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 2021-23

Semester-I

(Monsoon Semester, 2021)

Course Code: MTH-403

Course Name: LINEAR ALGEBRA

Course Credit: 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 acquaint the students with the Numerical analysis which is necessary to develop the basic understanding of numerical algorithms for solving problems in science, engineering and technology.

Course Outcome:

By the end of the course students should 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 concept of linear transformation.

Co^3: Knowledge about the Eigen vector, Eigen values minimal polynomials.

Co^4: Knowledge about the functional, inner product space and quadratic forms.

Co^5: How 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, 4th Edition, 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, 3rd Edition, McGraw Hill Education India, Pvt. Ltd., 2001.
4. Anton H. And Rorres C.: Elementary Linear Algebra, 11th Edition, 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	Programme Specific Outcomes 3
CO1	1	2	2	2		1	1	2
CO2	2	2	1	2		1	1	2
CO3	1	2	2	2		2	2	2
CO4	2	1	2	3		2	1	1
CO5	1	2	2	2		2	1	2

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

Course Code: MTH 406

Course Name: Real Analysis

Course Instructor: Dr Meenakshi

Credits: 4

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 functions, 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:

- Rudin, Walter, "Principles of Mathematical Analysis", 3rd Edition, McGraw Hill.
- 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. RussellA. 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

Course Code: IAM404

Course Name: Mathematical Methods

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

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

CO1 The methods of solving Fredholm integral equations.

CO2 The methods of solving Volterra integral equations.

CO3 The notion of variations, Euler Lagrange's equations.

CO4 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: 40
2. End Term Examination: 120
3. Continuous Internal Assessment: 40

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, eigen values and eigen functions, Resolve ntkernels, Symmetric kernels, Hilbert Schmidt the oremand solution of symmetric integral equations. **(10 Hours)**

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

Prescribed Text Books:

M.D. Raisinghania (2016), Integral equations and boundary value problems, S. Chand Publishing.
I.M. Gelfand and S.V. Fom in (2012): Calculus of Variations, Prentice Hall Inc.

Suggested Additional Readings:

F.G. Tricomi, (1985): Integral Equations, Cambridge University Press.
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 IAM 404 - Mathematical Methods

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

Course Code: MTH 502

Course Name: Operational Research

Course Instructor: Anuj Kumar

Credits: 2

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. **(10 Hour)**

Unit II: 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 III: Queueing systems, Queueing problem, Transient and steady states, Probability Distributions in Queueing systems .Poisson process)pure birth process(, Properties of poissions 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, Kedar Nath 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 503

Course Name: Discrete Mathematics

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: To introduce students to language and methods of the area of Discrete Mathematics. The special focus of the module is on basic mathematical concepts in discrete mathematics and on applications of discrete mathematics in algorithms and data structures. To show students how discrete mathematics can be helpful in modern computer science so that they may able to relate these to practical examples.

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

CO1 Be skillful in expressing mathematical properties formally by using the formal language of propositional logic.

CO2 Get experience to comprehend formal logical arguments.

CO3 Acquire ability to specify and manipulate basic mathematical objects such as sets, relations and functions.

CO4 Learn to use various techniques of mathematical induction which will help them prove simple mathematical properties of a variety of discrete structures.

CO5 Be able to apply some basic counting techniques to solve permutation and combination problems.

CO6 Get familiar with to construct mathematical problems along with their Mathematical proofs.

CO7 Know how to apply the knowledge they have gained to solve real life 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:

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

Course Contents:

Unit I

Logic, Propositional Equivalences, Partial Ordered Sets, Lattices and Algebraic Systems, Principle of Duality, Basic Properties of Algebraic Systems defined by Lattices, Distributive and Complemented Lattices, Boolean Lattices and Boolean Algebras, Boolean Functions and Boolean Expressions, Propositional Calculus, Pigeonhole principle: Simple form, Pigeonhole principle: Strong form, A theorem of Ramsey.

Unit II:

Two basic counting principles, Permutations of sets, Combinations of Sets, Generating permutations, Inversions in permutations, Generating combinations, Pascal's formula, The binomial theorem, Identities, Unimodality of binomial coefficients, The multinomial theorem, Newton's binomial theorem. The inclusion-exclusion principle, Combinations with repetition, Derangements. Some number sequences, linear homogeneous recurrence relations, Non-homogeneous recurrence relations.

Prescribed Text Books:

1. CL. Liu and DP. Mohapatra, (2012) Elements of Discrete Mathematics.4th Edition, Tata McGraw Hill Education.
2. Richard A. Brualdi, Introductory Combinatorics, 3rdEdition.

Suggested Additional Readings:

1. J. Matousek and J. Nesetril (2005). Invitation to Discrete Mathematics. Oxford University Press.
2. G. Edgar and PM. Michael (2003). Discrete Mathematics with Graph Theory. Prentice Hall.
3. Kenneth H. Rosen, Discrete Mathematics and Its Application, Tata McGraw-Hill, Fourth Edition.

Course Articulation Matrix of MTH 503- DISCRETE MATHEMATICS

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2
CO1	3	3	1	1		2	2
CO2	2	2	1	1		1	1
CO3	2	2	1	1		2	2
CO4	2	3	1	1		2	2
CO5	1	2	1	1		2	2
CO6	2	2	1	1		3	2
CO7	1	1	1	1		1	3

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

Semester II

Spring Semester- 2022

Course Code: MTH-404

Course Name: Abstract Algebra

Course 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 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. IsaacI.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: IAM401

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 esurvey/ 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, multi valued functions, Branch point. **(10Hours)**

UNIT-II: Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic function. **(10Hours)**

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

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

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, 8th Edition, 2008.

Course Articulation Matrix of IAM401-ComplexAnalysis

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	1	1		3	2
CO2	3	2	1	1		3	2
CO3	3	2	1	1		3	2
CO4	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 esurvey/ 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 Relate
3. Highly Related

Course Code: MTH 501

Course Name: Topology

Credits: 02

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:

The objectives of this course are to:

- To understand the meaning of topology with help of examples
- To make more precise the relationship between geometric translation/ construction and continuous map.

Course Outcomes:

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

CO^{1} An ability to construct and develop different topologies
CO^{2} An ability to explore applications of topologies
CO^{3} To learn basics of real number system by involving Topology

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: Topological Spaces, Bases for Topology, The Subspace Topology, Sub-basis for Topology, The Order Topology, The Product Topology, Closed Sets, Definition of Topology in terms of Closed Set, Limit Points, the Neighborhood System of a point, Subspace Topology, characterization of Closed Sets in a Subspace, Closure and Interior of a Set, characterization of Closure of a Set in a Subspace.

(10 Hours)

UNIT-II: Definition of a Continuous Function in a Topological Space, various characterizations of Continuous Function in a Topological Space, Quotient Spaces, Homeomorphisms, Definition of a Topological Property, the Product Topology, the Metric Topology, the Connected Spaces, Path Connectedness, Components and Local Connectedness. **(10 Hours)**

Prescribed text book:

J. R. Munkres, Topology, Second Edition, Prentice Hall, 1994.

Reference books:

1. J. L. Kelley, General Topology: Graduate Texts in Mathematics, Springer, 1955
2. M. A. Armstrong, Basic Topology :Undergraduate Texts in Mathematics, Springer, 1955.

Course Articulation Matrix of MTH 501- Topology

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	2		3	2
CO^2	3	2	2	1		3	1
CO^3	3	3	3	3		3	2

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

Course Code: IAM 407

Course Name: Differential Geometry

Credit: 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 prime objective of this course is to provide the basic concepts and knowledge of differential geometry by focusing at the various physical aspects through the different solution schemes/ techniques.

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

CO1 To know about the distinct kind of curves and their geometry.

CO2 To know about the distinct techniques/ schemes which are essential in the wide study of curves and surfaces.

CO3 To know about the famous naming theorems like Egregium theorem, Gauss-Bonnet theorem etc. which are necessary about the basic study of curves/ surfaces.

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

- Can explain about distinct curves and curvature along with their basic terminology which is soul part of the study of differential geometry.
- Will know about the different solution techniques/schemes related to the wide knowledge of curves and surfaces.
- Can explain about the second fundamental form, Gaussian curvatures, Pseudosphere, Geodesics and use of different basic theorems in various physical aspects.

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: The Second Fundamental Form, Curvature of curves on surface, Normal and Principal Curvatures, Gaussian and Mean curvatures. **(10 Hrs)**

Practicum

- Solving the Exercises of the selected Chapters.
- Implementation on the selected real world problems.

UNIT-II: The Pseudosphere, Gauss map, Geodesics: Basic Properties, Theorema Egregium and Gauss-Bonnet Theorem. **(10 Hrs)**

Practicum

- Solving the Exercises of the selected Chapters.
- Implementation on the selected real world problems.

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

Essential Readings:

- Andrew Pressley, Elementary Differential Geometry, Springer, 2010.

Suggested Additional Readings:

- M.P. doCarmo, Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.
- B. O'Neill, Elementary Differential Geometry, Academic Press, New York, 1966.

Course Articulation Matrix of IAM 407- DIFFERENTIAL GEOMETRY

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		2	2
CO2	3	2	1	1		3	3
CO3	2	2	1	1		1	2

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

Course Code: MTH 528

Course Name: Introduction to Rigorous and Precise Thinking

Credits: 02

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:

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 combinators

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: What is mathematics?, More than Arithmetic, Mathematical Notation, Modern college- level mathematics, Getting precise about language, the logical combinators, Implication, Quantifiers. **(10 Hours)**

UNIT-II: Proof, Proof by contradiction, Proving Conditional, Proving Quantified statements, Induction Proofs, Proving results about numbers, Real Numbers, Completeness and Sequences

(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

Course Code: MTH 529

Course Name: Basics of Propositional Logic

Credits: 02

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:

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

Semester III

(To Be offered in Monsoon 2022)

Semester IV

(To Be offered in Spring 2023)