हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
शाहपुर परिसर, शाहपुर, ज़िला काँगड़ा (हि.प्र.) - 176206
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Central University of Himachal Pradesh

Srinivasa Ramanujan Department of Mathematics, Shahpur Parisar

Program Specific Outcomes

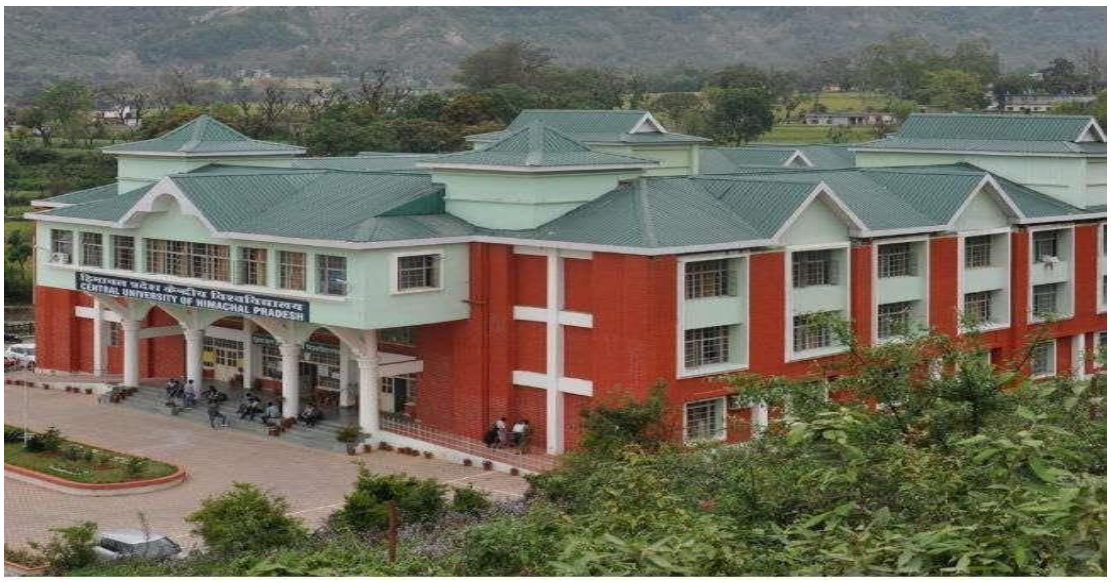
Program Outcomes

Course Outcomes & Course Contents

of

Master of Science in Mathematics (MSc Mathematics)

School of Mathematics, Computers & Information Sciences



Programme Specific Outcomes of Master of Science in Mathematics

PSO[1]: To possess the systematic understanding of the concepts, theories and methods of mathematics at higher education level.

PSO[2]: To deal with the real-world problems and their significance by critical understanding, analyzing and synthesizing the various mathematical concepts.

Programme Outcomes of Master of Science in Mathematics

PO[1]: To comprehend and analyze mathematical theories, methods, and findings in their appropriate contexts.

PO[2]: To learn the generalization of mathematical theories, as well as how to bridge them to broader concepts.

PO[3]: To review the literature related to pure/applied mathematics, and identify the knowledge gaps.

PO[4]: To analyze data critically, prepare scientific reports/papers, and defend the work.

Batch 2022-24

M.Sc. Mathematics
Semester-I
(Monsoon Semester, 2022)

COURSES OFFERED BY SRINIVASA RAMANUJAN DEPARTMENT OF MATHEMATICS

Sr. No.	Course Name	Course Code	Credits
Major Courses(Disciplinary Courses) (10 Credits)			
1	Ordinary Differential Equations	MTH 401	02
2	Linear Algebra	MTH 403	04
3	Real Analysis	MTH 406	04
Minor Courses(Disciplinary Courses) (04 Credits)			
4	Calculus of Variations	MTH 431	02
5	To be Chosen from the Course basket at University Level which is different and distinct from the programme which s/he is enrolled in.		02
Vocational/Skill Courses (04 Credits)			
6	Operational Research	MTH 502	02
7	Cryptography	MTH 548	02
Indian Knowledge System Courses (at University Level)(02 Credits)			
8	Indian Knowledge System	IKS	02

Major Disciplinary Courses (10 Credits)

Course Code: MTH-401

Course Name: Ordinary Differential Equations

Credits: 02

Course Instructor: Prof. Rakesh Kumar

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Outcomes: After completing the course satisfactorily, a student will be able:

CO1: Comprehend general theory of first order differential equations.

CO2: To analyze autonomous systems, bifurcation points and limit cycle.

CO3: To get familiar with Sturm-Liouville problems and the Riccati equation.

Learning Outcomes: The deliverables Learning Outcomes of this paper with students are following:

1) Can formulate differential equations.
2) Can check the existence and uniqueness of solutions.
3) Can check the independence and dependence of solutions of second order equations.

Attendance Requirements: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination:20%
2. End Term Examination:60%
3. Continuous Internal Assessment: 20%. i.e. 20 marks out of100

Course Contents:

UNIT I: First order differential equations: Basic results, Autonomous equations, generalized logistic equation, Bifurcation, Linear systems, Floquet theory, Autonomous systems: phase plane, stability of nonlinear systems, and linearization of nonlinear systems, existence and nonexistence of periodic solutions.

(Chapters - 1, 2 and 3) (10 HRS)

UNIT-II: Self-Adjoint Second Order Differential Equations: Basic definitions, Cauchy function and variation of constants formula, Sturm-Liouville Problems, Zeros of solutions and Disconjugacy, Factorizations and recessive and dominant solutions, The Riccati equation. **(Chapter - 5) (10 HRS)**

Text Book:

1. W.G. Kelley, A.C. Peterson, (2010). The Theory of Differential equations, Second Edition, Springer.

Reference Books

1. S. Ahmad, A. Ambrosetti, (2015). A Textbook on Ordinary Differential Equations, Second Edition, Springer Nature.

Course Articulation Matrix of MTH 401- ORDINARY DIFFERENTIAL EQUATIONS

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	3	2	2	3	3	2
CO2	1	2	1	2	1	2
CO3	2	3	2	1	2	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: MTH 403

Course Name: LINEAR ALGEBRA

Course Credit: 04

Course Instructor: Dr Meenakshi

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom

activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The main aim of this course is to introduce basic ideas and techniques of linear algebra which are used to solve systems of linear equations using various methods by appropriate proof-writing techniques.

Course Outcome:

By the end of the course students will be able to understand:

CO^1: The abstract definition of a set theory, and be familiar with the definition of Vector space with examples.

CO^2: All concepts of linear transformation.

CO^3: About the Eigenvector, Eigenvalues minimal polynomials.

CO^4: About the functional, inner product space and quadratic forms.

CO^5: How to apply some underlining and cross-cutting concepts of Vector space and related concepts.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination: 40

End Term Examination: 120

Continuous Internal Assessment: 40

Course Contents:

Unit I:

Vector Spaces, Subspaces, Basis and dimension, Linear Transformations, Quotient spaces, Direct sum, The matrix of a linear transformation, Duality **(12 Hours)**

Unit II:

Eigenvalues and eigenvectors, Annihilating polynomials, Invariant subspaces, Triangulation and diagonalization.

(10 Hours)

Unit III:

Canonical Forms, Jordan Form, Inner Product Spaces, orthonormal basis, Linear functional and adjoints.

(10 Hours)

Unit IV:

Bilinear Forms, Definition and examples, Symmetric and skew-symmetric bilinear forms.

(08 Hours)

Prescribed Text Book:

1. K. Hoffman and R. Kunze : Linear Algebra, Second Edition, Pearson,2015.

Suggested Additional Readings:

1. Strang G.: Linear Algebra and its Applications, 4thEdition, CENGAGE LEARNING, 2007.
2. Kumaresan S.: Linear Algebra, A Geometric approach, Prentice Hall of India,2000.
3. Lipschutz S. and Lipson M. L.: Linear Algebra, 3rdEdition, McGraw Hill Education India, Pvt. Ltd., 2001.
4. Anton H. and Rorres C.: Elementary Linear Algebra, 11thEdition, Wiley,2014.

Course Articulation Matrix MTH 403- Linear Algebra

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	1	2	2	2	1	1
CO2	2	2	1	2	1	1
CO3	1	2	2	2	2	2
CO4	2	1	2	3	2	1
CO5	1	2	2	2	2	1

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: MTH 406

Course Name: Real Analysis

Credits: 04

Course Instructor: Dr. Pankaj Kumar S/O Late Sh. Maniram

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is

- To obtain the thorough understanding of the origins of Number System
- To gain the knowledge of sequence and series of real numbers and convergence
- Studying the notions of continuous functions of real number system and their properties

Course Outcomes: After successful completion of the course, a student will be able to:

CO^{1} Define and recognize the basic properties of the field of numbers
CO^{2} Define and recognize the continuity and differentiability of the functions and their properties
CO^{3} Improve and outline the logical thinking of Number system
CO^{4} Understand Applications of Integration and Differentiation

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 40

2. End Term Examination: 120

3. Continuous Internal Assessment: 40

Course Contents:

Unit-I: Real and complex number systems, Basic Topology: Rational Numbers, Dedekind' Theorem, Cantor' Theory of Irrational Numbers, Ordered sets, Fields, The Real field and Complex field, Euclidean spaces, Countable and Uncountable sets, Metric spaces, Compact sets. **(10 Hours)**

Unit-II: Sequence, Series and Continuity: Sequence, subsequence, Convergent sequence, upper and lower limits, Series of non-negative terms, the root and ratio test, Power series and Summation by parts, Absolute convergence, Continuity and compactness, monotonic functions. **(10 Hours)**

Unit-III: Differentiation: Differentiation of a Real valued function, Mean value theorem, Differentiation of Vector valued functions, L. Hospital Rule, Taylor's Theorem and Derivatives of Higher order.

(10 Hours)

Unit-IV: Sequence, Series of Functions and Functions of several Variables: Uniform Convergence, Equi-continuous Families of Functions, The Stone-Weierstrass Theorem, Differentiations of a Function of Several Real Variables and the Contraction Principle. **(10 Hours)**

Prescribed Text Books:

1. Rudin, Walter, "Principles of Mathematical Analysis", 3rd Edition, McGraw Hill.
2. Robert G. Bartle, Donald R. Sherbert, "Introduction to Real Analysis" ,3rd Edition, Wiley.

Suggested Additional Readings:

1. G.F. Simmons, "Topology and Modern Analysis", 1st Edition, McGraw Hill.
2. Russell A. Gordon, "Real Analysis: A First Course", Addision-Wesley Higher Mathematics Series.

Course Articulation Matrix of MTH 406- Real Analysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	2	2	1		3	3
CO^2	3	2	2	1		3	2
CO^3	3	2	2	1		3	2
CO^4	3	2	2	1		3	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Minor Courses (4 Credits : 2 Credits from Department & 2 Credits from other Departments)

Course Code: MTH 431

Course Name: Calculus of Variations

Credits: 02

Course Instructor: Dr S. K. Srivastava

Credits Equivalent: (One credit is equivalent to 10 hours of lectures/organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work /Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/ dissertation/ thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the calculus of variations.

Course Outcomes: After successful completion of the course, a student will be able to understand:

CO[1] The notion of variations.

CO[2] The Brachistochrone problem and Isoperimetric problem.

CO[3] The Euler Lagrange's equations.

CO[4] Applications of calculus of variations.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examinations.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

Unit I: Calculus of Variations: Concept of variation, Linear functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema, Euler-Lagrange differential equation for n-dependent variables, Functional dependent on higher order derivatives, Functional dependent on functions of several variables.

(10 Hours)

Unit II: Applications of calculus of variations to various problems: Shortest distance, minimum surface of revolution, Brachistochrone problem, geodesic, Isoperimetric problem, Calculus of variations for problems in parametric form, Variational problems with moving boundaries. **(10 Hours)**

Prescribed Text Books:

I.M. Gelfand and S.V. Fom in (2012): Calculus of Variations, Prentice Hall Inc.

Suggested Additional Readings:

A. S. Gupta (1996): Calculus of Variations with Applications, Prentice–Hall of India.

Robert Weinstock (1975): Calculus of Variations with applications to Physics and Engineering, Dover Publications Inc.

Course Articulation Matrix of MTH 431 - Calculus of Variations

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	2	1	1		3	2
CO^2	3	2	1	1		3	2
CO^3	3	2	1	1		3	2
CO^4	3	2	1	1		2	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Vocational/Skill Courses

Course Code: MTH 502

Course Name: Operational Research

Credits: 02

Course Instructor: Dr. Pankaj Kumar S/o Sh. Krishan Singh

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the operational Research which is mainly concerned with the techniques of applying scientific knowledge, besides the development of science and provides an understanding which gives the expert/manager new insights and capabilities to determine better solutions in his decision–making problems, with great speed, competence and confidence.

Course Outcomes: After successful completion of the course, a student will be able to understand:

CO^{1} The formulation and solution to real mathematical models of LPP.
CO^{2} The Graphical and Simplex methods for the solution of LPP.
CO^{3} Degeneracy and dual Simplex methods.
CO^{4} Queueing systems and solution of Queueing Models.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

Unit I: Operations research & its scope, Necessity of operations research in industry. Introductions to Linear programming problems, General linear programming problems, Mathematical Formulation of L.P.P. and examples, Feasible, Basic feasible and optimal solutions, Extreme points, Graphical Methods to solve L.P.P., Simplex Method. Big M Method, Two phase Method, Degeneracy, Unrestricted variables, unbounded solutions, Duality in LPP, fundamental properties of Dual problems, dual simplex method and Revised Simplex method.

(10 Hours)

Unit II: Queueing systems, Queueing problem, Transient and steady states, Probability Distributions in Queueing systems. Poisson process (pure birth process), Properties of Poisson's arrivals, Exponential process, Markovian property, Pure death process, Service time distribution, Erlang service time distribution, Solution of Queueing Models. **(10 Hours)**

Prescribed Text Books:

1. Kanti Swarup, P.K. Gupta and Manmohan (2004), Operations Research, Sultan Chand & Sons, 12th Edition.

Suggested Additional Readings:

1. S. D. Sharma (2004), Operations Research, KedarNath Ram Nath & Co. 14th Edition.

Course Articulation Matrix of MTH 502- Operational Research

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	2	1	1	2	3
CO^2	3	2	1	1	2	3
CO^3	3	2	1	1	2	3
CO^4	3	2	1	1	2	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: MTH-548

Course Name: Cryptography

Course Credit: 02

Course Instructor: Dr. Pankaj Kumar S/O Late Sh. Maniram

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom

activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with basics of Cryptography and Network security.

Course Outcomes

After completing the course satisfactorily, a student will be able:

CO^1 To calculate probabilities by applying probability laws and theoretical results.

CO^2 To understand the axiomatic formulation of modern Probability Theory.

CO^3 To understand the Conditional Probability including the concept of Bayes' Theorem.

CO^4 To characterize probability models and function of random variables based on single & multiples random variables.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 40
3. Continuous Internal Assessment: 20

Course Contents:

Unit I:

Definition of a cryptosystem, Security attacks, Security services, Symmetric cipher model, Classical encryption techniques, Substitution and transposition ciphers, caesar cipher, Playfair cipher. Block cipher Principles, Shannon theory of diffusion and confusion, Data encryption standard (DES).

UNIT II:

Introduction to public key cryptography, Identity Based Public key Cryptography, RSA algorithm and security of RSA, Hash based security, Introduction to elliptic curve cryptography. Lattices based cryptography, Digital signature, Elgamal signature, Authentication, Key exchange protocols.

Prescribed books:

1. William Stallings, "Cryptography and Network Security", Principles and Practice, Fifth Edition, Pearson Education, 2012.

Reference books :

1. Douglas R. Stinson, "Cryptography theory and practice", CRC Press, Third edition, 2005.

Course Articulation Matrix MTH 548- Cryptography and Network Security

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	2	2	2	2	2	2
CO2	2	2	3	3	1	2
CO3	1	3	2	2	2	2
CO4	2	1	2	3	2	1

1. Partially Related
2. Moderately Related
3. Highly Related

Indian Knowledge System (IKS) Course (02 Credits)

Syllabus is framed centrally as per CUHP Guidelines, and is adopted in totality.

M.Sc. Mathematics
Semester-II
(Spring Semester 2023)

Sr. No.	Course Name	Course Code	Credits
Major Courses (10 Credits)			
1	Partial Differential Equations	MTH 402	02
2	Abstract Algebra	MTH 404	04
3	Complex Analysis	IAM 401	04
4	Numerical Analysis	IAM 403	02
Minor Courses (04 Credits)			
5	Linear Integral equations	MTH 432	02
	To be chosen from the Course basket at University Level which is different and distinct from the programme which s/he is enrolled in.		02
Vocational/Skill Courses (02 Credits)			
7	Basics of Fluid Dynamics	MTH 433	02
IKS (02 Credits)			
8	Introduction to Rigorous and Precise Thinking	MTH 528	02

Course Contents

Major Courses (12 Credits)

Course Code: MTH-404

Course Name: Abstract Algebra

Course Credits: 04

Course Instructor: Dr. Meenakshi

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

This course aims to provide a first approach to the subject of abstract algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings, fields.

Course Outcome:

By the end of the course students should be able to understand:

Co^1: The abstract definition of a group, and be familiar with the basic types of examples, including numbers, symmetry groups and groups of permutations and matrices.

Co^2: Description of algebraic techniques and basic elements of abstract algebra.

Co^3: The state axioms of groups, rings and fields.

Co^4: How apply some underlining and cross-cutting concepts of groups, rings and fields.

Co^5: The concept of cosets of a subgroup of a group and normal subgroups, symmetric groups, cyclic groups and their properties.

Co^6: The concept of quotient groups, homomorphism and isomorphism.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 40
2. End Term Examination: 120

3. Continuous Internal Assessment: 40

Course Contents:

Unit I

Laws of Composition, Groups and Subgroups, Examples of Groups and Subgroups, Groups generated by a Set, Cyclic Groups, Order of an element of a Group, Cosets, Lagrange's theorem, Index of a Subgroup, Cycle decomposition of a Permutation. Homomorphisms, Isomorphisms, Automorphisms, Normal Subgroups, Quotient Groups, The Isomorphism theorems, the Correspondence Theorem, Direct Product of Groups. **(12 hours)**

Unit II

Group Actions, Examples of Group Actions, Orbit and Stabilizer of Group Action, Orbit and Stabilizer Formula, Cayley's theorem, Conjugacy Classes, Center of a Group, Centralizer of a Subset, the Class Equation, Application of the Class Equation, the Center of a p-Group and related results, Simple Groups. **(08 hours)**

Unit III

Stabilizer and Normalizer of a Subgroup, the First Sylow theorem, the Second Sylow theorem, the Third Sylow theorem. Applications of Sylow Theorems, Definition of a Ring, Examples of Rings, Subrings, Homomorphisms of Rings, Kernel of a Homomorphism, Ideals, Ideal Generated by a Set, Principal Ideals. **(08 hours)**

Unit IV

Quotient Ring, Prime Ideals, Maximal Ideals, the Isomorphism theorems for Rings, the Universal Mapping Property of Quotient Rings, The Correspondence theorem, Dircet Product Rings, Integral Domains, Group of Units of a Ring, Associates, Irreducible Elements of Ring, Prime Elements of a Ring, Unique Factorization Domains, An Example of a Non-Unique Factorization Domain.

(12 hours)

Prescribed Text Books:

1. Isaac I.M., *Algebra: A Graduate Course, AMS (Graduate Studies in Mathematics),* Indian Edition.
2. Artin M., *Algebra,* Second Edition, PHI
3. Bhattacharya P. B., Jain S.K., Nagpaul S. R., *Basic Abstract Algebra,* Second Edition, Cambridge University Press.

Additional Text

1. Dummit D. S. and Richard M. Foote, *Abstract Algebra*, Third Edition, Wiley India
2. Jacobson N., *Basic Algebra,* Vol. 1, Hindustan Publishing Corporation, Delhi

Course Articulation Matrix MTH-404- Abstract Algebra

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	3	2		1	1	2
CO2	2	3	1	1		1	1	2
CO3	1	2	2	3		2	2	2
CO4	2	1	2	3		2	1	1
CO5	1	2	3	1		2	1	2
CO6	1	1	1	1		1	1	1

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: IAM 401

Course Name: Complex Analysis

Credits: 04

Course Instructor: Dr S. K. Srivastava

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives: The objectives of this course are to:

- Provide an introduction to the indispensable ideas for the development of the functions of a complex variable and
- equip students with clear understanding of the elementary concepts of the theory of complex analysis and skills to enable them to work with the concepts effectively.

Course Outcomes: After successful completion of the course the student will be able:

CO$^{1:}$ To understand Stereographic projection, analytic functions and singularities.

CO$^{2:}$ To understand Branch point, conformal transformations and homotopic curves.

CO$^{3:}$ To learn basics of complex integrations and Fundamental theorem of algebra.

CO$^{4:}$ To understand Maximum-Modulus theorem and Rouche's theorem etc.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination: 40
End Term Examination: 120
Continuous Internal Assessment: 40

Course Contents:

UNIT-I: Complex Numbers, Geometric description, Stereographic projection, Analytic functions, the Cauchy-Riemann equations, multivalued functions, Branch point. **(10 Hours)**

UNIT-II: Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic

function. **(10 Hours)**

UNIT-III: The Liouville theorem, The Morera theorem, Maximum-Modulus theorem, conformal transformations. **(10 Hours)**

UNIT-IV: Taylor's series, Laurent's series, Singularities of complex functions, the Cauchy Residue theorem, Evaluation of integrals. **(10 Hours)**

Prescribed text book:

J. B. Conway, Functions of one complex variable, International Student-Edition, Narosa Publishing House, 2000.

Reference books:

- K. Kodaira, Complex Analysis, Cambridge University Press,2007.
- J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill,8thEdition,2008.

CourseArticulationMatrixofIAM401-ComplexAnalysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme SpecificOutcomes 2
CO^1	3	2	1	1		3	2
CO^2	3	2	1	1		3	2
CO^3	3	2	1	1		3	2
CO^4	3	2	1	1		3	2

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: IAM 403

Course Name: Numerical Analysis

Credits: 02

Course Instructor: Prof. Rakesh Kumar

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The main objective of this course is to familiarize the students with basic numerical schemes and their applications.

Course Outcomes: After completing the course satisfactorily, the student will be able to:

CO1: Interpolate and approximate functions.
CO2: Perform numerical differential and integration.
CO3: Perform error analysis.
CO4: Apply basic numerical algorithms.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination:20%
End Term Examination:60%
Continuous Internal Assessment: 20%. i.e. 20 marks out of 100

Course Contents:

Unit I: Lagrange and Newton interpolations, interpolations using finite differences, Hermite interpolation, piecewise and spline interpolation, Polynomial approximation: least square approximation, orthogonal polynomials, uniform approximation, rational approximation. **(07 HRS)**

Practicum

- Solving the Exercises of the selected Chapters
- Implementation on the selected real world problems
- Performing simulations for the pattern of solutions

Unit II: Numerical Differentiation and Integration: methods based on interpolation, methods based on undetermined coefficients, composite integration methods, Romberg integration. **(07 HRS)**

Practicum

- Solving the Exercises of the selected Chapters
- Implementation on the selected real world problems
- Performing simulations for the pattern of solutions

Unit III: Initial and Boundary value problems: Taylor's series method, Runge-Kutta methods, shooting method. **(06 HRS)**

Practicum

- Solving the Exercises of the selected Chapters
- Implementation on the selected real world problems
- Performing simulations for the pattern of solutions

General Practicum:

i. Class Room Presentation
ii. Model/Chart/PowerPoint based presentations
iii. Assignment/ Write Up/Creative work
iv. Books/Journals Readings
v. Tutorials/PBL

Prescribed Text Book:

1. M.K. Jain, S. R. K. Iyengar and R. K. Jain: Numerical Methods, 6th Edition, New Age International (P) Limited, Publishers, New Delhi.

Suggested Additional Readings:

1. S. S. Sastri; Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd., 2005.
2. S.C. Chapra: Applied Numerical Methods with MATLAB, McGraw Hill, 2012.

Course Articulation Matrix of IAM 403- Numerical Analysis

Course Outcomes	Programme Specific Outcomes 1	ProgrammeSpecific Outcomes 2	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4
CO1	3	2	2	3	2	1
CO2	3	2	2	3	2	1
CO3	3	3	3	2	2	2
CO4	2	3	3	2	1	1

1. Partially Related 2. Moderately Related 3. Highly Related

Course Code: MTH 402

Course Name: Partial Differential Equations

Credits: 02

Course Instructor: Dr. Pankaj Kumar S/O Sh. Krishan Singh

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The main objective of this course is to familiarize the students with the basic idea of Partial Differential Equations, their formation and different solution techniques along with numerous applications.

Course Outcomes: After completing the course satisfactorily, the student will be able:

CO1: To form partial differential equations for different configurations.

CO2: To Classify the distinct types of partial differential equations.

CO3: To Understand the various mathematical techniques to handle the partial differential equations.

CO4: To apply the knowledge of partial differential equations in some physical problems.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination: 20%
End Term Examination: 60%
Continuous Internal Assessment: 20%. i.e. 20 marks out of 100

Course Contents:

Unit I: Partial Differential equations of first order: Formation of Partial Differential Equation; Solution of Partial Differential Equations of First Order; Integral Surfaces Passing Through a Given Curve; The Cauchy Problem for First Order Equations; Surfaces Orthogonal to a Given System of Surfaces; First Order Nonlinear Equations; Cauchy Method of Characteristics; Compatible Systems of First Order Equations; Charpit's Method.

Fundamental concepts: Classification of second order partial differential equations, Canonical forms, adjoint operators**. (10 Hrs)**

Unit II: Elliptic partial differential equations: maximum-minimum principle, separation of variables; Parabolic partial differential equations: maximum-minimum principle, separation of variables; and hyperbolic partial differential equations: separation of variables. **(10 Hrs)**

Prescribed Text Books:

1. K. Sankara Rao: Introduction to partial differential equations, PHI Learning Private limited, Delhi, 2011.

2. W.A. Strauss; Partial differential equations an introduction, John Wiley & Sons, 2008.

Suggested Additional Readings:

1. D. Bleecker & G. Csordas; Basic partial differential equations, VAN NOSTRAND REINHOLD NewYork, 1992 .

2. M. Renardy & R.C. Rogers: An introduction to partial differential equations, Springer, 2009.

3. H.F. Weinberger: A first course in partial differential equations, Dover, 1995.

Course Articulation Matrix of MTH 402- Partial Differential Equations

Course Outcomes	Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4
CO1	2	1	2	2	1	1
CO2	1	1	2	2	1	1
CO3	3	2	3	3	2	1
CO4	2	3	2	3	2	2

1. Partially Related
2. Moderately Relate
3. Highly Related

Minor Courses (04 Credits)

Course Code: MTH 432

Course Name: Linear Integral Equations

Credits: 02

Course Instructor: Dr Kranti Kumar

Credits Equivalent: (One credit is equivalent to 10 hours of lectures/organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work /Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/ dissertation/ thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the linear integral equations.

Course Outcomes: After successful completion of the course, a student will be able to understand:

CO^1 The methods of solving Fredholm integral equations.

CO^2 The methods of solving Volterra integral equations.

CO^3 The eigenvalues and eigenfunctions.

CO^4 Resolvent kernels and Symmetric kernels.

AttendanceRequirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examinations.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

Unit I: Review the basic concepts for solving ODE: First order and second order Linear differential equations, Series solution for ODE where x=0 is ordinary point, Leibnitz rule for differentiation of integrals, Cauchy formula for reducing multiple integrals to single integral and Laplace transforms. Integral equations: classification of integral equations; conversion from IVP to Volterra integral equations and conversely; conversion from BVP to Fredholm integral equations and conversely, Integral equations with separable kernels. **(10 Hours)**

Unit II: Method of successive approximations, eigenvalues and eigenfunctions, Resolvent kernels, Symmetric kernels, Hilbert Schmidt theorem and solution of symmetric integral equations. **(10 Hours)**

Prescribed Text Book:

M.D. Raisinghania (2016), Integral equations and boundary value problems, S. Chand Publishing.

Suggested Additional Reading:

F.G. Tricomi, (1985): Integral Equations, Cambridge University Press.

Course Articulation Matrix of MTH 432 - Linear Integral Equations

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	2	1	1		3	2
CO^2	3	2	1	1		3	2
CO^3	3	2	1	1		3	2
CO^4	3	2	1	1		2	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Vocational/Skill Courses (02 Credits)

Course Code: MTH 433

Course Name: Basics of Fluid Dynamics

Credits: 02

Course Instructor: Dr. Pankaj Kumar S/O Sh. Krishan Singh

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

The purpose of this course is to acquaint the students with the basics of fluid dynamics.

Course Outcomes:

After successful completion of the course, a student will be able to understand:

CO^1 The basic knowledge of various kinds of fluid flows.
CO^2 Basic laws and hypotheses observed in the dynamics of distinct fluids.
CO^3 Basic hydrodynamical equations related to different fluid flow problems.
CO^4 The knowledge of different basic mathematical tools which are important to analyze fluid flow.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

Unit I: Basic concepts: Types of fluids and flows, continuum hypothesis, Newton's law of viscosity, thermal conductivity, rotation and circulation, stress and rate of strain.

Unit II: Kinematics of flow field: Lagrangian and Eulerian approach, streamlines, pathlines, streaklines,

material derivative, stream function and its physical significance, vorticity vector, complex velocity potential, Kelvin's minimum energy theorem, source, sink, doublet and images in two dimensions drag and lift force, Kutta-Jukowski theorem.

Unit III: Basic hydrodynamic equations: Equation of continuity; Euler's equation; Kelvin's circulation theorem; Bernoulli equation; The Navier-Stokes equations and the equation of energy.

Unit IV: Dynamical similarity: Inspection and dimensional analysis; Rayleigh's technique; Buckingham theorem.

Prescribed Text Books:

1. Raisinghania M.D. (2011).Fluid Dynamics. Tenth Edition. S Chand & Company LTD. New Delhi.

2. Bansal J. L. (2004). Viscous Fluid Dynamics. Second Edition. Oxford and IBH Publishing, Delhi.

Suggested Additional Readings:

1. Kundu P.K. and Cohen I.M. (2010). Fluid Mechanics. Fourth Edition. Academic Press.

Course Articulation Matrix of MTH 433 - Basics of Fluid Dynamics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	2	3	1	1		2	2
CO^2	3	3	1	1		3	2
CO^3	3	2	1	1		3	3
CO^4	3	2	1	1		2	3

1. Partially Related
2. Moderately Relate
3. Highly Related

IKS (02 Credits)

Course Code: MTH 528

Course Name: Introduction to Rigorous and Precise Thinking

Credits: 02

Course Instructor: **Dr. Pankaj Kumar S/O Late Sh. Maniram**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

The objectives of this course are:

- To understand what is mathematics and its purpose
- To think for the development of Mathematics
- To know about why we need to learn about Mathematics
- To precise about mathematical statements
- To perform different types of proofs

Course Outcomes:

After successful completion of the course the student will be able:

CO^1 Explain different definitions of Mathematics

CO^2 Explain the basic ideas for the development of Mathematics

CO^3 Explain logical combinatorics

CO^4 To possess the knowledge to approach for proofs of Mathematical statements

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

UNIT-I: Rigorous Thinking, Types of Thinking, procedure of thinking, Getting precise about language, the logical combinatorics, Implication, Quantifiers. **(10 Hours)**

UNIT-II: Rigorous Mathematical Thinking, Computational Thinking, Reasoning, Logics, Arguments, Predicate, Quantifier, assertion and reason. Language and Grammar. **(10 Hours)**

Prescribed text book:

Keith Devlin, Introduction to Mathematical Thinking, Publisher: Keith Devlin, 331 Poe St, Unit 4, Palo Alto, CA 94301, USA

Course Articulation Matrix of MTH 528- Introduction to Rigorous and Precise Thinking

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	3	2	1	3	3
CO^2	3	3	2	1	3	2
CO^3	3	3	2	1	3	2
CO^4	3	3	2	2	3	3

1. Partially Related
2. Moderately Relate
3. Highly Related

M.Sc. Mathematics
Semester-III
(Monsoon Semester, 2023)

Sr. No.	Course Name	Course Code	Credits
Major Courses (Disciplinary Courses) (04 Credits)			
1	Mechanics	MTH 504	02
2	Mathematical Analysis	IAM 503	02
3	Functional Analysis	IAM 501	02
Minor Courses (Disciplinary Courses) (04 Credits)			
4	Research Methodology	MTH 551	04
Vocational/Skill Courses (04 Credits)			
5	Fundamentals of Statistics	MTH 410	04
Review of Literature, Research Proposal (08 Credits)			
6	Review of Literature	MTH 555	04
7	Research Proposal	MTH 556	04

Major Courses (Disciplinary Courses) (04 Credits)

Course Code: MTH 504

Course Name: Mechanics

Course Instructors: **Dr. Pankaj Kumar S/O Sh. Krishan Singh**

Credits: 02

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity/contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/fieldwork; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics, and to develop skills in formulating and solving physics problems.

Course Outcomes: After completing the course satisfactorily, the student will be able to:

CO^1: Understand the basic concepts related to the Lagrangian and Hamiltonian Mechanics.

CO^2: Understand Lagrange and Poisson's brackets and their role in mechanics.

CO^3: Learn about the various useful mathematical techniques/methods used in Lagrangian and Hamiltonian mechanics.

CO^4: Apply the basic concepts of mechanics to real-world problems and their significance.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in examinations.

Evaluation Criteria:

Mid-Term Examination: 20

End-Term Examination: 60 Continuous Internal Assessment: 20

Course Contents:

Unit I: Generalized coordinates, constraints, work and potential energy, generalized forces, the principle of virtual work, introduction to Lagrange's equation, Lagrange's equation for a particle in a plane, the classification of dynamical systems, Lagrange's equation for any simple dynamical system. Lagrange's equation for non-holonomic systems with moving constraints, Lagrange's equations for impulsive motion, and the Branchistochrone problem.

Unit II: Hamilton's principle, stationary values of a function, constrained stationary values, stationary value of a definite integral, Hamilton's equation, Derivation of Hamilton's equations. Ignorable coordinates, the Routhian function, modified Hamilton's principle, the principle of least action, and the Hamilton-Jacobi equation. Lagrange and Poisson brackets, invariance of Lagrange and Poisson brackets under canonical transformations.

Prescribed Text Books:

1. John L. Synge and Byron A. Griffith Principles of Mechanics, McGraw Hill, 3rd Edition.

2. Donald T. Green and Wood, Classical Dynamics, Prentice Hall of India, 1979.

Suggested Additional Readings:

1. K Sankara Rao, Classical Mechanics, Prentice Hall of India, 2005.

2. S.L. Gupta, V. Kumar and H.V. Sharma, Classical Mechanics, Pragati Prakashan, 13th Edition, 2019.

Course Articulation Matrix of MTH 504- Mechanics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	2	3	2	3	2
CO^2	3	2	3	2	3	2
CO^3	2	3	2	2	3	2
CO^4	2	3	2	2	2	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: IAM 503

Course Name: Mathematical Analysis

Course Credit: 02

Course Instructor: Dr. S. K. Srivastava

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom

activity/contact hours; 5 hours such as independent individual/ group work; obligatory/ optional work placement; literature survey/ urs of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload library work; data collection/fieldwork; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: This course aims to familiarize students with the abstract concepts central to contemporary analysis, fostering their deep understanding.

Course Outcome: By the end of the course students will be able to understand:

CO^1: Uniform Convergence and Improper Integrals

CO^2: Functions of bounded variation

CO^3: Directional derivative

CO^4: Lebesgue measure and Integrals

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in the examination.

Evaluation Criteria:

Mid-Term Examination: 20

End-Term Examination: 60

Continuous Internal Assessment: 20

Course Contents:

Unit I: Improper integrals, pointwise and uniform convergence of sequences of functions, functions of bounded variations, directional derivative, and derivative as a linear transformation. **(15 Hours)**

Unit II: Lebesgue measurable sets, measurable functions, convergence in measure, Lebesgue Integrals, Bounded Convergence Theorem, Monotone Convergence Theorem, and Lebesgue Dominated Convergence Theorem. **(15 Hours)**

Prescribed Text Books:

1. Tom M. Apostol (2022), Mathematical Analysis, Narosa Publishers, 2nd Edition.
2. P. K. Jain, V. P. Gupta and P. Jain (2012), Lebesgue measure and integration, Anshan Publishers, 2nd Edition.

Course Articulation Matrix IAM 503- Mathematical Analysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	2	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	2	2	2	2
CO4	3	3	2	2	2	1

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: IAM 501

Course Name: Functional Analysis

Course Instructors: Dr. Meenakshi

Credits: 02

Course Objectives:

- To introduce students to the ideas and some fundamental theorems of functional analysis
- To show students the use of abstract algebraic/ topological structures in studying spaces of functions
- To give students a working knowledge of the basic properties of bounded operators between different spaces.

Course Outcomes: After completion of the course, a student will be able to

CO^1 Understand how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis

CO^2 Demonstrate capacity for mathematical reasoning through analyzing, proving, and explaining concepts from operators

CO^3 Appreciate the role of Zorn's Lemma

CO^4 Have the knowledge of central concepts of functional analysis like norm, compactness, and inner product.

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity/contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/fieldwork; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Attendance Requirement:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in the examination.

Evaluation Criteria:

1. Mid-Term Examination: 20
2. End-Term Examination: 40
3. Continuous Internal Assessment: 20

Course Contents:

Unit-I: Metric Space, Examples of Metric Spaces, Open set, Closed set, Neighborhood, convergence, Cauchy sequence, completeness, completion of metric spaces, Normed Linear Spaces, Banach Spaces,

Properties of Normed Linear Spaces, Properties of Banach Spaces. **[10 Lectures]**

Unit-II: Compactness and Finite Dimensions, Linear Operators, Bounded and Continuous Operators, Linear Functional, Dual Space, Double Dual Space, Inner Product Spaces, Hilbert Spaces, Properties of Inner Product Spaces, Orthogonal Complement, Direct Sum, Orthonormal Sets and sequences.
[10 Lectures]

Prescribed Text Books:

1. E. Kreyszig, "Introductory Functional Analysis with Applications", Wiley Classic Library.

Suggested Additional Readings:

1. Bollobas, "Linear Analysis", Second Edition, Cambridge University Press.
2. N. Akhierzer and I. Glazman, "Theory of Linear Operators in Hilbert Spaces", Dover Books.

Course Articulation Matrix IAM 501- Functional Analysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	3	2	2	3	3	1
CO2	2	1	3	3	3	1
CO3	2	2	2	2	2	1
CO4	2	2	3	3	2	1

1. Partially Related
2. Moderately Related
3. Highly Related

Minor Courses (Disciplinary Courses) (04 Credits)

Course Code: **MTH 551**
Course Name: **Research Methodology**
Credits: **04**
Course Instructor: **Prof. Rakesh Kumar, Dr. Kranti Kumar**

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The main aim of this course is to develop the research aptitude in the students by acquainting them with the research design, methods and ethics of research.

Course Outcomes: After the successful completion of this course, the students will be able to

CO^1 analyze hypotheses, theories and scientific statements and methods

CO^2 design and critically analyze the proper research problems

CO^3 mathematically simulate the biological problems

CO^4 understand, and apply the Finite Element Methods and Artificial Neural networks.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

Course Contents:

Unit I: Research: Definition, Concepts and General introduction; Mathematics and science, Hypotheses, theories and laws; scientific statements: Their justification and acceptance, Objectives & types of Research; Attributes of good Research; Research Methods and Research Methodology; Research Process; Time/Effort Management; and Role of a Supervisor; Research methods in mathematics; Finding and Solving Research Problems.

Unit II: Mathematical Models in Biology: Basic concepts, equilibrium points, nullcline, Jacobian, local stability, global stability, bifurcation points, Predator-Prey models, Two competing populations, Infectious Disease Modeling: Elementary epidemic models-The SIR, SI and SIS models, Reproduction number, Hopf-Bifurcation

theorem (without proof).

Unit III: Finite Element Methods: Shape functions; 1D elements (linear, quadratic); 2D elements (triangles); strong forms; variational or weak forms; minimization forms; equivalence between various forms; Lax-Milgram lemma; Galerkin orthogonality; priori error estimate; posteriori error estimate; stability theorem; discretization of weak and minimization forms in FEM; FEM for model problems- Laplace equation; Poisson equation; convection diffusion problem and heat conduction equation.

Unit IV: Artificial Neural Network (ANN): Neural Network-an overview, Historical Development of Neural Network, Neural network architecture, weights, activation function, bias, threshold, training/learning algorithms types, Delta learning rule, McCulloch Pitts neuron model, Hebb Net, Gradient Descent Algorithm, Single and Multilayer Perceptron.

Prescribed Text Books:

1. P. Pruzan, Research Methodology, Springer, 2016.

2. C.R. Kothari, Research Methodology Methods & Techniques, Second Edition, New Age International publisher, 2004.

3. CS Chou, A. Friedman, Introduction to Mathematical Biology, Springer, (2010).

4. E.S Allman, J.A. Rhodes, Mathematical Models in Biology An Introduction, Cambridge University Press, New York, 2004.

5. M.G. Larson, F. Bengzon, The finite element method: Theory, implementation, and practice, Springer, 2010.

6. S.N. Sivanandam S. Sumathi, S.N. Deepa, Introduction to Neural Networks Using Matlab 6.0. Tata McGraw Hill Publishing Company, 2017.

Additional Suggested Readings:

1. J.N. Kapoor, Research Methodology for Scientists and Engineers, Mathematical Science Trust Society, 1997.
2. F. Brauer, C.C. Chavez, Mathematical Models in Population Biology and Epidemiology, Springer, 2nd Edition, 2012.
3. C. Johnson, Numerical solution of partial differential equations by finite element method. Dover publications, INC, New York, 2009.
4. S. Haykin, Neural Networks and Learning Machines. Pearson, Third Edition, 2016.
5. C.C. Agarwal, Neural Networks and Deep Learning, Springer, 2019.

Course Articulation Matrix of MTH 551- Research Methodology

Course Outcomes	Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4
CO1	3	2	3	3	2	2
CO2	3	2	3	3	2	3
CO3	2	3	2	2	3	3
CO4	2	3	3	2	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Vocational/Skill Courses (04 Credits)

Course Code: MTH 410

Course credit: 04

Course Name: Fundamentals of Statistics

Course Instructor: Dr. Pankaj Kumar s/o Late Sh. Mani Ram

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Course Objectives: The prime objective of this course is to make an understanding about the statistics in the students.

Course Outcomes

After completing the course satisfactorily, a student will be able:

CO^1 To characterize probability models and function of random variables based on single & multiples random variables.

CO^2 To understand the Basic Statistical Laws and Theoretical results.

CO^3 To understand advanced topics like WLLN, SLLN and others.

CO^4 To understand the concept of correlation.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Unit 1

Random Variable, Probability Mass Function, Probability Density Function, Cumulative Distribution Function. Expectation of a Random Variable, Properties of Expectation, Conditional Expectation And Its Properties, Bivariate Distributions and the Joint Probability Distribution, Independence of random variables, Marginal and Conditional Distributions, Discrete and Continuous Random Variable.

Unit 2

Expectation and Variance, Moment Generating Function, Probability Generating Function, Cumulative Generating Function, Characteristic Function and Their Properties, Continuity and Uniqueness Theorems.

Unit 3

Standard Discrete and Continuous Univariate Distributions. Convergence in Probability, Almost Sure Convergence, Convergence in Distribution and Their Relationships. Chebyshev's Inequality, Weak Law of Large Numbers (WLLN), Strong Law of Large Numbers (SLLN), Central Limit Theorems.

Unit 4

Karl Pearson's Correlation Coefficient, Spearman's Rank Correlation Coefficient, Principle of Least Square, Lines Of Regression, Simple Linear Regression, Coefficient Of Determination, Multiple Linear Regression, Coefficient of Multiple Determination.

Prescribed Text Book:

1. Hogg, R.V., McKean, J. & Craig, A.T. (2013). Introduction to Mathematical Statistics, 7th Edition. Pearson
2. Gupta S. C. and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi.
3. Goon, A.M., Gupta, M.K. & Dasgupta, B. (2016). Fundamentals of Statistics, Vol. I & II. World Press.

Course Articulation Matrix MTH-410 Fundamentals of statistics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	2	2	2	2	2	2
CO2	2	2	3	2	2	2
CO3	2	2	2	2	2	2
CO4	2	3	2	2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Review of Literature, Research Proposal (08 Credits)

Course Code: MTH 555

Course credit: 04

Course Name: Review of Literature

Course Instructor: Dr. Kranti Kumar

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Course Objectives: The prime objective of this course is to make an understanding about the review of literature as well as basic concepts of programming in Python in the students.

Course Outcomes

After completing the course satisfactorily, a student will be able:

CO^1 To understand the importance and methodology of literature review.

CO^2 To understand the basic concepts of programming in Python.

CO^3 To represent data as vectors and matrices and identify their properties and to optimize different types of functions commonly used in machine learning using properties of derivatives and gradients

CO^4 To understand the properties of commonly used probability distributions in machine learning and data science like Bernoulli, Binomial, and Gaussian distributions.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Unit 1

Review of important concepts of Linear Algebra for machine learning, System of linear equations, Solution of the system of linear equations, Determinants, Eigenvalues and eigenvectors.

Unit 2

Review of important concepts of Calculus for machine learning, derivatives and optimization, gradients and gradient descent, application of gradient and gradient descent in the optimization of neural networks.

Unit 3

Review of important concepts of Probability and Statistics for machine learning. Introduction to probability and important probability distributions.

Unit 4

Review of the basic concepts of programming languages, Introduction to Python, Jupyter Notebooks, Object-oriented programming, Variables and data types, Assignment statement, Loops, Strings, Lists, Control Flow, Functions and conditional statements.

Prescribed Text Book:

1. K. Hoffman and R. Kunze : Linear Algebra, Second Edition, Pearson,2015.
2. Robert G. Bartle, Donald R. Sherbert, "Introduction to Real Analysis", 3rd Edition, Wiley.
3. Hogg, R.V., McKean, J. & Craig, A.T. (2013). Introduction to Mathematical Statistics, 7th Edition. Pearson
4. R S Salaria: Programming for Problem Solving with Python, Second Edition, Khanna Publishers, 2023

Additional Suggested Readings:

1. Lipschutz S. and Lipson M. L.: Linear Algebra, 3rd Edition, McGraw Hill Education India, Pvt. Ltd., 2001.
2. Strang G.: Linear Algebra and its Applications, 4th Edition, CENGAGE LEARNING, 2007.
3. Rudin, Walter, "Principles of Mathematical Analysis", 3rd Edition, McGraw Hill.
4. Eric Matthes: Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 3rd Edition, No Starch Press,US

Course Articulation Matrix MTH-555 Review of Literature

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	2	2	2	2	2	2
CO2	2	2	3	2	2	2
CO3	2	2	2	2	2	2
CO4	2	3	2	2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: MTH 556

Course credit: 04

Course Name: Research Proposal

Course Instructor: All Faculty Members

The modalities for this course will be as per the minutes of the 9th Board of Studies meeting held on 09 September 2022 vide Agenda Item No. SRDM-BOS-9/22-6.

M.Sc. Mathematics
Semester-IV
(Spring Semester, 2024)

Sr. No.	Course Name	Course Code	Credits
Major Courses (Disciplinary Courses) (04 Credits)			
1	Number Theory	MTH 510	04
Minor Courses (Disciplinary Courses) (04 Credits)			
2	The Basics of Scientific Writing	MTH 552	02
3	Practical (Paper Publications/Seminar-Conference Presentation at National Level)	MTH 559	02
Vocational/Skill Courses (04 Credits)			
4	Statistical Inference	Offered on Swayam Portal By Prof.Nildari Chatterjee, IIT New Delhi	00
5	Artificial Intelligence	IAM 510	02
6	Basics of Propositional Logic	MTH 529	02
Dissertation & Viva-Voce (08 Credits)			
7	Dissertation and Viva-Voce	MTH 590	08

Major Courses (Disciplinary Courses) (04 Credits)

Course Code: MTH 510

Course Name: NUMBER THEORY

Course Credit: 04

Course Instructor: Dr Pankaj Kumar S/O Sh Krishan Singh

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom

activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The main aim of this course is to introduce the basic concepts of Number Theory, certain number theoretic functions and their properties

Course Outcome:

By the end of the course students will be able:

CO^1: To work on the solution of algebraic equations and on the theory of numbers.
CO^2: To know a more efficient avenue for testing whether certain numbers are roots of polynomials
CO^3 : To understand how Wilson's Theorem is used to construct formulas for primes
CO^4: To understand primitive roots and learn how to use them in proofs and explicit constructions
CO^5: To explore Prime number theory

Attendance Requirements

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

Mid Term Examination: 40

End Term Examination: 120

Continuous Internal Assessment: 40

Course Contents:

Unit I: Mathematical Induction and Binomial Theorem, The Integers, The Division Algorithm, The Greatest Common Divisor, The Euclidean Algorithm, The Diophantine Equation. **(10 Hours)**

Unit II: The Fundamental Theorem of Arithmetic, Basic Properties of Congruence, Binary and Decimal

Representation of Integers, Linear Congruences and the Chinese Remainder Theorem **(10 Hours)**

Unit III: Fermat's Little Theorem and Pseudoprimes, Wilson's Theorem, The Fermat-Kraittchik Factorization Method, The Sum and Number of Divisors, The Mobius Inversion Formula, the Greatest Integer Function **(10 Hours)**

Unit IV: Leonard Euler, Euler's Phi-Function, Euler's Theorem, Properties of the Phi-Function, The order of an Integer Modulo , Primitive Roots of Primes, Composite Numbers Having Primitive Roots, The Theory of Indices **(10 Hours)**

Prescribed Text Books:

1. David M. Burton: Elementary Number Theory, Seventh Edition, McGraw Hill, 2009.
2. Kenneth H. Rosen, Elementary Number Theory and its Applications, 6th ed., Pearson, 2014

Suggested Additional Readings:

1. Baker A.: A Concise Introduction to the Theory of Numbers, First Edition, Cambridge University Press, 1984.

Course Articulation Matrix MTH 510- NUMBER THEORY

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	3	2	2	1	2	3
CO2	2	2	1	1	2	1
CO3	1	2	1	2	2	2
CO4	2	2	2	3	2	2
CO5	2	2	2	3	2	3

1. Partially Related
2. Moderately Related
3. Highly Related

Minor Courses (Disciplinary Courses) (04 Credits)

Course Code: **MTH 552**

Course Name: **The Basics of Scientific Writing**

Course Credit: **02**

Course Instructor: Dr. S.K. Srivastava

Credits Equivalent: (One credit is equivalent to 10 hours of lectures/organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work /Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/ dissertation/ thesis; seminars, etc.)

Course Objective: The purpose of this course is to develop a research orientation among the Students of Mathematics and to acquaint them with the Fundamentals of Scientific writings and Research Tools.

Course Outcomes: After successful completion of the course, a student will be able to understand:

CO^1 Scientific Writing

CO^2 Latex

CO^3 Beamer

CO^4 Plagiarism

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examinations.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

Unit I: Scientific Writing: Writing a survey article, research paper, dissertation, and thesis writing.

(10 Hours)

Unit II: Research Tools: LaTeX, Beamer, Reference Manager like Zotero & Mendeley, Plagiarism detection software.

(10 Hours)

Prescribed Text Book:

[1] N. J. Higham, **Handbook of Writing for the Mathematical Sciences**, 2nd edition, Society for Industrial and Applied Mathematics, 1998.

[2] D. E. Knuth, T. Larrabee & P. M. Roberts, **Mathematical Writing**, Mathematical Association of America, 1989.

[3] L. Lamport, LaTeX, **a Document Preparation System**, Pearson, 2008.

Suggested Additional Reading:

[1] M. Alley, **The Craft of Scientific Writing** Fourth Edition, Springer, 2018.

[2] M. Goossens, F. Mittelbach, S. Rahtz, D. Roegel & H. Voss, **The LaTeX Graphics Companion**, Addison-Wesley, 2008.

[3] F. Mittelbach, M. Goossens, J. Braams, D. Carlisle & C. Rowley, **The LaTeX Companion** (Tools and Techniques for Computer Typesetting) 2nd Edition, Addison-Wesley Professional, 2004.

[4] T. Tantau, **The BEAMER class**: User Guide for version 3.49, 12th Media Services, 2016.

[5] N. R. Glassman, **Citation Management Tools: A Practical Guide for Librarians**, Rowman &

Littlefield, 2018.

Course Articulation Matrix of MTH 552 - The Basics of Scientific Writing

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO[1]	3	3	2	2	3	2
CO[2]	3	2	2	2	3	2
CO[3]	3	2	2	2	3	2
CO[4]	3	2	2	2	3	2

1. Partially Related
2. Moderately Relate
3. Highly Related

Course Code: MTH 559

Course Name: Practical (Paper Publications / Seminar-Conference Presentation at National Level)

Course Credit: 02

Course Instructor: All Faculty Members

The evaluation criteria will be adopted as per the necessary directions from the University or as per approval from BoS.

Vocational/Skill Courses (04 Credits)

Course Code: Offered on Swayam Portal

Course Name: Statistical Inference

Course Credit: 00

Course Instructor: Prof. Niladri Chatterjee, IIT Delhi

Course layout

Week 1 : Revision of Probability, Different Discrete and Continuous Distributions
Week 2 : Functions of Random Variables and their distributions, T, Chi-sq, F distributions and their Moments
Week 3 : Introduction of statistics and the distinction between Data and its properties, and probabilistic models
Week 4 : Estimator and methods of estimation, Properties of an estimator: Consistency, Unbiasedness, Efficiency and Sufficiency
Week 5 : Neyman Factorization, Cramer-Rao Bound
Week 6 : Confidence Intervals, Concepts of hypothesis testing, Characteristics of Good hypothesis, null and Alternative Hypotheses, Types of Errors
Week 7 : Inference on Population mean, Comparing two population means, Inference on Variance, Comparing two population variance
Week 8 : Neyman Pearson Lemma

Books and references

1. Probability and Statistics for engineers and scientists, Ed 4, Anthony J Hayter, Brroks/Cole, Cengage Learning.
2. Statistical Methods, R.J.Freund, W.J. Wilson and D.L Mohr, (Ed 3) Elsevier.
3. Mathematical Statistics: A Textbook, S. Biswas and G.L.Sriwastav, Narosa

For More Details, See the Link: **https://onlinecourses.nptel.ac.in/noc24_ma43/preview**

Course Name: Artificial Intelligence

Course Code: IAM 510

Credits: 02

Course Instructor: Dr. Pankaj Kumar S/O Late Sh. maniram

Credits Equivalent:

(One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work;data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

After completing the course satisfactorily, a student will be able:

• To know a strong foundation of fundamental concepts/techniques in Artificial Intelligence
• To enable the student to apply these techniques in applications which involve perception,
• Reasoning, knowledge representation and machine learning.

Learning Outcomes:

The deliverables Learning Outcomes of this paper with students are following:

- Can explain about the Artificial Intelligence and its Applications.
- Can explain about the Artificial Intelligence Techniques.
- Able to apply AI techniques in the various Applications.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimumof 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%

- Assignments: 10%
- Class Tests: 10%
- Class Participation: 5%

Course Contents

Unit-I: **(7 Hours)**

Introduction to AI- Definitions, Goals of AI, AI Approaches, AI Techniques, Branches of AI, Applications of AI.

Agents. **Problem Solving, Search and Control Strategies** - General problem solving, Search and control strategies, Exhaustive searches, Heuristic search techniques, Constraint satisfaction problems (CSPs) and models.

Unit-II **(7 Hours)**

Knowledge Representations Issues, Predicate Logic, Rules - Knowledge representation, KR using predicate logic, KR using rules.

Reasoning System – Overview, Symbolic reasoning and Statistical reasoning.

Unit-III **(6 Hours)**

Natural Language Processing, Pattern Recognition, Expert Systems, Fundamentals of Neural Networks, Fundamentals of Genetic Algorithms, Machine learning, Deep Learning (All topics in Unit III put only Definitions)

Prescribed Text Books

1. Elaine Rich and Kevin Knight, "Artificial Intelligence", McGraw-Hill
2. Dan W. Patterson, "Artificial Intelligence and Expert Systems", Prentice Hall of India.

References:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education
2. E Charniak and D McDermott, "Introduction to Artificial Intelligence", Pearson Education

Course Articulation Matrix IAM 510- Artificial Intelligence

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	2	2	2	2	2
CO2	2	2	3	3	1	2	2
CO3	2	3	2	2	2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Code: MTH 529

Course Name: Basics of Propositional Logic

Credits: 02

Course Instructor: Dr. Pankaj Kumar S/O Late Sh Maniram

Credits Equivalent: (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objectives:

The objective of this course is to develop a rational thinking in statements/decision making/ arguments.

Course Outcomes:

After successful completion of the course the student will be able:

CO^{1} State the converse, inverse, contrapositive and negation of a conditional statements including quantified statements
CO^{2} Construct the truth tables, and interpret the results
CO^{3} To write different types of proofs

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 20
2. End Term Examination: 60
3. Continuous Internal Assessment: 20

Course Contents:

UNIT-I: Set and Proposition, Finite and Infinite set, Mathematical Induction, Principle of Inclusion and Exclusion, Multisets, Propositions, Logical Connectives, Conditional and Biconditional, Well-Formed formulas, Tautologies. **(10 Hours)**

UNIT-II: Logical Equivalence, Theory of Inference for Statement Calculus, Validity using Truth Tables, Rules of Inference, Consistency of Premises, Predicate Calculus, The Statement Function, Variables and Quantifier, Predicate Formula, Free and Bound variable, The Universe of Discourse, Inference Theory of Predicate Calculus, Valid formula and Equivalences, Theory of Inference for Predicate Calculus, Formulas involving more than one Qualifier, Euclidean Algorithms. **(10 Hours)**

Prescribed text book:
C. L. Liu, "Elements of Discrete Mathematics", McGraw Hill publication.

Reference books:
Kenneth H. Rosen, Discrete Mathematics and its Applications, McGraw Hill

Course Articulation Matrix of MTH 529- Basics of Propositional Logic

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4	Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO^1	3	3	2	1	3	2
CO^2	3	3	2	1	3	2
CO^3	3	3	2	1	3	3

1. Partially Related
2. Moderately Relate
3. Highly Related

Dissertation & Viva-Voce (08 Credits)

Course Code: MTH 590
Course Name: Dissertation and Viva-Voce
Course Credit: 08
Course Instructor: All Faculty Members

The evaluation criteria will be adopted as per the necessary directions from the University or as per approval from BoS.