Guru Kashi University

Master of Science in Mathematics
(M.Sc. Maths)

Session: 2023-24

Department of Mathematics

Graduate Outcomes of the Programme:

The graduates will adapt and shows resilience in the face of challenges and focuses on solutions that make them feel empowered, happier, and more capable, also takes personal responsibility, accountability, and pride in pursuing and draws on gained knowledge, experience to contribute in a positive and ethical manner.

Programme Learning Outcomes : After completion of the program, the learner will be able to:

1. Develop critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
2. Excel in explaining the importance of Mathematics and its techniques to solve real-life problems.
3. Apply mathematical knowledge in industries, teaching, or securing acceptance in high-quality further educational and professional programs in Mathematics.
4. Enlarge their abilities in using technology efficiently for conducting research and in their professional practices.
5. Acquire mathematical and statistical knowledge and skills appropriate to professional activities and demonstrate the highest standards of ethical issues in Mathematics.
6. Cultivate a core of mathematical and technical knowledge that is adaptable to changing technologies.

Programme Structure

Semester: I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
MMH101	Abstract Algebra	Core	4	0	0	4
MMH102	Real Analysis	Core	4	0	0	4
MMH107	Topology	Core	4	0	0	4
MMH108	Complex Analysis	Core	4	0	0	4
MMH109	Ordinary and Partial Differential Equations	Compulsory Foundation	4	0	0	4
Discipline Elective– I (Any one of the following)						
MMH110	Mathematical Methods	Discipline Elective-I	3	0	0	3
MMH111	Probability and Mathematical Statistics					
MMH112	Field Theory					
MMH113	Mathematical Modelling					
Total			**23**	**0**	**0**	**23**

Semester: II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
MMH212	Calculus Variations and Integral Equations	Core	4	0	0	4
MMH213	Functional Analysis	Core	4	0	0	4
MMH214	Classical Mechanics	Core	4	0	0	4
MMH215	Differential Geometry	Core	4	0	0	4
Discipline Elective–II (Any one of the following)						
MMH216	Discrete Mathematics	Discipline Elective-II	3	0	0	3
MMH217	Operations Research					
MMH218	Special Function					
MMH219	Integral Transforms and Their Applications					
Value added course- For other Department also						
MMH220	Linear Algebra	Value Added Course	2	-	-	2
Total			**21**	**0**	**0**	**21**

Semester: III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
MMH318	Research Methodology	Research Based Skill	4	0	0	4
MMH319	Research Proposal	Research Based Skill	2	0	4	4
MMH320	Ethics and IPR	Interdisciplinary	2	0	0	2
MMH321	Proficiency in Teaching	Skill Based	2	0	0	2
MMH322	Computer Lab (MATLAB programming)	Skill Based	1	0	2	2
MMH323	Service Learning	Community Linkage	0	0	4	2
MMH399	XXXX	MOOC	-	-	-	4
Total			**11**	**0**	**10**	**20**

Semester: IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**
MMH402	Dissertation	Research Skill based	-	-	-	**20**
Total			-	-	-	**20**
Grant Total Credits			**55**	**0**	**10**	**84**

Evaluation Criteria for Theory Courses

A. Continues Assignment. (25 marks)

   a) CA – I Surprise test (Two Best out of three) (10 Marks)
   b) CA – II Assignment(s) (10 Marks)
   c) CA – III Term Paper/Quiz/Presentations (05 Marks)

B. Attendance (05 marks)
C. Mid Semester Exam [30 Marks]
D. End Semester Exam [40 Marks]

SEMESTER-I

Course Title: Abstract Algebra

Course Code: MMH101

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Analyze Cauchy's theorem for the Abelian group and Sylow's theorem.
2. Compute the Permutation groups and its Conjugacy.
3. Perform the Homomorphism, Ideals, and Quotient rings in ring theory.
4. Design the Polynomial rings and polynomials over the rational field.

COURSE CONTENT

UNIT-I **15 hours**

Normal subgroups and Quotient Groups-Homomorphism-Cauchy's theorem for Abelian Group Sylow's theorem for Abelian Group-Automorphism-Cayley's theorem

UNIT-II **17 hours**

Permutation groups- Conjugacy- Normalizer-Centre-Cauchy theorem-Sylow's Theorem-Direct products. Rings-Homomorphism-Ideals-Quotient Rings-Maximal Ideal-Field of Quotients of integral domain

UNIT-III **12 hours**

Euclidean rings-Polynomial rings- polynomial over the rational field-polynomial rings over commutative rings

UNIT-IV **16 hours**

Vector spaces-elementary basic concepts-Extension fields-The Transcendence of e - roots of polynomials-Construction with straightedge and compass-Finite fields

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative teaching, Project-based learning, Group discussion, E-team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Readings: -

- *Luther I.S. and Passi I.B.S.(2007).Algebra, Vol.I& II, Narosa Publishing House, New Delhi.*
- *Gallian J.A. (1999). Contemporary Abstract Algebra, Narosa Publishing House, New Delhi.*
- *Singh, Surjeet and QaziZameeruddin (2006).Modern Algebra, Vikas Publishing House, New Delhi .8thEdition.*
- *Bhattacharya P.B, Jain S.K. and Nagpal S.R.(2012).Basic Abstract Algebra.Cambridge University Press,New Delhi.*
- *David. S. Dummit, Richarad M. Foote, (2004), Abstract Algebra, John-Wiley & sons, Third edition.*
- *Fraleigh J.B. (2013.),A first course in abstract algebra, Narosa publications, Seventh edition.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Real Analysis

Course Code: MMH102

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes:

After completion of this course, the learner will be able to:

1. Apply the knowledge and concepts of real analysis in order to study the theoretical development of different mathematical techniques and their applications.
2. Describe the nature of abstract mathematics and explore the concepts in further detail. Identify challenging problems in real variable theory and find their appropriate solutions.
3. Apply the theory of Riemann-Stieltjes integral in solving definite integrals arising in different fields of science and engineering.
4. Extend their knowledge of real variable theory for further exploration of the Course for going into research.

COURSE CONTENT

UNIT-I **17 hours**

Sequence and Series of functions: Introduction, Uniform Convergence, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem

UNIT-II **15 hours**

Measure Sets: Outer Measure, Lebesgue Measure, Properties of Measurable Sets, Non-Measurable Sets. Measurable Functions: Definition & Properties of Measurable Functions, Characteristic Functions, Step Functions, and Simple Functions, Little Wood's three Principles.

UNIT-III **12 hours**

Differentiation and Integration: Differentiation of monotone functions. Application of Differentiation. Absolute continuity. Convex functions. The general integral, Integration of series, Riemann integration

UNIT-IV **16 hours**

The Lebesgue integral: The Lebesgue integral of a bounded function over a set of finite measures. The integral of a non-negative function. The general Lebesgue integral. Convergence in measure.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-based Learning, Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Apostol, Tom. (1987). Mathematical Analysis - A Modern Approach to Advanced Calculus. Addison - Wesley Publishing Company, Inc.Indian Edition by Narosa Publishing House New Delhi.*
- *Goldberg, R.R. (2012). Methods of Real Analysis. Oxford and IHB Publishing Company, New Delhi.*
- *Malik, S.C. (1984). Mathematical Analysis, Wiley Eastern, New Delhi.*
- *Rudin, Walter. (1983), Principles of Mathematical Analysis. Third Edition (International Student Edition) McGraw-Hill Inc.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Topology

Course Code: MMH107

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain interior, closure, and boundary points, limit points of subsets and basis and sub basis of topological spaces.
2. Analyse the continuous maps between two spaces and maps from space into product space and determine a common topological property of given two spaces.
3. Illustrate the connectedness and path connectedness of the product of an arbitrary family of spaces.
4. Apply Urysohn's lemma, Tietze's extension theorem, Urysohn's metrization theorem and Analyze Hausdorff spaces.

COURSE CONTENT

UNIT - I **14 hours**

Topological spaces, basis and sub basis, ordered topology, quotient topology, product topology, Limit points, adherent points, Derived sets, Closure, interior, exterior and boundary points of a set, subspace.

UNIT - II **14 hours**

Continuity, homeomorphism, countability axioms, first and second countable spaces, Separable

Space Connectedness: connected sets, component, path component, local connectedness, disconnected sets, Totally Disconnected sets, locally connected spaces.

UNIT - III **16 hours**

Compact spaces; limit point compact and sequentially compact spaces, local compactness and one point compactification, finite product of compact spaces, Tychonoff's theorem (without proof).

UNIT-IV **16 hours**

Separation axioms (T0, T1, T2, T3 spaces, Regular space, completely regular spaces, Normal spaces), their characterizations and basic properties, Urysohn's lemma, Statement of Tietze's extension theorem, statement of Urysohn'smetrization theorem.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *James R. Munkers (2002), Topology. Second Edition. Prentice Hall of India.*
- *Singh T.B. (2013), Elements of Topology, CRC Press, Taylor & Francis.*
- *John L. Kelley(2004), General Topology. Dover Publications.*
- *Bourbaki N. (1995), General Topology . Springer-Verlag Berlin Heidelberg.*
- *Simmons, G, F. (1983), Introduction to Topology and Modern Analysis .McGraw Hill, New York.*
- *E.T. Copson. (1968), Metric Spaces. Cambridge University Press.*
- *S. Willord. (2012),General Topology. Addison Wesley Publishing Company.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Complex Analysis

Course Code: MMH108

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Learning Outcomes:

After completion of this course, the learner will be able to:

1. Illustrate fundamental concepts of Complex analysis and its use in mathematics.
2. Define and analyze limits and continuity for functions of complex variables.
3. Evaluate complex integral and apply Cauchy Integral Theorem and formulas.
4. Checking limit and continuity of complex function and apply the concept of analyticity and the Cauchy- Riemann Equation.

COURSE CONTENT

UNIT-I **18 hours**

Complex plane, geometric representation of complex numbers. Elementary functions: Trigonometric function, complex exponential function, logarithmic and hyperbolic functions. Complex valued functions and their continuity. Curves, connectivity through polygonal lines.

UNIT-II **14 hours**

Analytic functions, Cauchy-Riemann equations, Harmonic functions and Harmonic conjugates. Power series, exponential and trigonometric functions, Bilinear transformations, critical points, fixed points, cross ratio, Problems on cross-ratio and bilinear transformation.

UNIT-III **12 hours**

Complex Integration, line integral, Cauchy's theorem for a rectangle, Cauchy's theorem in a disc, index of a point with respect to a closed curve Cauchy's integral formula, higher derivatives.

UNIT-IV **16 hours**

Morrera's theorem, Liouville's theorem, the general form of Cauchy's theorem. Maximum Modules principle, Schwarz Lemma. Taylor series and Laurent series.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Shanti Narayan. (1986), Theory of Functions of a Complex Variable. S. Chand and Co. Seventh Edition.*
- *Copson, E. T.(1985), An Introduction to the Theory of Functions of a Complex Variable. The English Language Book Society and Oxford University Press.*
- *Knopp, K. (1947), Theory of Functions. (Translated by F. Bagemite) in Two Volumes, Dover Publications, Inc. New York.*
- *Pati, T. (1971), Functions of a Complex Variable. Allahabad, Pothishala.*
- *Saks, S and Zygmund, A. (1952), Analytic Functions. (Translated by E. J. Scott) Poland, Warszawa.*
- *Silverman, R. (1967), Introductory Complex Analysis, Prentice-Hall Inc. Englewood Cliffs, N. J.*
- *Deshpande, J. V. (1989), Complex Analysis. Tata McGraw-Hill Publishing Company Ltd.*
- *Tutschke Wolfgang and Vasudeva, Harkrishan L. (2005), An Introduction to Complex Analysis, Classical and Modern Approaches. Chapman and Hall/CRC.*
- *Ponnusamy S. (2005), Foundations of Complex Analysis. Second Edition Narosa Publishing House, New Delhi.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Ordinary and Partial Differential Equations

Course Code: MMH109

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Illustrate ordinary differential equations of various types, their solutions, and fundamental concepts about their existence.
2. Analyze stability of linear and non-linear systems. Solve the first-order linear and non-linear equations.
3. Evaluate problems of ordinary differential equations arising in various fields.
4. Formulate series solution of first order equation and second order linear equation and understand the method of successive approximations

COURSE CONTENT

UNIT-I **16 hours**

Qualitative Properties of Solutions – The Sturm Comparison Theorem – Eigen Values and Eigen Functions – Vibrating String**.** Legendre Polynomials. Properties of Legendre Polynomials, Bessel Functions.

UNIT-II **17hours**

Method of successive approximations, Existence and Uniqueness Theorem. System of differential equations, nth order differential equation, Existence and Uniqueness of solutions, dependence of solutions on initial conditions and parameters.

UNIT-III **15 hours**

Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian, Abel

Liouville formula, Reduction of order, Adjoint systems and self-adjoint systems of second order, Floquet Theory.

UNIT-IV **12 hours**

Linear 2nd order equations, preliminaries, Sturm's separation theorem, Sturm's fundamental comparison theorem, Sturm Liouville boundary value problem, Characteristic values & Characteristic functions, Orthogonality of Characteristic functions, Expansion of a function in a series of orthonormal functions.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *E. Coddington& N. Levinson (2010), Theory of Ordinary Differential Equations, Tata Mc-Graw Hill, India.*
- *S.L. Ross. (1984), Differential Equations, 3rd edition, John Wiley & sons (Asia).*
- *N. P. Bali, Bhavanari Satyanarayana, (2012), A Text book of Engineering Mathematics, IndraniPromod Kelkar, University Science Press, New Delhi.*
- *A.C. King, J. Billingham, S.R. Otto. (2003). Differential Equations, Linear, Nonlinear, Ordinary, Partial, Cambridge University Press.*
- *Williams E. Boyce and Richard C. DI Prima (2001), Elementary differential equations and boundary value problems, John Wiley and sons, New York, Seventh Edition.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Mathematical Methods

Course Code: MMH110

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain Co-ordinate Transformation and orthogonal co-ordinates
2. Illustrate Fourier series and able to apply Fourier transform
3. Apply Maline and Hankel transforms
4. Analyze problems based on Bessel's and Legendre's functions

COURSE CONTENT

UNIT-I **17 hours**

Curvilinear Co-ordinates: co-ordinate transformation, orthogonal co-ordinates, change of coordinates, cartesian, cylindrical and spherical coordinates, expressions for velocity and acceleration ds, dv and ds2 in orthogonal coordinates, area, volume and surface area in cartesian, cylindrical and spherical coordinates in few simple cases, gradient, divergence, curl, Laplacian in orthogonal coordinates, contravariant and co-variant components of a vector, metric coefficients and the volume element. Contravariant and co-variant components of a vector, metric coefficients and the volume element.

UNIT-II **18 hours**

Fourier Series: Periodic Functions, Euler's formulae for Fourier series, Fourier series for discontinuous functions, half range series, Parseval's identity, Fourier integral theorem.

Fourier Transform: Definition and properties, Fourier transform of some elementary functions, convolution theorem, application of Fourier transforms to solve ordinary and partial differential equation.

UNIT-III **13hours**

Mellin Transform: Definition, elementary properties, Mellin transform of derivatives, Integrals, Inverse Mellin transform, Convolution theorem, Inverse Mellin transform of two functions.

Hankel Transform: Definition, Elementary properties, Hankel transform of derivatives, Exponential functions, Inversion formula for Hankel transformation, Parseval's theorem, relation between Hankel and Laplace transform.

UNIT-IV **12hours**

Bessel's functions, Bessel function of second kind of order n, Trigonometric expansion involving Bessel Functions, Bessel Integral, Fourier-Bessel Expansion, ber and bei function.

Legendre's associated functions and differential equation, integral expression for associated Legendre polynomial, recurrence relation for associated Legendre polynomial.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Sneddon, I. N.(1972), The Use of integral Transforms, McGraw Hill.*
- *Bell W. W.(2004), Special Functions for Scientists and Engineers, Courier Corporation.*
- *Spiegel M., Lipschutz S., Spellman D.(2011), Vector Analysis, Schaum's Series* **.**
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Probability and Mathematical Statistics

Course Code: MMH111

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Compute the probabilities of composite events using the basic rules of probability.
2. Demonstrate understanding the random variable, expectation, variance and distributions. Explain the large sample properties of sample mean.
3. Apply the concept of the sampling distribution of a statistic, and in particular describe the behaviors of the sample mean.
4. Analyze the correlated data and fit the linear regression models.

COURSE CONTENT

UNIT-I **16 hours**

Measures of variability of data: Central and non-central moments, Sample and Population variance. Skewness and Kurtosis.

Correlation & Regression Analysis: Scatter diagram. Karl Pearson's and Spearman's rank correlation coefficient. Linear Regression and its properties. Multiple Regression, Partial and multiple correlation. Theory of attributes. Modes of convergence and their interrelationships, law of large numbers, central limit theorem.

UNIT-II **16 hours**

Random Variables and Distributions: Discrete and Continuous random variables. Probability mass function and Probability density function. Cumulative distribution function. Expectation of single- and two-dimensional random variables. Properties of random variables. Moment generating function and probability generating functions.

UNIT-III **12 hours**

Discrete Distributions: Bernoulli distribution. Binomial distribution. Poisson distribution, Negative Binomial and Hypergeometric distributions. Uniform.

UNIT-IV **16 hours**

Continuous Distributions: Normal distribution. Normal approximation to Binomial and Poisson distributions. Beta, Gamma, Chi-square and Bivariate normal distributions. Sampling distribution of mean and variance (normal population). Chebyshev's inequality, weak law of large numbers, Central limit theorems.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings: -

- *Goon, A.M., Gupta, M.K., Dasgupta, B. (1998), Fundamentals of Statistics, Vol-I & Vol-II . 7th Ed.*
- *Sheldon Ross. (2002), A First Course in Probability, 6th edition, Pearson Education Asia.*
- *Meyer, P.L. (1970), Introductory Probability and Statistical Applications. Generic Publisher.*
- *Hogg, R.V. and Craig, T.(2002), Introduction to Mathematical Statistics. MacMillan.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Field Theory

Course Code: MMH112

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Grasp the concepts of fields, extension of fields and splitting fields of polynomials.
2. Establish all properties of finite fields and Galois theory and their application.
3. Implement the concepts of vector spaces, basis, dimension and linear transformations.
4. Derive the Roots of unity and cyclotomic polynomials. Cyclic extension, Polynomials solvable by radicals.

COURSE CONTENT

UNIT-I **18 hours**

Fields, examples, Algebraic and transcendental elements, Irreducible polynomials. Gauss Lemma, Eisenstein's criterion, Adjunction of roots, Kronecker's theorem, algebraic extensions.

UNIT-II **14 hours**

Algebraically closed fields. Splitting fields, Normal extensions, multiple roots, finite fields, Separable extensions, perfect fields, primitive elements, Lagrange's theorem on primitive elements.

UNIT- III **15 hours**

Automorphism groups and fixed fields, Galois extensions, Fundamental theorem of Galois theory, Fundamental theorem of algebra.

UNIT-IV **13 hours**

Roots of Unity and cyclotomic polynomials. Cyclic extension, Polynomials solvable by radicals, Symmetric functions, cyclotomic extension, quintic equation and solvability by radicals.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Bhattacharya, P. B. Jain, S. K. &Nagpal, S, R. (1995), Basic abstract algebra (Chapters 15-17, Chapter and Nagpaul18:excluding section 5), Cambridge University Press.*
- *M. Artin (2010), Algebra. Pearson Education, India.*
- *Luther I.S. and PassiI.B.S.(1993), Algebra, Vol.I& II, Narosa Publishing House, New Delhi.*
- *Gallian J.A. (2008), Contemporary Abstract Algebra, Narosa Publishing House, New Delhi.*
- *Singh Surjeet and QaziZameeruddin(2006), Modern Algebra, Vikas Publishing House, New Delhi 8th Edition.*
- *Burnside W. (1955), The Theory of Groups of Finite Order. 2nd Ed., Dover, New York, 1955.*
- *Hungerford T.W. (1974), Algebra, Springer.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Mathematical Modelling

Course Code: MMH113

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Illustrate various techniques of mathematical modeling.
2. Apply mathematical models in different fields and situations.
3. Apply mathematical modeling through partial differential equations.
4. Analyze Stochastic models and their needs.

COURSE CONTENT

UNIT-I **16 hours**

Introduction and the technique of mathematical modeling, Classification and characteristics of mathematical models, Mathematical modeling through algebra, Effects of Immigration and Emigration on Population size, decrease of temperature, Diffusion, Change of price of a commodity, Logistic law of population growth, A simple compartment models, Diffusion of glucose or a Medicine in the blood stream.

UNIT-II **15 hours**

Mathematical modelling of epidemics, A simple epidemics model, A susceptible-infected-susceptible (SIS) model, SIS model with constant number of carriers, Simple epidemic model with carriers, Model with removal, Model with removal and immigration, Mathematical modeling in economics, Mathematical modeling in medicine, A model for diabetes mellitus, Arms race and battles: Richardson model for arms race, Lamechester combat model.

UNIT-III **14 hours**

Mathematical modeling through partial differential equations: Mass-balance Equations, Momentum balance Equations, Variational principles, Probability generating function, Modeling for traffic on a highway.

UNIT-IV **15 hours**

Stochastic models of population growth, Need for stochastic models, Linear birth-death-immigration emigration processes, Linear birth-death process, Linear birth-death-immigration process, Linear birth-death-emigration process, Non-linear birth-death process.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- Burghes D.N. and Wood A.D. (1980), *Mathematical Models in the Social, Management and Life Sciences,* John Wiley and Sons.
- Andrews J.G. and Mclone R.R. (1976), *Mathematical Modeling,* Butterworths (Pub.) Inc.
- Suggested digital platform: NPTEL/SWAYAM/MOOCs.

SEMESTER II

Course Title: Calculus Variations and Integral Equations

Course Code: MMH212

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain the methods to reduce Initial value problems associated with linear differential equations to various integral equations.
2. Categorise and solve different integral equations using various techniques
3. Describe the importance of Green's function method for solving boundary value problems associated with nonhomogeneous ordinary and partial differential equations.
4. Evaluate various mathematical and physical problems using variational techniques.

UNIT-I **17 hours**

Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Laplace transfrom method for a difference kernel. Solution of a Volterra integral equation of the first kind.

UNIT-II **16 hours**

Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholmresolvent kernel as a

ratio of two series. Fredholm equations with separable kernels. Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homonogenous Fredholm equations with degenerate kernels.

UNIT-III **12 hours**

Green function, Use of method of variation of parameters to construct the Green function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function, Hilbert-Schmidt theory for symmetric kernels.

UNIT-IV **15 hours**

Motivating problems of calculus of variations, Shortest distance, Minimum surface of resolution, Brachistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives. Conditional extremum under geometric constraints and under integral constraints.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Jerri, A.J., Introduction to Integral Equations with Applications, A Wiley-Interscience Publication, 1999.*
- *Kanwal, R.P., Linear Integral Equations, Theory and Techniques, Academic Press, New York.*
- *Lovitt, W.V., Linear Integral Equations, McGraw Hill, New York.*
- *Hilderbrand, F.B., Methods of Applied Mathematics, Dover Publications.*
- *Gelfand, J.M., Fomin, S.V., Calculus of Variations, Prentice Hall, New Jersey, 1963.*

Course Title: Functional Analysis

Course Code: MMH213

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain convergence of operators by using a suitable norm, compute the dual spaces.
2. Analyze weak and strong convergence and uniform boundedness theorem, open mappingtheorem and closed graph theorem.
3. Explain the properties of compact operators.
4. Apply the operators into self-adjoint, unitary and normal operators

UNIT-I **15 hours**

Normed spaces, Banach spaces, Finite dimensional normed spaces and subspaces, Compactness and finite dimension, Bounded and continuous linear operators, Linear operators and functionals on finite dimensional spaces, Normed spaces of operators, Dual spaces.

UNIT-II **15 hours**

Hahn Banach theorems for real and complex normed spaces, Adjoint operator, Reflexive spaces,Uniform boundedness theorem strong and weak convergence, Convergence of sequences of operators and functionals, Open mapping theorem, Closed graph theorem.

UNIT-III **15 hours**

Hilbert spaces, Orthogonal complements and direct sums, Bessel's inequality, Total orthonormal sets and sequences, Representation of functionals on Hilbert spaces, Hilbert adjoint operators, Self-adjoint, unitary and normal operators.

UNIT-IV **15 hours**

Compact operator and its relation with continuous operator, Compactness of linear transformation on a finite dimensional space, Properties of compact operators, Compactness of the limit of the sequence of compact operators.

Transaction Mode-: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Kreyszig E. (2006), Introductory Functional Analysis with Applications, John Wiley & Sons, India.*
- *Simmons George F. (1963), Introduction to Topology and Modern Analysis, McGraw-Hill BookCompany.*
- *Bachman G. and NariciL.(2000), Functional Analysis, Dover Publications.*
- *Bhatia R.(2009), Notes on Functional Analysis, Hindustan Book Agency, India.*
- *Schechter M.(2001), Principles of Functional Analysis, Second Edition, American Mathematical Society.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Classical Mechanics

L	T	P	Cr
4	0	0	4

Total Hours:60

Course Code: MMH214

Learning Outcomes

After completion of this course, the learner will be able to:

1. Illustrate the concept of tensors; Gradient, Divergence and Curl in Tensor notations
2. Analyze strain tensor and its various concepts.
3. Analyze stress tensor and principal stresses.
4. Apply Generalized Hooke's Law to real world problems.

COURSE CONTENT

UNIT-I **15 hours**

Summation convention, coordinate transformation, cartesian tensor of various orders, algebra of tensors, contraction, symmetric and skew-symmetric tensor, Kronecker delta, Alternating tensor, Gradient, Divergence, Curl in tensor notations, Gauss-divergence theorem, partial derivatives, contravariant and covariant tensors.

UNIT-II **14 hours**

Deformation in elastic bodies, homogeneous strain and its properties, Affine transformation, infinitesimal affine transformation, geometric interpretation of components of strain, strain quadric of Cauchy, strain-displacement relations, Strain invariants, principal direction and principal strain, homogeneous deformation.

UNIT- III **18 hours**

Stress vector and stress tensor, symmetry of stress tensor, stress quadric of Cauchy, equation of equilibrium and motion, principal stresses.

UNIT-IV **13 hours**

Generalized Hooke's Law- relation between stress and strain, Elastic constants and their physical significance, strain energy function and its connection with Hooke's Law, Beltrami-Michell compatibility equations.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Young, E. C.(1993), Vectors and tensor analysis, 2nd edition.*
- *Kolsky, H.(1963), Stress waves in Solids. Dover Publications.*
- *Ghosh, P. K.(1975), Mathematics of waves and vibrations. New Delhi: The Macmillan Company of India Limited.*
- *Timoshenko S. and Goodier N.(1970), Theory of Elasticity, McGraw Hill, New York.*
- *Fung Y.C.(2009), Foundations of Solid Mechanics, Prentice Hall, New Delhi.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Discrete Mathematics

Course Code: MMH216

L	T	P	Cr
3	0	0	3

Total Hours:45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Implement the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc.
2. Use Euler and Bernoulli's equations and the conservation of mass to determine velocity and acceleration for incompressible and inviscid fluid.
3. Acquire the concept of rotational and irrotational flow, stream functions, velocity potential, sink, source, vortex etc.
4. Analyze simple fluid flow with Navier - Stoke's equation of motion.

COURSE CONTENT

UNIT-I **13hours**

Relations and Functions: Binary relations, equivalence relations and partitions, partial order relations, inclusion and exclusion principle, Hasse diagram, Pigeon hole principle. Mathematical Logic: Basic logical operations, conditional and bi-conditional Statements, tautologies, contradiction, quantifiers, prepositional calculus

UNIT-II **10hours**

Mathematical Logic: Basic logical operations, conditional and bi-conditional Statements, tautologies, contradiction, quantifiers, prepositional calculus.

UNIT-III **12 hours**

Trees and Colouring of the graph: Rooted tree, search tree, tree traversals, spanning trees, minimal spanning trees, Kruskal's algorithm. Chromatic number, four-colour problem,chromatic polynomials.

UNIT-IV **10 hours**

Grammar and Languages: Phrase structure grammars, rewriting rules, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Trambley, J.P. and Manohar,R. (2017), Discrete Mathematical Structure with Applications to computer science. McGraw Hill Education.*
- *Balakrishan, V. K. (2000), Introductory Discrete Mathematics. Dover Books on Computer Science.*
- *Johnsonbaugh, R. (2007), Discrete Mathematics. Pearson.*
- *Rosen, K. (2019), Discrete Mathematics And its Application. McGraw Hill.*
- *Suggested digital platform: NPTEL/ SWAYAM/ MOOCs.*

Course Title: Operation Research

Course Code: MMH217

L	T	P	Cr
3	0	0	3

Total Hours:45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Establish some real-life problems into Linear programming problems.
2. Apply the simplex method to find an optimal vector for the standard linear programming problem and the corresponding dual problem.
3. Evaluate optimal solutions of transportation problems and assignment problems.
4. Formulate and linear programming model of two-person zero sum game.

COURSE CONTENT

UNIT-I **12 hours**

Linear Programming and examples, Convex Sets, Hyperplane, Open and Closed half-spaces, Feasible, Basic Feasible and Optimal Solutions, Extreme Point & graphical methods. Simplex method, Charnes-M method, two phase method.

UNIT-II **10 hours**

Determination of Optimal solutions, unrestricted variables, Duality theory, Dual linear Programming Problems, fundamental properties of dual Problems, Complementary slackness, Unbounded solution in Primal. Dual Simplex method.

UNIT-III **13 hours**

Revised Simplex method, Transportation Problems, Balanced and unbalanced Transportation problems, U-V method, Paradox in Transportation problem, Assignment problems. Integer Programming problems, Pure and Mixed Integer Programming problems, Travelling salesman problem.

UNIT-IV **10 hours**

Game theory: Two-person zero-sum game, game with mixed strategy, Dominance property.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *G. Hadley (1995), Linear Programming, Narosa Publishing House, 6th edition.*
- *N.S. Kambo (1984), Mathematical Programming Techniques, Affiliated East-West Press Pvt.Ltd. New Delhi, Madras.*
- *Suresh Chandra, Jayadeva, Aparna Mehra (2009), Numerical Optimization with Applications, Narosa Publishing House,1st edition.*
- *4. S.M. Sinha (2006), Mathematical Programming, Theory and Methods, Elsevier, 1st edition.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Special Function

Course Code: MMH218

L	T	P	Cr
3	0	0	3

Total Hours:45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Illustrate the general properties of Hypergeometric series, functions and their linear relationship.
2. Explain methods of studying Legendre's function, recurrence relation and their applications.
3. Evaluate Bessel's linear differential equations from application point of view.
4. Explore, formulate and solve this concept in real life situation.

COURSE CONTENT

UNIT-I **12 hours**

Hypergeometric Functions: The hypergeometric series, An integral formula for the hypergeometric series, The hypergeometric equation, Linear relations between the solutions of the hypergeometric equation, Relations of contiguity, The confluent hypergeometric function, Generalised hypergeometric series.

UNIT-II **12 hours**

Legendre Functions: Legendre polynomials, Recurrence relations for the Legendre polynomials, The formulae of Murphy and Roderigues, Series of Legendre polynomials, Legendre's differential equation, Neumann's formula for the Legendre functions, Recurrence relations for the functions Qn (μ).

UNIT-III **10 hours**

The use of Legendre functions in potential theory, Legendre's associated functions, Integral expression for the associated Legendre function, Surface spherical harmonics, Use of associated Legendre functions in wave mechanics.

UNIT-IV **11 hours**

Bessel Functions: The origin of Bessel functions, Recurrence relations for the Bessel coefficients, Series expansions for the Bessel coefficients, Integral expressions for the Bessel coefficients, The addition formula for the Bessel coefficients, Bessel's differential equation, Spherical Bessel functions, Integrals involving Bessel functions, The modified Bessel functions, The Ber and Bei functions, Expansions in series of Bessel functions, The use of Bessel functions in potential theory, Asymptotic expansion of Bessel functions.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *L. Andrews, (1985), Special Functions for Engineers and Applied Scientists, Macmillan.*
- *N. N. Lebedev, (1976), Special Functions & Their Applications, Revised Edition, Dover.*
- *W. W. Bell,(1968), Special Functions for Scientists and Engineers, Dover.*
- *Sao, G.S.(2020), Special functions, Shree shiksha Sahitya Parkasham , Meerut.*
- *Dhaonchak,P.K.(2016), Special function and Integral functions, Jeevan sons Publications.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Integral Transforms and Their Applications

Course Code: MMH219

L	T	P	Cr
3	0	0	3

Total Hours:45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Familiar with the notation and terminology related to differential equations, Laplace Transform, Fourier Transform.
2. Differentiate between ODE and PDE, know the methods to solve differential equations and be able to solve ODE and PDE of special type.
3. Analyze the utility of Laplace Transform and Fourier series in solving PDE.
4. Integrate and differentiate the Hankel transform and Fourier transform functions and examine the theory of integral equations.

COURSE CONTENT

UNIT-I **12 hours**

Laplace Transforms: Definition and examples, Existence theorem and basic properties, Convolution theorem and properties of convolution, Differentiation and Integration of Laplace transform, the inverse Laplace transform and examples, Tauberian theorems for Laplace transforms and Watson's Lemma, Laplace transforms of fractional integrals and fractional derivatives.

UNIT-II **12 hours**

Applications of Laplace Transform to solve/evaluate: Ordinary and partial differential equations, Initial and boundary value problems, Integral equations, Definite integrals, Difference equations and Differential-difference equations. Finite Laplace Transforms: Definition and examples, Basic operational properties, Applications, Tauberian theorems for finite Laplace transforms.

UNIT-III **10 hours**

Hankel Transforms: Definition and examples, operational properties, Applications to solve partial differential equations. Fourier Transforms: Fourier Integral formulas, Definition and examples, Basic properties, Fourier cosine and sine transforms and examples, Basic properties of Fourier cosine and sine transforms, Multiple Fourier transforms.

UNIT-IV **11 hours**

Applications of Fourier Transform to solve/evaluate: Ordinary and Partial differential equations, Integral equations, Definite integrals. Applications of Multiple Fourier transform. Finite Fourier Cosine and Sine Transforms: Definition and examples, Basic properties, Applications, Multiple finite Fourier transforms and their applications. Mellin Transforms: Definition and examples, Basic operational properties and Applications.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *LoknathDebnath(1995), Integral Transforms and Their Applications, CRC Press, Inc.*
- *P.P.G. Dyke (2001) An Introduction to Laplace Transforms and Fourier Series, Springer-Verlag, London.*
- *Austin Keane (1965), Integral transforms, Science Press.*
- *Brian Davies (2001), Integral Transforms and their Applications, 3rd Edition, Springer-Verlag, New York, Inc.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Linear Algebra

Course Code: MMH220

L	T	P	Cr
2	0	0	2

Total Hours:30

Course Learning Outcomes:

After completion of this course, the learner will be able to:

1. Evaluate the direct sum of vector space.
2. Apply vectors, inner products and linear transformations to real world problems.
3. Develop an algebraic understanding of eigenvalues and eigen vectors.
4. Evaluate unitary and linear transformation to various physical problems.

COURSE CONTENT

UNIT I **8 hours**

Direct sum of a vector space, Dual Spaces. Annihilator of a subspace, Quotient Spaces. Algebra of Linear transformations.

UNIT II **8 hours**

Adjoint of a linear transformation, Inner product spaces, Eigen values and eigenvectors of a linear transformation. Diagonalization. Invariant subspaces.

UNIT -III **8 hours**

Canonical forms, Similarity of linear transformations, Reduction to triangular forms, Nilpotent transformations, Primary decomposition theorem, Jordan blocks and Jordan forms, Invariants of linear transformations.

UNIT -IV **6 hours**

Hermitian, Self adjoint, Unitary and normal linear transformation, Symmetric bilinear forms, skew symmetric bilinear forms, Group preserving bilinear forms.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Herstein I. N. : Topics in Algebra, 2nd Edition, Willey eastern Limited*
- *Hoffman, Kenneth and Kunze R: Linear Algebra, Prentice Hill of India Private Limited., 1984.*
- *Sahi and Bist, Linear Algebra, Narosa Publishing House.*
- *Surjit Singh, Linear Algebra, Vikas publishing House (1997)*

SEMESTER III

Course Title: Research Methodology

Course Code: MMH318

L	T	P	Cr
4	0	0	4

Total Hours:60

Learning Outcomes

After completion of this course, the learner will be able to:

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Illustrate main approaches in legal methodology, have basic knowledge on qualitative research techniques
3. Have adequate knowledge of the key issues of disciplinary and interdisciplinary legal research.
4. Develop an adequate literature review and identify relevant references to formulate a theoretical framework in accordance with the research topic.

Course Content

UNIT I **15 hours**

Research: its concept, nature, scope, need and Objectives of Research, Research types, Research Methodology Research process – Flow chart, description of various steps, Selection of research problem.

UNIT II **15 hours**

Research Design: Meaning, Objectives and Strategies of research, different research designs, important experimental designs,

Methods of Data Collection and Presentation: Types of data collection and classification, Observation method, Interview Method, Collection of data through Questionnaires, Schedules, data analysis and interpretation, editing, coding, content analysis and tabulation.

UNIT III **15 hours**

Sampling Methods: Different methods of Sampling: Probability Sampling methods, Random Sampling, Systematic Sampling, Stratified Sampling, Cluster

Sampling and Multistage Sampling. Non probability Sampling methods, Sample size.

UNIT IV **15 hours**

Report writing and Presentation: Types of reports, Report Format – Cover page, Introductory page, Text, Bibliography, Appendices, Typing instructions, Oral Presentation

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-based Learning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Panneerselvam R , 'Research Methodology', PHI, New Delhi.*
- *Cooper, D.R.,Schindler, P.S., 'Business Research Methods,' Tata McGraw Hill .*
- *Gupta S P,' Statistical Methods', Sultan Chand & Sons, Delhi.*
- *Ronald E Walpole, 'Probability and Statistics for Engineers and Scientists' (International Edition) , Pearson Education.*
- *Geode, Millian J. & Paul K. Hatl, "Methods in Research", McGraw Hills, NewDelhi.*
- *Kothari C.R., "Research Methodology", New AgePublisher*
- *Nargundkar R, Marketing Research, Tata McGraw Hill, New Delhi,2002.*
- *Sekran, Uma, "Business Research Method", Miley Education,Singapore.*
- *https://www.academia.edu/*
- *https://www.studeersnel.nl*
- *https://www.scribd.com.*

Course Title: Research Proposal

Course Code: MMH319

L	T	P	Credits
2	0	4	4

Total Hours: 30

Learning Outcomes

After completion of this course, the learner will be able to:

1. Develop research questions and hypotheses.
2. Carry out a critical literature review, using well developed analytical and synthesis skills.
3. Understand research design, and be able to choose rigorous and practical research methods to address a problem focused research question(s).
4. Formulate and write a research proposal, using high level written and verbal communication skills.

Course Content

The research proposal is a document of around 3000-4000 words outlining the research the students will undertake. Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study. Regardless of the research area and the methodology students choose, all research proposals must address the following questions:

What students plan to accomplish, why they want to do it and how they are going to do it.

Introduction:

- Topic area
- Research question
- Significance to knowledge

Make sure the proposal starts on a general level with some type of introductory remarks before going into the details of the specific research question you are proposing. This can be accomplished by providing
a frame of reference, a definition, or a discussion of the significance of the topic in the field. Make sure the research question is fully stated in one place.

Literature Review:

- Previous research: others & yours

 Interlocking findings and unanswered questions
 Your preliminary work on the topic
 The remaining questions and inter-locking logic
 Reprise of your research question(s) in this context

The literature review demonstrates the applicant's knowledge of the main research achievements in the area of study. Pay attention to provide some of the key references in your area of research which requires doing extensive research on your part. Make sure whether you can easily determine how the proposal is building on earlier studies, as well as exploring a line of research that is new.

Methodology / Theoretical Framework:

 Approach
 Data needs
 Analytic techniques
 Plan for interpreting results
 Expected results

Provide a full description of your general research design, as well as the specific methods and procedures used in your research project. This section discusses what measures the researcher will take in order to
test the study's hypothesis.

i) Describe your theoretical approach or type of analysis, if applicable
ii) Explain the details of your methods

Objectives:

i) Give a concise and clear outline of what you intend to find out in your project and what objectives you want to achieve.
ii) Research questions may take the form of a hypothesis to be tested against a specific set of criteria or a more open-ended inquiry.
iii) Objectives should establish the relevance and value of the proposed research in the context of current academic thinking.
iv) Your proposal needs to show why the intended research is important and to justify the reason for doing the research.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

References:

Provide a list of all references that you have cited in the proposal.

Course Title: Ethics & IPR
Course Code: MMH320

L	T	P	Credits
2	0	0	2

Total Hours :30

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain different kind of ethics and values.
2. Apply professional ethics in research.
3. Illustrate the role of IPRs in professional life.
4. Elucidate the importance of patents and copyrights.

Course Content

UNIT I **10 hours**

Ethics: Definition, moral philosophy, nature of moral judgments and reactions, scope, Ethics with respect to science and research, Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance.

UNIT II **10 hours**

Introduction to Intellectual Property rights: Concept & theories, Kinds of intellectual Property Rights, Advantages & Disadvantages of IPR, Development of IPR in India, Role & Liabilities of IPRs in India. Rights of trademark-kind of signs used as trademark-types, purpose & functions of a trademark, trademark protection, trademark registration, selecting and evaluating trade mark, trade mark registration process.

UNIT III **5 hours**

Patents: Introduction to Patents, Object of Patent Law, Inventions not Patentable, Obtaining Patents, Rights and Obligations of a Patentee.

UNIT IV **5 hours**

Databases and Research Metrics: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, Altmetrics, Google Scholar, Research Gate, Pub-med etc.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning, Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Course Title: Proficiency in Teaching

Course Code: MMH321 Total Hours :30

L	T	P	Credits
2	0	0	2

Learning Outcomes

After completion of this course, the learner will be able to:

1. Design the learner-centered instructional plans and learning outcomes.
2. Apply innovative teaching strategies and technologies to engage learners.
3. Analyze the different assessment methods to evaluate student learning.
4. Develop effective communication and classroom management skills.

Course Content

UNIT I **10 hours**

Overview of the course and its objectives - Theories of learning and their implications for teaching - Understanding the role of the teacher and student in the learning process - Writing clear and measurable learning outcomes.

Meaning Nature, definition, scope, and importance Pedagogy, Andragogy, and Heutagogy – Skills-based approach to teaching (Teaching skills), Micro-teaching, Macro teaching. Methods and approaches of teaching - CAM, Structure-function approach, Synthetic and Analytic approach, Jurisprudential inquiry model

UNIT II **6 hours**

Understanding the diverse needs and backgrounds of learners - Creating an inclusive and supportive learning environment - Facilitating active learning and student engagement strategies

Lectures, discussions, and demonstrations - Group work, collaborative learning, and cooperative learning - Problem-based learning, case studies, and simulations

UNIT III **7 hours**

Integrating technology tools into instruction – Online, blended learning, flipped learning, and M-learning approaches - Using educational software and platforms effectively.

Formative and summative assessment methods – Difference between Assessment, Evaluation and Measurement, E-assessment tools,

UNIT IV **7 hours**

The importance of reflective practice in teaching - Self-assessment and evaluation of teaching effectiveness –Need for Professional development - Teaching in multicultural and international classrooms - Culturally responsive teaching practices.

Meaning, Definition of teaching model - Assumptions, Importance, Role, and type of teaching models. Historical teaching model, Philosophical model of teaching

Transaction Mode: Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-based Learning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Ali, L. (2012). Teacher education. New Delhi: APH Publishing Corporation*
- *Anandan, K. (2010). Instructional technology in teacher education. New Delhi: APH Publishing Corporation.*
- *Bruce R Joyce and Marsha Weil, Models of Teaching, Prentice Hall of India Pvt Ltd, 1985.*
- *Chalan, K. S. (2007). Introduction to educational planning and management. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chand, T. (2008). Principles of teaching. New Delhi: Anmol Publications Pvt. Ltd.*

Course Title: Computer Lab (MATLAB programming)

Course Code: MMH322

L	T	P	Cr
1	0	2	2

Total Hours:30

Learning Outcomes

After completion of this course, the learner will be able to:

1. Understand the main features of the MATLAB program development environment to enable their usage in the higher learning.
2. Implement simple mathematical functions/equations in numerical computing environment.
3. Interpret and visualize simple mathematical functions and operations there on using plots.
4. Write simple programs in MATLAB to solve scientific and mathematical problems

COURSE CONTENT

UNIT-I **8 hours**

Operators:-Arithmetic Operator, Logical, Relational.

UNIT-II **8 hours**

Branch and Loop:-If statement, If-else statement, Else-if statement, Pause, Break, Continue Switch-case, try-catch, Return Statement, For Loop, While Loop, Example(like a project).

UNIT-III **7 hours**

Script and Function:-Script Design, Function Design, Types Of Function, Example (like a project).

UNIT-IV **7 hours**

GUI (Graphical User Interface):-Introduction of GUI, GUI Function Property, GUI Component Design, GUI Container, Writing the code of GUI Callback, Dialog Box, Menu Designing

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-basedLearning,Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.

Suggested Readings:-

- *Rudra Pratab (2016), Getting Started with MATLAB, Oxford Univ. press, Seventh Edition.*
- *K.Srinivasa Rao (2012), Introduction to MATLAB, IMRF International Publications .*
- *P.Nagarajan, K.Srinivasa Rao (2009), Numerical Methods with Programs in MATLAB, University Press, SCSVMV.*
- *MiszaKalechman (2008), Practical MATLAB-Basics for Engineers, CRC Press.*
- *D.M.Etter (1997), Engineering Problems Solving with MATLAB, Prentice Hall.*
- *Suggested digital platform: NPTEL/SWAYAM/MOOCs.*

Course Title: Service Learning

Course Code: MMH323

L	T	P	Credits
0	0	4	2

Total Hours :30

Learning Outcomes

After completion of this course, the learner will be able to:

1. Explain the meaning of service learning and active learning.
2. Illustrate engaged teaching and engaged research
3. Attain greater levels of civic behaviour and social responsibility;
4. have greater commitment to a service-oriented career.

Course Content

Service learning: principles of service learning; classification of service learning models; difference between service learning and other community experiences; historical context of university community partnership; physics students and service learning. Service Learning for a postgraduate physics student and its scope in research.

Conceptualization of the idea of service learning through the following practical implementations:

(i) conducting awareness programmes on scientific temper for nearby communities,

(ii) organizing demonstrations of scientific experiments for school children to eradicate the fear of pursuing higher studies in science,

(iii) surveying the need of the communities and find out various possibilities of providing the solutions from physics point of view

(iv) providing consultancy to school students for various inter school science competitions.

(v) providing video lectures and/or demonstrations for school students.

SEMESTER IV

Course Title: Dissertation

Course Code: MMH402

L	T	P	Cr
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Guidelines for Dissertation:

The purpose of the dissertation in M.Sc. 4th semester is to introduce research methodology to the students. It may consist of a review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to the subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of the subject (Experimental or Theoretical) under the guidance of the allotted supervisor of the department. The students must submit their dissertations in the department as per the date announced for the submission**.**
Internal assessment of the dissertation work will be carried out by the respective supervisor through
power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through a power-point presentation given by candidates. This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions, conclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be 12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and a half) space.
- The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)

● The total no. of written pages should be between 40 to 60 for the dissertation.

2. The candidate shall be required to submit two soft-bound copies of the dissertation along with a CD in the department as per the date announced.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the semester.

4. The candidate will defend her/his dissertation/project work through a presentation before the External examiner at the end of the semester and will be awarded marks.

5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva -voce.

Transaction Mode- Lecture, Demonstration, Video Based Teaching, Collaborative Teaching, Project-based Learning, Group Discussion, E-team Teaching, Flipped Teaching, Quiz, Open Talk, Case Analysis.