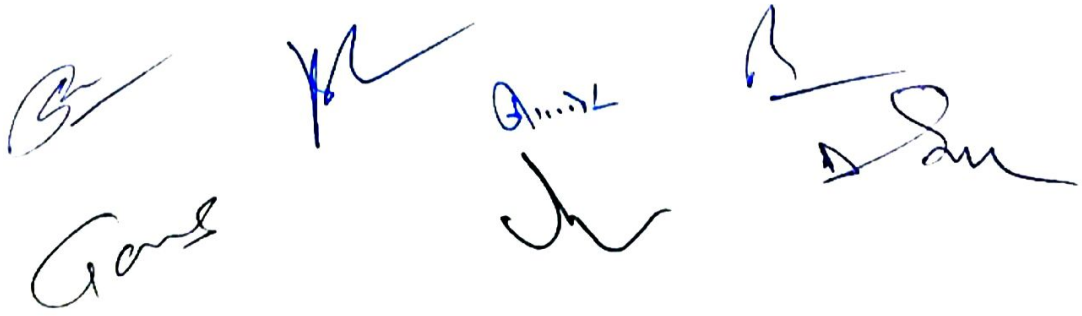


Program Outcomes

1. Foster critical thinking skills and enable students to objectively conduct scientific investigations, evaluating practices and theories through mathematical approaches.
2. Cultivate students' ability to formulate hypotheses, model solutions, validate findings, and draw conclusions.
3. Develop effective communication skills for expressing mathematical ideas.
4. Illuminate the importance of utilizing mathematical knowledge to serve society and empower students to make a positive impact.
5. Equip students with quantitative and analytical reasoning skills for practical application.
6. Foster self-learning habits through self-directed study, peer discussions, and adaptability to evolving academic environments.
7. Cultivate teamwork and leadership qualities, enabling students to function effectively as individuals and leaders in diverse situations.
8. Prepare students for research pursuits in various mathematical fields and careers focused on research.
9. Instill moral and ethical values in students' behavior and professional lives.

Program Specific Outcomes

1. Apply mathematical concepts, tools, and techniques to solve real-world problems in interdisciplinary fields.
2. Deepen their understanding of abstract mathematical concepts and explore avenues for further investigation.
3. Mathematically model real-world problems and utilize findings to enhance quality of life.
4. Identify challenging mathematical problems and engage in their resolution.
5. Pursue research in pure or applied mathematics.
6. Dedicate themselves to acquiring mathematical knowledge and skills necessary for professional activities, while adhering to the highest ethical standards.
7. Qualify for national-level tests such as NET/GATE, etc.
8. Effectively communicate mathematical ideas and contribute to the propagation and popularization of mathematics in society.

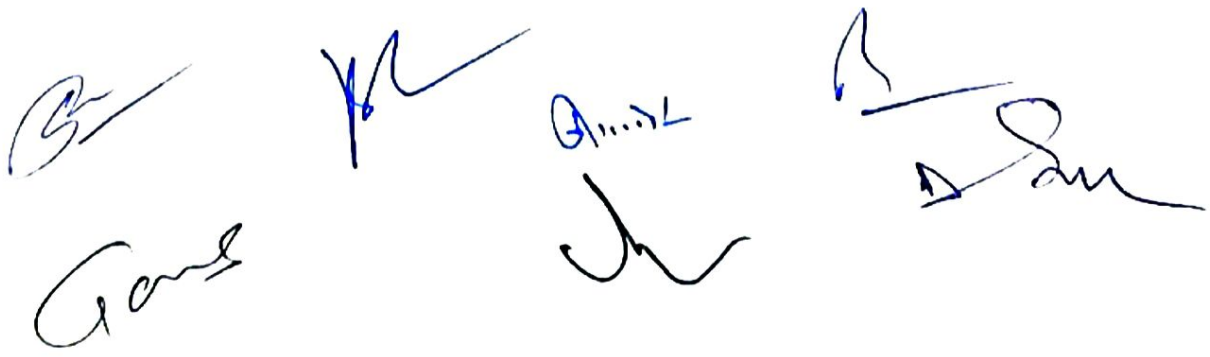


Detailed Syllabus of Degree with Research /Post Graduation Courses

First Semester

MTH101 - Discrete Mathematics
Unit 1. Principle of mathematical induction partially ordered sets, Lattices: Lattices as partially ordered sets, Their Properties, Lattices, and algebraic systems, Principle of duality, Sub lattices, Complete, Complemented and Distributive lattices.
Unit 2. Boolean algebra, Boolean functions, Boolean expressions, Applications to switching circuits.
Unit 3. Elements of graph theory: Basic terminology, Paths and circuits, Eulerian and Hamiltonian graphs, planar graphs, Directed graphs.
Unit 4. Trees: Rooted trees, Path lengths, spanning trees, minimum spanning trees.
Books Recommended: 1. C. L. Liu: "Elements of Discrete Mathematics", Tata McGraw Hill Education,2008. 2. Ram Babu: "Discrete Mathematics", Pearson Edition India, 2011. 3. Lipschutz: "Discrete Mathematics", Tata McGraw Hill, 2011.

MTH102 - Abstract Algebra
Unit 1. Introductions of group, Relation of conjugacy, Conjugate class of a group, Class equation, Lagrange's theorem, Cayley's theorem, Sylow's theorem and its applications.
Unit 2. Normal and subnormal series, Composition series, Jordan Holder theorem, Chain conditions, Commutators. Solvable groups, solvability of subgroups and factor groups, Nilpotent groups, and their equivalent characterizations.
Unit 3. Rings, ideals, prime and maximal ideals, quotient rings. Factorization theory in commutative domains, Prime and irreducible elements, Euclidean Domains, Principal Ideal Domain, Divisor chain condition, Unique Factorization Domains, examples, and counter examples, Polynomial rings over domains, Eisenstein's irreducibility criterion, Unique factorization in polynomial rings over U.F.D.s.
Unit 4. Fields, Finite fields, Field extensions, Galois group.
Books Recommended: 1. J.A. Gallian - "Contemporary Abstract Algebra", Narosa Publication. 2. N. Jacobson - "Basic Algebra", Vol.1, Hindustan Publishing Co., New Delhi. 3. Ramji Lal - "Fundamentals in Abstract Algebra", Chakra Prakashan, Allahabad, 1985. 4. I.N. Herstein - "Topics in Algebra", Wiley Eastern Ltd., N.D., 1975. 5. D.S. Dummit and R.M. Foote - "Abstract Algebra", John Wiley, N.Y. 6. J.B. Fraleigh - "Abstract Algebra", Narosa Publication.



MTH103 - Real Analysis

Unit 1. Functions of several variables: Concept of functions of two variables, Simultaneous and iterated limits in functions of two variables, Partial derivatives: Definition and examples, Existence and continuity, Interchange of order of differentiation, Directional derivatives.

Unit 2. Composite functions, Continuity of function of two variables, Differentiability of functions of two variables, Taylor's Theorem.

Unit 3. Definition and examples of metric space, pseudo metric, discrete and usual metric space, diameter of a set. Open and closed sets in a metric space, Interior point, Limit point, Adherent point, Closed set, Neighbourhood, Closure of a set, Interior of a set, Bolzano-Weirstrass theorem, Complete metric space, Cauchy sequence, Convergent sequence, Bounded Sequence.

Unit 4. Separated sets, Connected and disconnected sets, Continuity and connectedness, Compactness, Compactness and uniform continuity, Continuity and Uniform continuity in a metric space.

Books Recommended:

1. S.C. Malik and Savita Arora: "Mathematical Analysis".
2. W. Rudin: "Principles of Mathematical Analysis".
3. T.M. Apostol: "Mathematical Analysis".
4. S.K. Mapa: "Introduction to Real Analysis"
5. Terence Tao: "Real Analysis"
6. J. R. Munkres: "Analysis on Manifolds".
7. E.T.Copson, "Metric Space"

MTH104 - Differential Geometry and Tensor Calculus

Unit 1. Curve in space, parameterized curves, Regular curves, Helices, Arc length, Re-parameterization (byarc length), Tangent, Principal normal, Binormal, Osculating plane, Normal plane, Rectifying plane, Curvature torsion of smooth curves, Serret-Frenet formulae, Frenet approximation of space curve.

Unit 2. Order of contact, Osculating circle, Osculating sphere, Spherical indicatrices, Involutes and Evolutes, Bertrand Curves, Intrinsic equations of space curves, Isometries of R^3, Fundamental theorem of space curves, Surfaces in R^3.

Unit 3. Curvature of curves on surfaces, Normal curvature, Principal curvatures, Geometric interpretation of principal curvatures, Euler theorem, Mean curvature, Lines of curvature, Rodrigue's formula, Umbilical points, Minimal surfaces, Definition and examples, Gaussian curvature, Intrinsic formulae for the Gaussian curvature, Isometries of surfaces.

Unit 4. n-dimensional real vector space, Covariant vectors, Contravariant vectors, Kronecker delta, Fundamental algebraic operations: Addition, Multiplication, Tensor product, Dual vector space, Second order tensors, Tensors of type (r, s), Symmetry and Skew symmetry of tensors, Contraction, and Inner product, Quotient law of tensors, Christoffel symbol.

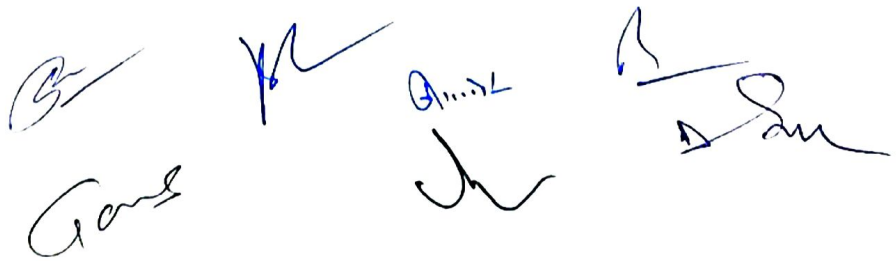
Books Recommended:

1. C.E. Weatherburn: "Riemannian Geometry and Tensor Calculus".
2. Andrew Pressley: "Elementary Differential Geometry".
3. J.A. Thorpe: "Elementary Topics in Differential Geometry".
4. D. Somasundaram: "Differential Geometry, A First Course".
5. T.J. Willmore: "An Introduction to Differential Geometry".
6. N. J. Hicks, Notes on Differential Geometry, Van Nostrand.

Second Semester

MTH201 - Linear Algebra
Unit 1. A brief review of vector space, Inner products, Orthogonality, Best approximations, Projections, Cauchy-Schwartz inequality.
Unit 2. Adjoint of a linear transformation, Self-adjoint transformations, Unitary operators. Normal operators: Definition and properties and Spectral theorem.
Unit 3. Eigen vectors and eigen values of a linear operator, Minimal polynomial of a linear operator and its relations to characteristic polynomial, Cayley-Hamilton theorem.
Unit 4. Bilinear forms, Symmetric and skew-symmetric bilinear forms, Groups preserving bilinear forms.
Books Recommended: 1. Sheldon Axler - "Linear Algebra Done Right". 2. Kenneth Hoffman and Ray Kunze - "Linear Algebra". 3. Serge Lang - "Linear Algebra". 4. Gilbert Strang - "Linear Algebra and its Applications". 5. Hadley - "Linear Algebra". **6.** H. Helson - "Linear Algebra", Hindustan Book Agency, New Delhi, 1994.

MTH202- Complex Analysis I
Unit 1. Conformal mappings, Power series representation of analytic functions, Analytic functions as mappings, Riemann sphere, Linear transformations, Mobius transformation, Cross ratios, Mobius transformation on circles.
Unit 2. Analytic Continuation: Direct Analytic Continuation, Monodromy theorem, Poisson Integral Formula, Analytical Formula, Analytical Continuation via Reflection.
Unit 3. Entire functions, Hadmard's three circle theorem, Meromorphic functions, The argument principle, Rouche's theorem, Schwarz lemma, The open mapping theorem.
Unit 4. Linen of half planes in complex plane, Extended complex plane, Stereographic projection. Maximum modulus principle, Little Picard Theorem, Great Picard Theorem.
Books Recommended: 1. Lars V. Ahlfors - "Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable", McGraw-Hill Education. 2. John B. Conway - "Functions of One Complex Variable I". 3. Walter Rudin - "Real and Complex Analysis". 4. S. S. Ponnusamy and Silverman J. - "Complex Variables with Applications". 5. Denish G. Zill and Patrick D. Shanahan - "Complex Analysis", Jones & Bartlett Learning. 6. D. Sarason - "Complex Function Theory", Hindustan Book Agency, Delhi, 1994.



MTH203- Differential Equations

Unit 1. Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, Singular solutions of first order ODEs, System of first order ODEs., General theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function, Wronskians.

Unit 2. Formation of P.D.Es. First order P.D. Es, Classification of first order, P.D.Es, Complete, general and singular integrals, Lagrange's or quasi-linear equations, Integral surfaces through a given curve. Orthogonal surfaces to a given system of surfaces, Characteristic curves.

Unit 3. Pfaffian differential equations, Compatible systems, Charpit's method, Jacobi's Method. Cauchy problem for first order PDEs.

Unit 4. Classification of second order P.D.Es, Linear PDEs equations with constant coefficients, General solution of higher order PDEs with constant coefficients, Reduction to canonical forms.

Books Recommended:

1. M.D. Raisinghania - "Advanced Differential Equations".
2. D.P. Choudhary and H.I. Freedman - "A Course in Ordinary Differential Equations".
3. T. Amaranath - "An Elementary Course in Partial Differential Equations".
4. Erwin Kreyszig - "Advanced Engineering Mathematics".
5. S. L. Ross - "Differential Equations", Wiley Publications.
6. G. F. Simmons - "Differential Equations with applications and historical notes", CRC Press.

MTH204- Operations Research

Unit 1. Introduction to Operations research, methodology of Operations research, Features of Operations research problems, Different models in Operations research, Opportunity and shortcomings of Operations research's approach.

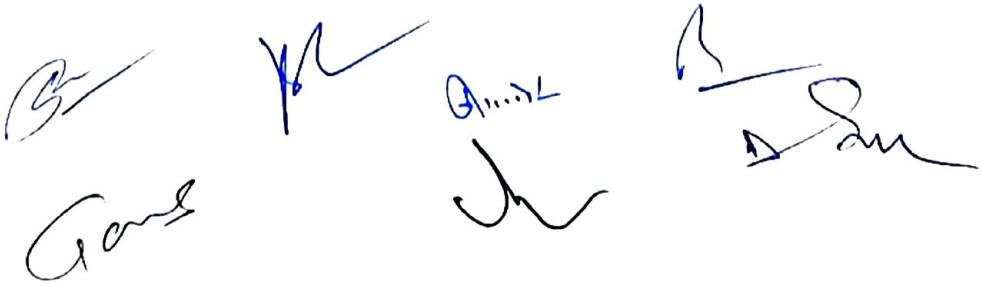
Unit 2. Game theory: two persons zero sum game, game with saddle points, rule of dominance; algebraic, graphical and linear programming, concept of mixed strategy. Sequencing problems: processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Unit 3. Revised simplex method and bounded variable problems. Pure and Mixed Integer Programming, Gomory's cutting plane method for Integer Programming, Fractional Cut Method, Sensitivity analysis.

Unit 4. Dynamic Programming under certainty, Nonlinear Programming Method, Quadratic Programming, Kuhn-Tucker conditions.

Books Recommended:

1. Hamdy A. Taha: "Operations Research: An Introduction".
2. Wayne L. Winston: "Operations Research: Applications and Algorithms".
3. Richard Bronson: "Operations Research: A Practical Introduction".
4. Kanti Swarup, P.K. Gupta, Man Mohan: "Operations Research: Theory and Applications".
5. S. Kalavathy: "Operations Research".
6. S. S. Rao: "Optimization Theory and Applications" , Wiley Eastern.



Third Semester

MTH301- Number Theory

Unit 1. Arithmetical Functions and its Averages-Arithmetical functions, The Mobius function $\mu(n)$, Euler totient function $\varphi(n)$, A relation connecting μ and A product formula for $\varphi(n)$, Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula.

Unit 2. The Mangoldt function $\Lambda(n)$, Multiplicative functions, Multiplicative functions and Dirichlet multiplication ,The inverse of a completely multiplicative function, Liouville's function $\lambda(n)$,The divisor function $\sigma_\alpha(n)$, Generalised convolution, Derivatives of arithmetical functions, The Selberg identity, Averages of arithmetical functions.

Unit 3. Some elementary theorems on distribution of prime numbers -Chebyshev's functions $\psi(x)$ and $\vartheta(x)$, Relations connecting $\vartheta(x)$ and $\pi(x)$, Some equivalent forms of the prime number theorem, Inequalities for $\pi(n)$ and p_n, Shapiro's Tauberian theorem, Applications of Shapiro's theorem , asymptotic formula for the partial sums , The partial sums of the Mobius function.

Unit 4. Quadratic Residues- Definition and Examples, Legendre's symbol and its properties, Evaluation of $(-1|p)$ and $(2 \mid p)$, Quadratic reciprocity law, Jacobi symbol.

Books Recommended:

1. Ivan Niven, Herbert S. Zuckerman, and Hugh L. Montgomery – "An Introduction to the Theory of Numbers".
2. G. H. Hardy and E. M. Wright – "An Introduction to the Theory of Numbers".
3. Kenneth Ireland and Michael Rosen – "A Classical Introduction to Modern Number Theory".
4. Neal Koblitz – "A Course in Number Theory and Cryptography".
5. Harold Davenport – "The Higher Arithmetic: An Introduction to the Theory of Numbers".
6. D.M. Burton: "Elementary Number Theory", 6thEdition, Tata McGraw Hill.
7. Apostol T.M., Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi, 1990.
8. W. Stallings: Cryptography and Network Security-Principles and Practices; PHI; 2004

MTH302- Topology

Unit 1. Basic concepts in Topology: Topology on a set, a topological space with examples, topologies on the real number system.

Unit 2. Neighborhood of a point/set, Open and closed sets, interior, boundary, closure, limit point, Derived sets of a set, Base and sub-base of a topology, Separable Spaces, First and Second Countable spaces.

Unit 3. Continuous map, open and closed maps, homeomorphisms, Topological invariants, Pasting Lemma, Subspaces, product spaces, quotient space.

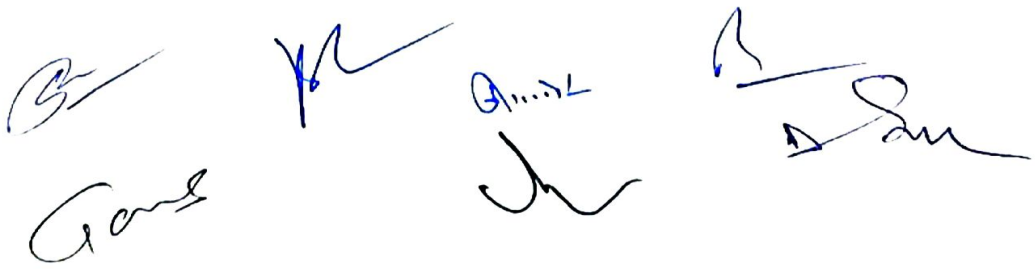
Unit 4. Connectedness and disconnected space, Path-wise connected space, Compactness- Compact spaces, Compactness of a metric space, Local compactness, Tychonoff's Theorm, Components, Separation axioms: regular space, T_0, T_1, T_2, spaces etc., Normal and completely regular space, Finite intersection property.

Books Recommended:

1. James R. Munkres – "Topology".
2. John McCleary – "A First Course in Topology: An Introduction to Mathematical Thinking".
3. C. Wayne Patty – "Foundations of Topology".
4. Ryszard Engelking – "General Topology".
5. Terence Tao: "Basic concepts in Topology".
6. G. F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Education.

MTH303- Measure Theory
Unit 1. Countable sets, uncountable sets, Relation between the cardinality of a non-empty set and the cardinality of its power set, Boolean ring, σ-ring, Boolean algebra and σ-algebra of sets, Set function.
Unit 2. Measure and outer measure, Measurable sets and Lebesgue measure, Example of non-measurable sets, Measurable functions.
Unit 3. The Lebesgue integral, The Lebesgue integral of a bounded and unbounded function over a set of finite measure, First Mean Value Theorem, The integral of nonnegative functions. Cantor's trinary sets, The general Lebesgue integral, Convergence in measure.
Unit 4. Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, convex functions.
Books Recommended: 1. H. L. Royden and P. M. Fitzpatrick,"Real Analysis" (4th Edition). 2. Terence Tao , "An Introduction to Measure Theory". 3. Patrick Billingsley , "Probability and Measure" (3rd Edition). 4. I. K. Rana, An Introduction to Measure and Integration, Narosa. 5. P. K. Jain: "Measure Theory", New Age International.

MTH304- Algebraic Topology
Unit 1. Basic definitions and concepts of point-set topology, Homotopy and homotopy equivalence, Fundamental group and its properties
Unit 2. Simplicial complexes and their properties, Simplicial homology and chain complexes, Singular homology and the singular chain complex
Unit 3. Homology groups of spheres, torus, and other spaces, Homology operations and long exact sequences, Applications of homology to classification of spaces
Unit 4. Homotopy groups and higher homotopy groups, CW-complexes and cellular homology, Category theory and its relation to algebraic topology
Books Recommended: 1. G.E. Bredon: "Geometry and Topology", Springer 2014. 2. J.J. Rotman: "An Introduction to Algebraic Topology", Springer 2011. 3. E.H. Spainer: "Algebraic Topology" Springer 1989. 4. Marcelo Aguilar: "Algebraic Topology from a Homotopical Viewpoint", Springer 2002. 5. James R. Munkres – "Topology".



MTH305- Fluid Mechanics

Unit 1: Classification of fluids, Continuum model, Eulerian and Lagrangian approach of description, Differentiation following the fluid motion, Irrotational flow, Vorticity vector, Equipotential surfaces, Streamlines, path lines and streak lines of particles, Stream tube and stream surface, Mass flux density, Conservation of mass leading to equation of continuity (Euler's form), Boundary surface, Conservation of momentum and its mathematical formulation (Euler's form), Integration of Euler's equation under different conditions, Bernoulli's equation, Steady motion under conservative body forces.

Unit 2: Theory of irrotational motion, Kelvin's minimum energy and Circulation theorems,Potential theorems, Two-dimensional flows of irrotational, incompressible fluids, Complex potential, Sources, Sinks, Doublets and Vortices, Milne-Thomson circle theorem, Images with respect to a plane and circles, Blasius theorem.

Unit 3: Three-dimensional flows, Sources, sinks, doublets, Axis-symmetric flow and Stokes stream function, Butler sphere theorem, Kelvin's inversion theorem, Weiss's sphere theorem, Images with respect to a plane and sphere, Axis-symmetric flows and stream function, Motion of cylinders and spheres.

Unit 4: Viscous flow, stress and strain analysis, Stokes hypothesis, Navier-Stokes equations of motion, Some exactly solvable problems in viscous flows, Steady flow between parallel plates, Poiseuille flow, Steady flow between concentric rotating cylinders.

Books Recommended:

1. F. Chorlton: "Text Book of Fluid Dynamics", CBS Publisher, 2005.
2. R.W. Fox, P.J. Pritchard and A.T. McDonald: "Introduction to Fluid Mechanics", Seventh Edition, John Wiley & Sons, 2009.
3. P.K. Kundu, I.M. Cohen, D.R. Dowling: "Fluid Mechanics", Sixth Edition, Academic Press, 2016.

MTH306- Mathematical Statistics

Unit 1: Elements of probability, Sample space, Discrete probability, Baye's theorem, Random variables and distribution functions, Mathematical expectations and moments.

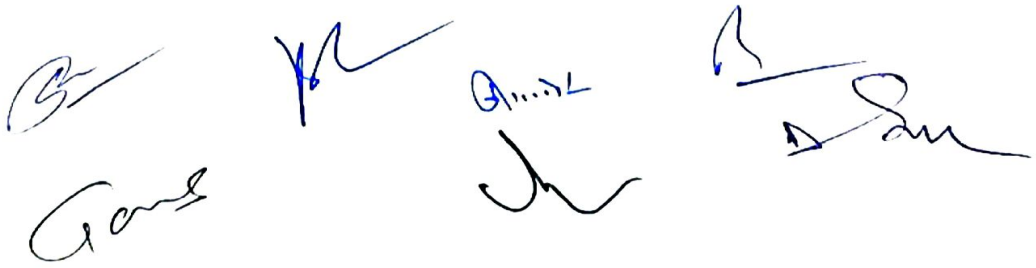
Unit 2: Some standard discrete and continuous univariate distributions: Binomial, Poisson, Normal, Gamma and Beta distributions.

Unit 3: Correlation, Rank correlation, Regression line, Multiple and Partial correlation of three variables only, Data reduction techniques, Canonical correlation.

Unit 4: Concepts of sampling, Stratified sampling and systematic sampling, Test of hypothesis: t, z , Chi square test.

Books Recommended:

1. S.C. Gupta and V.K. Kapoor: "Fundamental of Mathematical Statistics", S. Chand.
2. M.G. Kandall: "Advanced Theory of Statistics"
3. C.E.Weatherburn: "A first Course on Mathematical Statistics", Cambridge Univ. Press, 1968.



MTH307- Combinatorial Mathematics

Unit 1. Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, counting subsets, Set-partitions, Stirling numbers

Unit 2. Principle of Inclusion and Exclusion, Derangements, Inversion formulae.
Generating functions: Algebra of formal power series, generating function models, Calculating generating functions, Exponential generating functions. Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

Unit 3. Integer partitions, Systems of distinct representatives. Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

Unit 4. Latin squares, Hadamard matrices, Combinatorial designs: t designs, BIBDs, Symmetric designs.

Books Recommended:

1. J. H. van Lint, R. M. Wilson: "A Course in Combinatorics".
2. Krishnamurthy, V.: "Combinatorics: Theory and Applications".
3. Cameron, P. J.: "Combinatorics: Topics, Techniques, Algorithms".
4. Sane, S. S.: "Combinatorial Techniques".
5. Brualdi, R. A.: "Introductory Combinatorics".
6. Hall, M. Jr.: "Combinatorial Theory".

MTH308- Operations Research-II

Unit 1. Inventory Control, Functional Role of inventory control, Classification of EOQ models with shortages and without shortages.

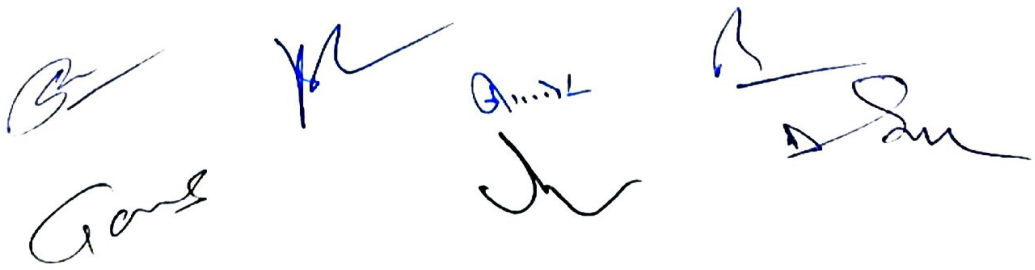
Unit 2. Queuing Theory, Characteristics of Queuing System, Probability distribution in Queuing System, Single served Queuing model, M/M/1 Queuing models, Multiple server queuing models.

Unit 3. Markov Chain, Application of Markov analysis, State and transition probabilities.

Unit 4. Network flow problem, minimal spanning tree problem, shortest route problem, Maximal flow problem, Minimum cost flow problems, Critical path analysis, PERT and CPM.

Books Recommended:

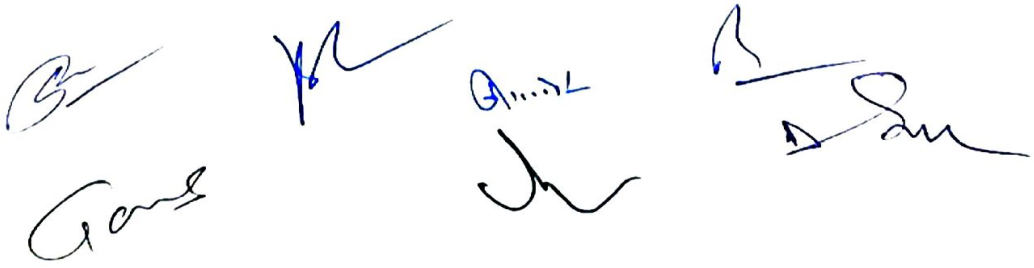
1. Hamdy A. Taha: "Operations Research: An Introduction".
2. Wayne L. Winston: "Operations Research: Applications and Algorithms".
3. Richard Bronson: "Operations Research: A Practical Introduction".
4. Kanti Swarup, P.K. Gupta, Man Mohan: "Operations Research: Theory and Applications".
5. S. Kalavathy: "Operations Research".
6. S. S. Rao: "Optimization Theory and Applications" , Wiley Eastern.



Fourth Semester

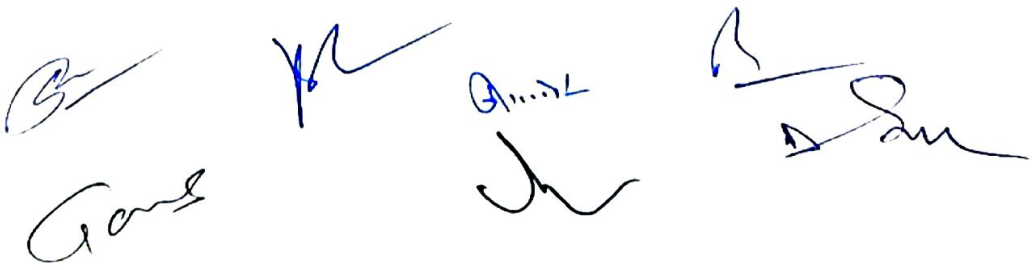
MTH401- Functional Analysis
Unit 1. Metric convergence of sequences, Normed spaces, Banach Space, Properties of Normed spaces, Finite dimensional normed spaces, and subspaces; Compactness and finite dimension, linear operators, Bounded and continuous linear operators; Linear functional; linear operator sand functional on finite dimensional spaces, Normed spaces of operators, Dual space.
Unit 2. Fundamental Theorems of Normed and Banach Space: Zorn's Lemma, Hahn Banach Theorem, Hahn Banach Theorem for complex vector spaces and normed spaces, Adjoint operators, Uniform boundedness theorem, Strong and Weak convergence, Convergence of sequences of operators and functional, Open mapping theorem and Closed graph theorem.
Unit 3. Inner product space; Hilbert space; Properties of Inner product spaces, Orthogonal complements and direct sums, Orthonormal sets, and sequences; Hilbert adjoint operators, Self- Adjoint, Unitary and normal operators.
Unit 4. Fixed point, Contraction mapping, Banach contraction principle, Applications of Banach's theorem to Linear, Differential, and Integral equations.
Books Recommended: 1. Walter Rudin: "Functional Analysis". 2. Michael Reed and Barry Simon: "Functional Analysis". 3. Erwin Kreyszig: "Introductory Functional Analysis with Applications". 4. John B. Conway: "A Course in Functional Analysis". 5. Ravi P. Agarwal: "An Introduction to Functional Analysis". 6. G. F. Simmons: "Introduction to Topology and Modern Analysis", McGraw Hill,1963.

MTH402 – Special Functions
Unit 1. Preliminaries, Beeta and Gamma function and their properties, Gauss multiplication theorem, the hypergeometric differential equation, Gauss hypergeometric function.
Unit 2. Integral representation of hypergeometric function, Evaluation of hypergeometric function, the confluent hypergeometric differential equation, Confluent hypergeometric function.
Unit 3. Legendre's equation, Legendre's polynomial, Legendre's function of the second kind General solution of Legendre's equation, Rodrigue's formula, Legendre polynomials, A generating function of Legendre's polynomial , Orthogonality of Legendre polynomials.
Unit 4. Bessel's equation, solution of Bessel's equation, Bessel's functions Recurrence Formulae, Equations reducible to Bessel's equation, orthogonality of Bessel's Functions, A generating function for Basic properties.
Books Recommended: 1. E. D. Rainville: "Special functions". 2. Nirvikar Saran: "Special Functions". 3. W.W.Bell: "Special Function for Scientists and Engineers". 4. U. P. Singh: "Special Function & Their Application".



MTH403- Calculus of Variations and Integral Equations
Unit 1. Variation and its properties, Linear functional, the fundamental lemma of the calculus of variations, Euler-Lagrange equations, Variational problems for functional involving several dependent variables, Functional depends on higher order derivative, Functional dependent on the functions of several independent variables, Variational problems in parametric form, Isometric problems.
Unit 2. Sufficient conditions for extremum**:** Proper field, Central field, Extremal field, Jacobi condition, Weierstrass function, Legendre condition.
Unit 3. Linear integral equation: Definition and classification with various examples, Conversion of IVP and BVP to an integral equation and vice-versa, Eigen value and eigen functions, Solution of homogeneous and general Fredholm integral equations of second kind with separable and degenerate kernels.
Unit 4. Solution of Fredholm and Volterra integral equations of second kind by method of successive approximations, Resolvent kernels and its results.
Books Recommended: 1. I.M. Gelfand and S.V. Fomin: "Calculus of Variations" 2. G.A. Seregin and V.A. Solonnikov: "Calculus of Variations and Partial Differential Equations" 3. R. Kress: "Linear Integral Equations" 4. S.K. Pundir: "Calculus of Variations". 5. M D Raisinghania: "Integral Equations & Boundary Value Problems".

MTH404 – Dynamics of Rigid Bodies
Unit 1. Generalized coordinates, Lagrange's equations of motion, small oscillations.
Unit 2. Hamiltonian's canonical equations, Hamilton's principle, and principle of least action.
Unit 3. Conservation of linear and angular momentum under finite and impulsive forces, Conservation of energy.
Unit 4. Euler's equations of motion, Kinetic energy, Eulerian angles, Instantaneous axis of rotation.
Books Recommended: 1. "Dynamics- Part II": A.S. Ramsey, Cambridge University Press, 1944. 2. "Classical Mechanics": H. Goldstein, Pearson Education. 3. "A Textbook on Dynamics": Ray and Sharma, S. Chand Ltd., 2005. 4. "Dynamics of Rigid Body": S.L. Loney, Cambridge University Press.



MTH405- Algebraic Coding Theory

Unit 1: The communication channel, The coding problem, Types of codes, Error detecting and error-correcting codes, Linear codes, Hamming metric, Description of linear block codes by matrices.

Unit 2: Dual codes, Standard array, Step-by-step decoding, Modular representation, Error-correction, Capabilities of linear codes, Bounds of minimum distance for block codes, Plotkin bound, Hamming sphere packing bound, Bounds for burst-error detecting and correcting codes.

Unit 3: Important linear block codes, hamming codes, Golaycodes, Perfect codes, Quasi perfect codes, Reed-Muller codes, Codes derived from Hadamard matrices, Product codes, Concatenated codes.

Unit 4: A double error correcting decimal code and an introduction to BCH codes, BCH bounds, Cyclic codes, Matrix representation of cyclic codes, Error detection and cyclic codes, MDS codes.

Books Recommended:

1. V. Pless and W.C. Huffman: "Fundamental of Error- Correcting Codes", Cambridge Univ. Press.
2. Ramond Hill: "A First Course in Coding Theory", Oxford Univ. Press.
3. M.Y. Rhee: "Error Correcting Coding Theory", McGraw-Hill, 1989.
4. E.R.Berlckamp: "Algebraic Coding Theory", World Sci. Pub. Pvt. Ltd.

MTH406- Algebraic Number Theory

Unit 1. Euclidean rings, Gaussian integers, Eisenstein integers, algebraic numbers, algebraic number fields, conjugate and discriminants, algebraic integers, integral bases, norms and traces, rings of integers, quadratic fields, cyclotomic fields

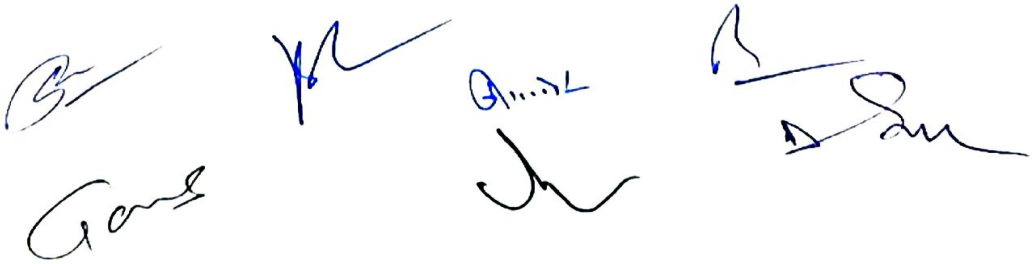
Unit 2. Trivial factorization, factorization into irreducibles, examples of non-unique factorization into irreducible, prime factorization, Euclidean quadratic fields, consequence of unique factorization, some Diophantine equations, the Ramanujan-Nagell theorem,

Unit 3. Factorization of Ideals – Dedekind domains, Fractional ideals, Prime factorization of ideals, norm of an ideal, non-unique factorization in cyclotomic fields

Unit 4. Lattices, the quotient torus, Minkowski theorem, the two-squares theorem, The four-square theorem, geometric representation of algebraic numbers, The space L^{st} , The class group, finiteness of the class-group, unique factorization of elements in an extension ring, factorization of a rational prime, Minkowski constants, class number calculations

Books Recommended:

1. Stewart, I. N. and Tall, D. O. – "Algebraic Number Theory and Fermat's Last Theorem".
2. Murty, R. and Esmonde, J. – "Problems in Algebraic Number Theory".
3. Alaca, S. and Williams, K. S. – "Introductory Algebraic Number Theory".
4. Ireland, K. and Rosen, M. – "A Classical Introduction to Modern Number Theory".
5. Markus, D. A. – "Number Fields".
6. Lang, S. – "Algebraic Number Theory".



MTH407- Fuzzy Set Theory

Unit 1. Fuzzy sets, Basic definitions, Alpha-cut sets, Convex fuzzy sets, Basic operation on fuzzy sets, Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and differences, t-norms and t-corners.

Unit 2. The extension principle, The Zadeh's extension principle, Images and inverse image of fuzzy sets, Fuzzy numbers, Element of fuzzy arithmetic.

Unit 3. Fuzzy relation and fuzzy graphs. Fuzzy relation on fuzzy sets, Composition of fuzzy relation, Min-max composition and properties, Equivalence relations, Fuzzy compatibility relation, Fuzzy relation equations.

Unit 4. Fuzzy logic, An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy qualifiers, Linguistic variables, and hedge.

Books Recommended:

1. George J. Klir and Bo Yuan: "Fuzzy Sets and Fuzzy Logic: Theory and Applications".
2. Didier Dubois and Henri Prade: "Fuzzy Sets and Systems: Theory and Applications".
3. Hans-Jürgen Zimmermann: "Fuzzy Set Theory and Its Applications".
4. A.K. Bhargava: "Fuzzy set theory, Fuzzy logic and their Applications".
5. Kwang H. Lee: "First Course on Fuzzy Theory and Applications".

MTH408- Mathematical Modeling

Unit 1. Introduction to Mathematical Modeling: modeling process, Classifications of mathematical models, Characteristics and limitations of mathematical models, Some simple illustrations. Basic concepts of ordinary differential equations; Mathematical modeling through differential equations, linear growth and decay models, Nonlinear growth and decay models.

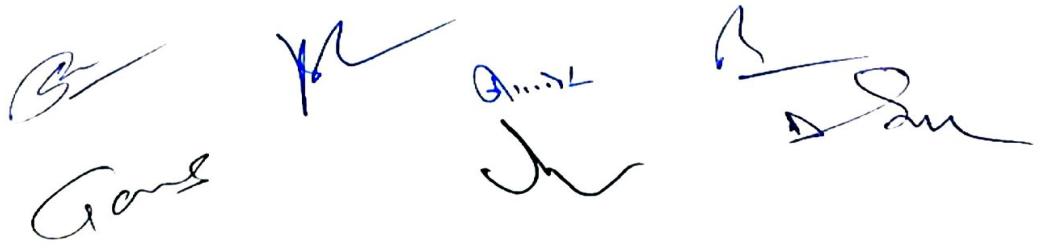
Unit 2. Mathematical modeling through systems of ordinary differential equations of first order: Mathematical models in population dynamics and epidemics, Mathematical Modeling through second order differential equations: Mathematical Modeling of planetary motion, circular motion, motion of satellites, etc.

Unit 3. Mathematical modeling through difference equations, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in population dynamics, economic and finance.

Unit 4. Mathematical Modeling through partial differential equations: PDE model for birth-death immigration-emigration process, PDE model for a stochastic epidemic process with no removal, Mathematical modeling through linear programming.

Books Recommended:

1. J. N. Kapur, Mathematical Modeling, Wiley Eastern.
2. C. Dyson, Elvery Principles of Mathematical Modeling Academic Press ,New York
3. D. N. Burghes, Mathematical Modeling in the Social Management and Life Science, Ellie Herwoo and John Wiley,1988.
4. F. Charlton, Ordinary Differential and Difference Equations, Van Nostrand,1989



MINOR/ADDITIONAL/INTERDISCIPLINARY / MULTIDISCIPLINARY COURSE IN MATHEMATICS

GRADUATION-4th Year (SEMESTER- VII/VIII) /POST GRADUATION-1st Year

Degree with Honours /Research

Minor Elective: Research Methodology

Programme: Minor/Additional/ Interdisciplinary / Multidisciplinary Course	**Year: Fourth**	**Semester: Seventh/ Eighth**
Subject: Mathematics		
Course Code: MEC03	**Course Title:** Research Methodology	
Course outcomes: On completion of this course, the student will be able to understand the basics of research and some methodology.		
Credits: 4	**Minor Elective**	
Max. Marks: 25+75	**Min. Passing Marks:** As per university norms	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: (4-0-0)		
Course Title: Research Methodology		

Unit	**Topics**	**No. of Lectures**
I	Perception of Research, Meaning of Research, Empirical and theoretical research, Inductive and Deductive logics.	**15**
II	Research hypothesis, Scientific Methods, Research Design, Type of Data and Collection. Use of computers in obtaining results, valid & invalid generalization.	**15**
III	Sampling, Sampling Distribution, Testing of Hypothesis.	**15**
IV	Correlation and Regression, Time Series Analysis.	**15**

Suggested Readings:

1. Ethics in Research and Publication Ethics: Philosophy and ethics, Scientific conduct, Publication ethics.
2. Write Mathematics Right by L. Radhakrishna, Narosa Publishing House, 2003.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc. (C.S.) and other subject's students.

Suggested Continuous Evaluation Methods: Max. Marks: 25

S.No.	**Assessment Type**	**Max. Marks**
1	**Class Tests**	**10**
2	**Online Quizzes/Objective Tests/ Presentation**	**5**
3	**Attendance**	**5**
4	**Assignment**	**5**

Course perquisites: To study this course a student must have studied Mathematics.