K.K. UNIVERSITY

NALANDA, BIHAR - 803115

SCHOOL OF APPLIED SCIENCES

MASTER OF SCIENCE (M.Sc.)

MATHEMATICS

(Two Year Full Programme)

2022-2023

PROGRAMME STRUCTURE & SYLLABUS M.Sc.

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Berauti, Nepura, Bihar Sharif
Nalanda - 803115 (Bihar)

(Mathematics)
Course Structure

Year	Semester	Course Code	Course Title	L	T	P	C
1	1	MSMT 1101	Modern Algebra	5	0	0	5
		MSMT 1102	Fluid Mechanics	5	0	0	5
		MSMT 1103	Real Analysis	5	0	0	5
		MSMT 1104	Advance Topology	5	0	0	5
			Total	**20**	**0**	**0**	**20**
	2	MSMT 1201	Operation Research	5	0	0	5
		MSMT 1202	Fundamentals of Computer	5	0	0	5
		MSMT 1203	Integral Equation	5	0	0	5
		MSMT 1204	Discrete Mathematics	5	0	0	5
			Total	**20**	**0**	**0**	**20**
2	3	MSMT 2101	Integration Theory	5	0	0	5
		MSMT 2102	Complex Analysis	5	0	0	5
		MSMT 2103	Partial differential Equation	5	0	0	5
		MSMT 2104	Functional Analysis	5	0	0	5
			Total	**20**	**0**	**0**	**20**
	4	MSMT 2201	Linear Algebra	5	0	0	5
		MSMT 2202	Numerical Analysis	5	0	0	5
		MSMT 2203	Integral Transform	5	0	0	5
		MSMT 2205	Project /Dissertation	5	0	0	5
			Total	**20**	**0**	**0**	**20**

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MSMT 1101: MODERN ALGEBRA

L	T	P	Cr
5	**0**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Commutators and commutator subgroups of a group and their properties, solvable groups, Relation between commutator sub groups and solvability, Some important properties of solvable groups, Normal and composition series and their important properties.	**10**
II	Concept of divisibility in a ring and associates, irreducible and reducible elements, unique factorization domain (U.F.D.), Principal ideal domain (P.I.D.), Euclidean domain, Unique factorization theorem in an Euclidean domain, Relationship between U.F.D., P.I.D. and Euclidean domain**.**	**10**
III	Concept of extension of a field, finite extension and transitivity of finite extensions, Algebraic elements, The field F(a) obtained by adjoining an element a to F.	**10**
IV	Finiteness of F(a) and algebraicity of a, Algebraic extension and related results, simple extensions. Roots of a polynomial over a field F in an extension field of f and related results, splitting field for a polynomial over a field F.	**10**
V	Existence of multiple roots of a polynomial and irreducibility of the polynomial, Fixed field G(K,F) of a group of automorphisms of a field K, finiteness of G(K, F), Normal extension.	**10**

REFERENCE BOOKS:	
Topics in Algebra	I. N. Herstein, Blaisdell Publishing Company, New York.
Basic Abstract Algebra	P.B. Bhattarcharya, Cambridge University Press, India.
Advanced Course in Modern Algebra	K.K. Jha – Nav Bharat Prakashan, Delhi-6

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MSMT 1101: FLUID MECHANICS

L	T	P	Cr
5	**0**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Lagrangian and Eulerian methods. Equation of continuity in different coordinate system. Boundary surfaces. Stream lines. Path lines and streak lines. Velocity potential, Irrotational and rotational motions. Vortex lines.	**10**
II	Lagrange's and Euler's equations of motion. Bernoulli's theorem. Equation of motion by flux method. Impulsive actions. Stream function Irrotational motion.	**10**
III	Complex velocity potential. Sources, sinks doublets and their images in two dimensions. Conformal mapping. MilneThomson circle theorem.	**10**
IV	Two-dimensional Irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid. Theorem of Blasius.	**10**
V	Motion of a sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere. Equation of motion of a sphere.	**10**

REFERENCE BOOKS :		
1.	A Treatise on Hydro mechanics	W.H.Besaint & A. S. Ramsey, Part II. CBS Publishers. Delhi. 1988.
2.	An Introduction of Fluid Mechanics	G.K. Batchelor, Foundation Books. New Delhi1994.
3.	Textbook of Fluid Dynamics	F. Choriton. Textbook of Fluid Dynamics. C.B.S. Publishers. Delhi 1985.
4.	Fluid dynamics	M.D. Raisinghania, S.Chand Publication.

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MSMT1103: REAL ANALYSIS

L	T	P	Cr
5	0	0	5

UNITS	CONTENTS	Contact Hrs.
I	Riemann-Stieltje's Integral : Definition and existence of the Riemann-Steieltje's integral, Linearity properties of the integral, Integration and differentiation, The fundamental theorem of calculus.	10
II	Rearrangements of term of a series, Riemann's theorem, Power series, Uniqueness theorem for power series, Abel's and Tauber's theorems. .	10
III	Sequences and series of function : Point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence & Integration, Uniform convergence & differentiation, Weierstrass approximation theorem.	10
IV	Functions of several variables : Linear transformations, Derivatives in an open subset of **R**, Chain rule, Partial derivatives interchange of the order of differentiation derivatives of higher orders, Taylor's theorem for functions of two variables.	10
IV	Jacobians and functions with non-zero Jacobians, Inverse function theorem, Implicit function theorem, Extremum problems with constraints, Lagrange's multiplier method.	10

REFERENCE BOOKS :

1.	Principles of Mathematical Analysis	W. Rudin ,McGrow-Hill book company,INC.
2.	Mathematical Analysis.	T.M. Apostol ,Narosa Publishing House, New Delhi.

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MSMT 1104: ADVANCE TOPOLOGY

L	T	P	Cr
5	0	0	5

UNITS	CONTENTS	Contact Hrs.
I	Notion of a topological space, open set topology and fundamental concepts of open sets, closed sets, neighborhoods, adherent points, accumulation points, closure, interior and boundary in a topological space, subspace. Important interrelations between fundamental concepts.	10
II	Convergence of sequences in a topological space, continuity and homomorphism, characterisations of continuity and homeomorphism, base and subbase of a topology, continuity and sequential continuity. .	10
III	Separation axioms in a topological space, T_0, T_1, T_2, Regular find normal space and their mutual implication relationships, unique limit of sequences in a Hausdorff (T_2) space. Hereditary and topological properties.	10
IV	Compactness concept in a topological space, compact subsets of a topological space with Hansdorff property, characterization of compactness by closed sets with finite intersection property, compactness and continuity, compact sets in real line R (under usual topology)	10
IV	Connected and disconnected spaces, connectedness and continuity, characterizations of connected and disconnected spaces, connected sets in a topological space, sufficient conditions under which union of connected sets is connected, connected sets in R (under usual topology).	10

REFERENCE BOOKS :

1.	Advanced General Topology	Prof. K.K. Jha – Advanced General Topology, Nav Bharat Prakashan, Delhi-6.
2.	Introduction to General Topology and Modern Analysis	G.F.Simmons , McGraw Hill Book Company, INC.

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MSMT 1201: OPERATION RESEARCH

L	T	P	Cr
5	0	0	5

UNITS	CONTENTS	Contact Hrs.
I	Origin and development of O.R. applications of O.R., Nature and features of O.R., Model in O.R. and its classification, advantages and limitations, Hyper plane, supporting and separating hyper planes, Hyper sphere, convex. Sets and their properties, convex combination of vectors**.**	**10**
II	Simplex method for solving a linear programming problem, Basic solution, Degenerate solution, Basic feasible solution, fundamental theorem of linear programming, conditions of optimality.	**12**
III	Two-phase method, Big-M method of solving a linear programming problem. Duality in linear programming, Duality theorems, existence theorem, Dual simplex method.	**08**
IV	Integer programming, fractional cut method, Branch and bound method. General non-linear programming problem, Lagrange's multipliers.	**10**
V	Conditions for a general non-linear programming problem, Kuhn-Tucker conditions for general non-linear programming, Conditions for non-negative saddle point.	**10**

REFERENCE BOOKS:

1	Operations Research	Hamdy A. Taha , An introduction, Macmillan Co. INC, New York.
2	Operations Research	Dr. B. S. Geoel & S. K. Mittal , Pragati Prakashan.

MSMT1202: FUNDAMENTAL S OF COMPUTER

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs
I	**Computer Fundamentals :** History of Computers**,** Types of Software**,** Memory Types**,** Uses of Computer.	10
II	**Languages :** Generations of Computers**,** Machine Language Assembly Language, High Level Language.	10
III	**Number System,** Decimal, Binary, Octal, Hexadecimal, number conversation.	**10**
IV	**Components**: Input Unit, Output Unit, CPU, Input and Output Dev**ices,** Memory.	10
V	**Computer Communication & Internet:** Basic of Computer Networks, Types of computer Networks, Internet, Application of Internet, Communication on Internet.	10

REFERENCE BOOKS :		
1.	Introduction to Information Technology	ITL Education Solutions Ltd., Pearson Education India
2.	Computer Fundamentals	Pradip K. Sinha, , BPB Publications,

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MSMT 1203: INTEGRAL EQUATIONS

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Definition and classification, conversion of initial and boundary value problems to an integral equation, Eigen-Values and Eigen functions. Solutions of homogeneous and general Fredholm integral equations of second kind with separable kernels.	**10**
II	Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations, Resolvent kernel and its results.	**10**
III	Integral equations with symmetric kernels: Complex Hilbert space, Orthogonal system of functions, fundamental properties of eigen values and eigen functions for symmetric kernels.	**10**
IV	Expansion in eigen-functions and bilinear forms, Hilbert-Schmidt theorem. Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem. Fredholm theorems.	**10**
V	Solution of Volterra integral equations with convolution type kernels by Laplace transform .Solution of Volterra integral equations with convolution type kernels by Laplace transform**.**	**10**

REFERENCE BOOKS :

1.	Linear Integral Equations	W.V.Lovitte, over Publications; Reissue edition (2005).
2.	Linear Integral Equations	Preston M. A. and Bhaduri R. K, Birkhäuser; 2nd edition , (1996).
3.	Linear Integral Equations	S.G. Mikhlin, , Routledge, (1961).

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MSMT 1204: DESCRETE MATHEMATICS

L	T	P	Cr
5	0	0	5

UNITS	CONTENTS	Contact Hrs.
I	Set Theory: Definition of Sets, Venn Diagrams, complements, cartesian products, power sets, counting principle, cardinality and countability (Countable and Uncountable sets), proofs of some general identities on sets, pigeonhole principle. Relation: Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.Function: Definition and types of function, composition of functions, recursively defined functions.	**10**
II	Propositional logic: Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms(conjunctive and disjunctive), modus ponens and modus tollens, validity,predicate logic, universal and existential quantification. Notion of proof: proof by implication, converse, inverse, contra positive, negation, and contradiction, direct proof, proof by using truth table, proof by counter example.	**10**
III	Combinatories: Mathematical induction, recursive mathematical definitions, basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relation), generating function (closed form expression, properties of G.F., solution of recurrence relation using G.F, solution of combinatorial problem using G.F.)	**10**
IV	Algebraic Structure:Binary composition and its properties definition of algebraic structure; Groyas Semi group, Monoid Groups, Abelian Group, properties of groups, Permutation Groups, Sub Group, Cyclic Group, Rings and Fields (definition and standard results).	**10**
V	Graph terminology, types of graph connected graphs, components of graph, Euler graph, path and circuits, Graph colouring, Chromatic number. Tree: Definition, types of tree(rooted, binary), properties of trees, binary search tree, tree traversing (preorder, inorder, postorder). Finite Automata: Basic concepts of Automation theory, Deterministic finite Automation (DFA), transition function, transition table, Non Deterministic Finite Autom(NDFA), Mealy and Moore Machine, Minimization of finite Automation.	**10**

REFERENCE BOOKS :		
1.	Discrete Mathematics and its Applications	Kenneth H. Rosen, Mc.Graw Hill, 2002.
2.	Combinatories: Theory and Applications	V. Krishnamurthy, East-West Press.
3.	Discrete Matheamatical Structures	Kolman, Busby Ross, Prentice Hall International

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MSMT 2101: INTEGRATION THEORY

L	T	P	Cr
5	**0**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Signed measure, Hahn decomposition theorem, Mutually singular measures.	**10**
II	Signed measure, Hahn decomposition theorem, Mutually singular measures.	**10**
III	Lebesgue-Stieltjes integral, Product measures, Fubini's theorem, Differentiation and integration. .	**10**
IV	Decomposition into absolutely continuous parts, Bair sets, Baire measure, Continuous functions with compact support.	**10**
V	Regularity of measure on locally compact spaces. Integration of continuous functions with compact support. Riesz Markoff theorem.	

REFERENCE BOOKS :		
1.	Real Analysis	H. L. Royden -Mecmillan Publishing Co. INC
2.	Measure and Integration	S. K. Berberian -, Chelsea Pub. Co. N.Y.
3.	An Introduction to Measure and Integration	Inder K. Rana , Narosa Pub. House, Delhi. .

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MSMT 2102: COMPLEX ANALYSIS

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Complex integration, Cauchy-Goursat theorem, Cauchy's integral formula, Higher order derivatives, Morera's theorem**.**	**10**
II	Cauchy inequality, Liouville's theorem, Fundamental theorem of Algebra, Taylor's theorem, Laurents series, Maximum modulus principle, Schwarz lemma**.**	**10**
III	Singularities, Zeros & poles, Residues, Cauchy's residue theorem, Evaluation of real integrals, Branches of many valued functions with special reference to argz, Log z and z^n**.**	**10**
IV	Meromorphic functions, Principle of argument, analytic continuation, uniqueness of direct analytic continuation.	**10**
V	Bilinear transformation, their properties and classifications, Definition and examples of conformal mappings, Necessary and sufficient condition of conformal mappings, Preservance of cross-ratio under the bilinear transformation.	**10**

REFERENCE BOOKS :		
1.	Theory of functions of a complex variable	Shanti Narayan ,S.Chand and company Ltd., New Delhi
2.	Applied complex variable,	John W. Dettman , Macmillan Company, New York.

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MSMT 2103: PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	Cr
5	**0**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Partial differential equations of the first order, Integral surface, Orthogonal surfaces, Non-linear Partial differential equations, Charpit's method, Jacobi's method**.**	**12**
II	Homogeneous and non Homogeneous linear partial differential equation with constant co-efficient, Methods for finding C.F. and P.I. of linear homogeneous Partial Differential Equations**.**	**8**
III	Solution of equations under given geometrical conditions. Monge's method for integration of the equation Rr+Ss + Tt = V**.**	**10**
IV	Classification and solution of Partial Differential Equations of order two and their examples. Cauchy's problem for seemed order Partial Differential Equations characteristic equation and characteristic curves of the second order Partial Differential Equations. Reduction of linear Partial Differential Equations. in two variables to canonical form and then classifications into elliptic, parabolic and hyperbolic forms**.**	**10**
V	Laplace's, heat and wave equations in one and two dimensions in Cartesian, polar and cylindrical forms, Solution of Laplace' s equation, heat equations and wave equations.	

REFERENCE BOOKS :		
1.	Ordinary and partial Differential Equation	M.D. Raisinghania , S. Chand & Company Ltd.
2.	Differential Equation	Bhargava & Chandramouli, Pragati Prakashan.
3.	Advanced Partial Differential Equation	Pundir & Pundir –, Pragati Prakashan.

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MSMT 2104: FUNCTIONAL ANALYSIS

L	T	P	Cr
5	**0**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Definition, examples and counter examples of normed linear spaces and Banach spaces, continuity of vector addition scalar multiplication and the norm function in a normed linear space, quotient space of a normed linear space, Lemma of F. Riesz.	10
II.	Continuous linear transformation and functional & normed linear spaces of bounded linear transformations, dual spaces with examples, uniform boundedness theorem and some of its consequences, open mapping and closed graph theorems, Hahn- Banach theorem for real linear spaces, complex linear spaces and normed linear spaces.	10
III	Definition and examples of inner product spaces and Hilbert spaces, Cauchy-Schwrz inequality, continuity of inner product function, Parallelogram law, Polarisation identity, Lemma of F. Riesz on closed convex set in H.	
IV	Orthogonal complements, Projection theorem in a Hilbert space, Orthonormal sets, Bessel's inequalities, characterization on theorem for complete orthonormal set in a Hilbert space, Frechet Riesz representation theorem for bounded linear functionals in H	**10**
V	Adjoint of an operator on H, self-adjoint operators and positive operators in H, normal operators, Unitary operators.	

REFERENCE BOOKS:	
Functional Analysis with Applications	K. K. Jha , Students Friends, Patna
Functional Analysis with Applications	A. H. Siddiqui, , Tata McGraw Hill, Publishing Company Ltd., New Delhi.
Introduction to Topology and Modern Analysis	G. F. Simmons,McGraw Hill Book Company, New York, 1963.

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MSMT 2201: LINEAR ALGEBRA

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Systems of linear equations, Matrices, Elementary row operations, Row-reduced echelon matrices. Vector spaces Subspaces, Bases and dimension, Ordered bases and coordinates.	**10**
II	Linear transformations, Rank-nullity theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Linear functionals, Annihilator, Double dual, Transpose of a Linear Transformation.	**10**
III	Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley-Hamilton theorem, Invariant subspaces	**10**
IV	Direct-sum decompositions, Invariant direct sums, The primary decomposition theorem, Cyclic subspaces and annihilators, Cyclic decomposition, Rational, Jordan forms.	**10**
V	Inner product spaces, Orthonormal bases, Gram-Schmidt process**.**	**10**

REFERENCE BOOKS :		
1.	Linear Algebra	K.hoffman and R. Kunze, , 2nd Edition, Prentice- Hall of India, 2005.
2.	Algebra	M.Artin , Prentice – Hall of India,2005.

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MSPHY2202: NUMERICAL ANALYSIS

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Numerical computation and Error analysis: Numbers and their accuracy, Floating point arithmetic Errors in numbers, Error estimation, General error formulae, Error propagation in computation.Inverse problem of error analysis and Numerical instability. Algebraic and transcendental equations: Bisection method, Iteration method, Regula-Falsi method, Secant method, Newton-Raphson's method. Convergence of these methods. Lin-Bairstow's method, Muller's method, Graeffe's root squaring method, Solution of system of nonlinear equations, Complex roots by Newton-Raphson's method.	**10**
II	System of linear algebraic equations: Gauss elimination method without pivoting and with pivoting, Gauss-Jordon method, LU-factorization method, Jacobi and Gauss-Seidal methods, Convergence of iteration methods, Round-off errors and refinement, ill-conditioning, Partitioning method, Inverse of matrices. Eigen values and eigen vectors: Rayleigh Power method, Given's method and Householder's method.	**10**
III	Interpolation: Finite differences, Newton's interpolation formulae, Gauss, Stirling's and Bessel's formulae, Lagrange's, Hermite's and Newton's divided difference formulae. Numerical differentiation and integration: differentiation at tabulated and non-tabulated points, Maximum and minimum values of tabulated function,	**10**
IV	Newton-Cotes Formulae-Trapezoidal, Simpson's, Boole's and Weddle' rules of integration with errors, Romberg integration, Gaussian integration, Double integration by Trapezoidal and Simpson's rules Ordinary differential equations: Taylor series and Picard's methods, Euler's and modified Euler methods, Runge-Kutta methods, Predictor-Corrector methods:.	**10**
V	Adams-Bashforth's and Milne's methods. Error analysis and accuracy of these methods. Solution of simultaneous and higher order equations, Boundary value problems: Finite difference and Shooting methods	**10**

REFERENCE BOOKS :	
Methods for Engineers and Scientists	Sharma, J.N., Numerical, 2nd Edition. NarosaPubl. House New Delhi/Alpha Science International Ltd., Oxford UK, 2007.
Numerical Methods.	Balagurusamy, E., New Delhi: Tata McGraw Hill,1999

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MSPHY2203: INTEGRAL TRANSFORM

L	T	P	Cr
4	**1**	**0**	**5**

UNITS	CONTENTS	Contact Hrs.
I	Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform, Convolution theorem, Laplace transform of periodic functions, unit step function and impulsive function, Application of Laplace Transform in solving ordinary and partial differential equations and Simultaneous linear equations**.**	**10**
II	Fourier transform, properties of Fourier transform, inversion formula, convolution, Parseval's equality, Fourier transform of generalized functions, application of Fourier transforms in solving heat, wave and Laplace equation. Fast Fourier transforms	**10**
III	Hankel Transform, Inversion formula for Hankel Transform,Some important results for Bessel Functions,	**10**
IV	Linearity property, Hnakel Transfrom of derivative of a function, Parseval theorem**.**	**10**
V	Mellin Transform (Def.), The Mellin inversion Theorem, Linearity Property, Mellin Transform of derivatives, Mellin Transform of integrals, Convolution theorem for Mellin Transform**.**	**10**

REFERENCE BOOKS :	
Fourier Transforms	Goldberg, R.R., Cambridge University Press, 1970.
Laplace Transform Theory	Smith, M.G., Van Nostrand Inc., 2000.

MSMT 2204: DISSERTATION

L	T	P	Cr
0	**0**	**10**	**5**

	TOPICS
I	Modern Algebra
II	Fluid Mechanics
III	Topology
IV	Graph Theory
V	Functional Analysis

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