The following courses are offered by Srinivasa Ramanujan Department of Mathematics for the students of M.Sc. Mathematics for Spring Semester 2022:

S. No.	Course Name	Course Code	Credit	Lecture & Tutorial	Name of Faculty
Batch 2020-22, Semester-IV					
1	Fluid Dynamics	IAM 405	04	4L, 2T	Dr Pankaj Kumar S/O Sh. Krishan Singh
2	Differential Geometry	IAM 407	04	4L, 2T	Dr S K Srivastava
3	Field Theory and Galois Theory	MTH 500	04	4L, 2T	Dr. Meenakshi
4	Mathematical Methods	IAM 404	04	4L, 2T	Dr Pankaj Kumar S/O Late Maniram
5	M. Sc. Project	MTH 550	04	4L, 2T	**Group A** (Dr R Kumar) **Group B** (Dr SK Srivastava) **Group C** (Dr Pankaj Kumar S/O Late Maniram) **Group D** Dr Pankaj Kumar S/O Sh. Krishan Singh) **Group E** (Dr. Meenakshi)
Batch 2021-23, Semester-II					
Major Courses (10 credits)					
1	Complex Analysis	IAM 401	04	4L, 2T	Dr S K Srivastava
2	Abstract Algebra	MTH 404	04	4L, 2T	Dr. Pankaj Kumar S/O Late Sh. Maniram
3	Numerical Analysis	IAM 403	02	2L, 1T	Dr R Kumar
Major Courses (2 credits)					
4	Interdisciplinary Course*				
Minor Courses (4 credits)					
1	Topology	MTH 501	02	2L, 1T	Dr Pankaj Kumar S/O Late Maniram
2	Differential Geometry	IAM 407	02	2L, 1T	Dr Pankaj Kumar S/O Krishan Singh
Vocational/Skill (2 credits)					
1	Basics of Propositional Logic	MTH 529	02	2L, 1T	Dr. Meenakshi
IKS (2 credits)					
1	Rigorous and Precise Thinking	MTH 528	02	2L, 1T	Dr. Meenakshi

*Students have to opt for two credits interdisciplinary course that is different and distinct from the programme in which s/he is enrolled.

Workload of the Faculty members of the Department

Name of Faculty	Course Name	Course Code	Credits	Lectures & Tutorials / Remedial Classes
Dr Rakesh Kumar	Numerical Analysis	IAM 403	02	2L, 1T
	Applied Functional Analysis	IAM 603	04	4L, 2T
	Research and Publication Ethics	CPE-RPE	02	2L, 1T
	MSc Project	MTH 550	04	4L, 2T
Dr SK Srivastava	Complex Analysis	IAM 401	04	4L, 2T
	Differential Geometry	IAM 407	04	4L, 2T
	Research Methodology	MTH 601	04	4L, 2T
	MSc Project	MTH 550	04	4L, 2T
	Advanced Topics in Topology and Analysis	MTH 611	04	4L, 2T
Dr Pankaj Kumar S/O Late Maniram	Abstract Algebra	MTH 404	04	4L, 2T
	Mathematical Methods	IAM 404	04	4L, 2T
	MSc Project	MTH 550	04	4L, 2T
	Cryptography and Network Security	MTH 643	04	2L, 1T
	Indian Traditional Knowledge and Practices*	MTH 651	02	1L, 1T
	Probability Theory	MTH 413	02	2L, 1T
Dr Pankaj Kumar S/O Sh. Krishan Singh	Differential Geometry	IAM 407	02	2L, 1T
	Fluid Dynamics	IAM 405	04	4L, 2T
	MSc Project	MTH 550	04	4L, 2T
	Advanced Fluid Dynamics	MTH 644	04	4L, 2T
	Partial Differential Equations and Integral Equations	MTH 408	02	2L, 1T
	Indian Traditional Knowledge and Practice*	MTH 651	02	1L, 1T
Dr Meenakshi	Topology	MTH 501	02	2L, 1T
	Field Theory and Galois Theory	MTH 520	04	4L, 2T
	MSc Project	MTH 550	04	4L, 2T
	Basics of Propositional Logic	MTH 529	02	2L, 1T
	Commutative Algebra	MTH 624	04	4L, 2T
	Introduction to Rigorous and Precise Thinking	MTH 528	02	2L, 1T

The following courses are offered by Srinivasa Ramanujan Department of Mathematics for the students of PhD Mathematics for Spring Semester 2022:

Batch 2020-22, Semester-IV					
Compulsory Courses (10 Credits)					
S. No.	**Course Name**	**Course Code**	**Credit**	**Lecture & Tutorial**	**Name of Faculty**
1	Research Methodology	MTH 601	04	2L, 1T	Dr S K Srivastava
2	Research and Publication Ethics	CPE-RPE	02	2L, 1T	Dr Rakesh Kumar
3	Indian Traditional Knowledge and Practice	MTH 651	02	2L, 1T	Dr Pankaj Kumar S/O Late Sh. Maniram
4	Pedagogy of Teaching-Learning Process*	TTR 622	02		
Optional Courses (Specialisation#) (08 Credits)					
5	Applied Functional Analysis	IAM 603	04	4L, 2T	Dr Rakesh Kumar
6	Commutative Algebra	MTH 624	04	4L, 2T	Dr Meenakshi
7	Advanced Fluid Dynamics	MTH 644	04	4L, 2T	Dr Pankaj Kumar S/O Sh. Krishan Singh
8	Cryptography and Network Security	MTH 643	04	4L, 2T	Dr Pankaj Kumar S/O Late Sh. Maniram
9	Advanced Topics in Topology and Analysis	MTH 611	04	4L, 2T	Dr S K Srivastava

*The course Pedagogy of Teaching-Learning Process will be offered and taught by the Department of Education.

#The students will have two choose at least two (maximum three) courses from the optional course list according to their specialisation

The following courses are offered by Srinivasa Ramanujan Department of Mathematics for the students of M.Sc. Mathematics for **Spring Semester 2021**:

S. N.	Course Name	Course Code	Credit	Lecture & Tutorial	Name of Faculty
Batch 2019-21, Semester-IV					
1	Fluid Dynamics	IAM 405	04	4L, 2T	Dr Pankaj Kumar S/O Sh. Krishan Singh
2	Differential Geometry	IAM 407	04	4L, 2T	Dr S K Srivastava
3	Operational Research	MTH 502	04	4L, 2T	Dr Pankaj Kumar S/O Late Maniram
4	Functional Analysis	IAM-501	04	4L, 2T	Dr. Meenakshi
5	M. Sc. Project	MTH 550	04	4L, 2T	**Group A** (Dr S K Srivastava) **Group B** (Dr R Kumar) **Group C** (Dr. Meenakshi) **Group D** Dr Pankaj Kumar S/O Sh. Krishan Singh) **Group E** (Dr Pankaj Kumar S/O Late Maniram)
Batch 2020-22, Semester-II					
1	Complex Analysis	IAM 401	04	4L, 2T	Dr S K Srivastava
2	Numerical Analysis	IAM 403	04	4L, 2T	Dr R Kumar
3	Real Analysis	MTH 406	04	4L, 2T	Dr. Meenakshi
4	Partial Differential Equations	MTH 402	04	4L, 2T	Dr Pankaj Kumar S/O Sh. Krishan Singh
Skill Development					
1	Introduction to Mathematical Statistics	MTH 527	02	2L, 1T	Dr Pankaj Kumar S/O Late Maniram
Human Making					
1	Introduction to Rigorous and Precise Thinking	MTH 528	02	2L, 1T	Dr Pankaj Kumar S/O Late Maniram

Semester IV

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
    i. Subjective / Objective Assignment: 10 %
    ii. Numerical Assignments using programming: 10 %
    iii. Presentations and Class Tests: 5 %

Course Name: Fluid Dynamics
Course Code: IAM 405
Credits: 04

Course Contents:

Unit I: Basic Concepts, Orthogonal Curvilinear Coordinates, Kinematics of Fluid in Motion, General Theory of Stress and Strain, Equations of Motion of Inviscid Fluids, Bernoulli's Equation and its Applications.

Unit II: The Navier-Stokes Equations and the Energy Equation, Dynamical Similarity, Inspection Analysis and Dynamical Analysis:- Rayleigh's Technique and Buckingham π-Theorem.

Unit III: Laminar Flow of Viscous Incompressible Fluids with Temperature Distribution:- Plane Couette Flows, Plane Poiseuille Flows, Generalized Plane Couette Flows, Hagen-

Poiseuille Flow, Flow in Tubes of Various Cross-Sections, Jeffery-Hamel Flow, Flow of two Immiscible Fluids, Flow with Constant Fluid Properties and with Variable Viscosity, and Flow in the Neighbourhood of a Stagnation Point.

Unit IV: Boundary Layer Theory: Velocity and Thermal Boundary Layers.

Prescribed Text Books:

1. Bansal J. L. (2004). Viscous Fluid Dynamics. Second Edition. Oxford and IBH Publishing, Delhi.
2. Raisinghania M.D. (2011).Fluid Dynamics. Tenth Edition. S Chand & Company LTD. New Delhi.

Suggested Additional Readings:

1. Schlichting H. and Gersten K. (2000). Boundary Layer Theory. Eighth Edition. Springer Verlag. Germany.
2. Kundu P.K. and Cohen I.M. (2010). Fluid Mechanics. Fourth Edition. Academic Press.

Course Name: **Differential geometry**
Course Code: IAM 407
Credits: 04

Course Contents:
Unit I: Curve, Arc-length, Reparametrization, Level curves, Curvature of Plane curve, Frenet-Formulas.

Unit II: Global Properties of Curves: Simple closed curves, The Isoperimetric Inequality, Four vertex Theorem, Surfaces in Euclidean Spaces, Length of curves on surface, Isometries and conformal mappings of surfaces, Surface area.

Unit III: The Second Fundamental Form, Curvature of curves on surface, Normal and Principal Curvatures, Gaussian and Mean curvatures.

Unit IV: The Pseudosphere, Gauss map, Geodesics: Basic Properties,Theorema Egregium and Gauss-Bonnet Theorem.

Prescribed Text Books:

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 Name: OPERATIONAL RESEARCH

Course Code: MTH 502

Credits: 04

Course Contents:

Unit I:

Linear programming problem (LPP). Formulation and examples, feasible, basic feasible and optimal solutions. Graphical method to solve LPP. Simplex method, Charnes Big M method, two phase method, degeneracy. Duality theory, dual LPP, fundamental properties of dual problems, dual simplex algorithm.

Unit II:

Integer programming; gomory's method, branch and bound method.

Transportation problem: Mathematical formulation, basic feasible solution of T.P. by North West corner method, least cost method, Vogle's approximation method. Unbalanced TP UV method, degeneracy in TP.

Unit III:

Assignment Problem: Mathematical formulation, assignment method, Hungarian method, unbalanced AP.

Network techniques: Shortest path model, dijkastra algorithm, spanning trees, minimum spanning trees, Kruskal's algorithm, Prim's algorithm.

Unit IV:

Game theory: Two person zero sum games, the maxmin-minmax principle, pure strategies, mix strategies, graphical solution of 2xnand mx2 games, dominance property, general solution of mxn rectangular games, LPP of GP

Prescribed Text Book:

1. S.D. Sharma, operations research, kedar nath ram Nath and co. 14th edition 2004.
2. Kanti swarup, PK Gupta and Manmohan operations research, sultan chand and sons 12th edition, 2004.
3. R. paneerselvam , operations research, prentice hall of india pvt ltd, 2004.

Suggested Additional Readings:

1. G. Hadley, linear programming , Narosa pub. House,2002.
2. H.A. Taha operations research , An introduction prentice hall of india pvt ltd, 7th edition 2004.

1. J.K. sharma, operations research, macmillan India pvt ltd 2003

Course Name: Functional Analysis

Course Code: **IAM-501**

Credits: 04

Course Contents:

Unit I

Banach Spaces: The definition and some examples, continuous linear transformations. The Hahn- Banach Theorem (statement only), the Open Mapping Theorem, the Closed Graph Theorem.

Unit II

The Uniform Boundedness Theorem, The natural embedding of N in N**, reflexivity. Hilbert Spaces: The definition and some simple properties, orthogonal complements, orthonormal sets.

Unit III

The conjugate space H*, the adjoint of an operator, self-adjoint, normal and unitary operators, Projections.

Unit IV

Spectral Theory: Spectral Theory in Finite Dimensional Normed Spaces. Basic Concepts. Spectral Properties of Bounded Linear Operators. Further Properties of Resolvent and Spectrum.

Text Books

1. G.F. Simmons, Introduction to Topology and Modern Analysis, International Student Edition, McGraw Hill Book Company, Inc. 1963, (Chapter 9: §§ 46-51 and Chapter10: §§ 52-59).

2. E. Kreyszig, Introductory Functional Analysis with Applications, John, Wiley and Sons, Wiley Classics Library Edition Published, 1989 (Chapter 7).

Semester II

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 10 %
ii. Numerical Assignments using programming: 10 %
iii .Presentations and Class Tests :5 %

Course Code: IAM-401

Course Name: Complex Analysis

Credit-4

Instructor Name: Dr. S. K. Srivastava

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

Course Contents:

UNIT-I: Complex Numbers, Geometric description, Stereographic projection, Analytic functions, the Cauchy-Riemann equations, Multivalued functions, Branch point. [10 Lectures]

UNIT-II: Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic function [10 Lectures]

UNIT-III: The Liouville theorem, The Morera theorem, Maximum-Modulus theorem, Conformal transformations. [10 Lectures]

UNIT-IV: Taylor's series, Laurent's series, Singularities of complex functions, the Cauchy Residue theorem, Evaluation of integrals. [10 Lectures]

Prescribed text book:

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

Reference books:

1. K. Kodaira, Complex Analysis, Cambridge University Press, 2007.

2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw-Hill, 8th Edition, 2008.

Course Name: NUMERICAL ANALYSIS

Course Code: IAM 403

Credits: 04

Course Contents:

Unit I: Lagrange and Newton interpolations, interpolations using finite differences, Hermite interpolation, piecewise and spline interpolation, bivariate interpolation.

Unit II: Polynomial approximation: least square approximation, orthogonal polynomials, uniform approximation, rational approximation.

Unit III: Numerical Differentiation and Integration: methods based on interpolation, methods based on undetermined coefficients, composite integration methods, Romberg integration.

Unit IV: Initial and Boundary value problems for ordinary differential equations: Taylor's series method, Euler and modified Euler method, Runge-Kutta methods, stability analysis, finite-difference method, shooting method.

Prescribed Text Books:

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 Name: **Real Analysis**
Course Code: MTH 406
Credits: 04

Course Contents:

Unit-I:Real and complex number systems, Basic Topology: Ordered sets, Fields, The Real field and Complex field, Euclidean spaces, Countable and Uncountable sets, Metric spaces, Compact sets.

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.

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.

Unit-IV: Sequence, Series of Functions and Functions of several Variables: Uniform Convergence, Equicontinuous Families of Functions, The Stone-Weierstrass Theorem, Differentiations of a Function of Several Real Variables and the Contraction Principle.

Prescribed Text Book:

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

Suggested Additional Reading:

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 Name: PARTIAL DIFFERENTIAL EQUATIONS
Course Code: MTH 402
Credits: 04

Course Contents:

Unit I: Mathematical models leading to partial differential equations, First and second order equations, Cauchy-Kowalewski's theorem (for first order), Classification of second order equations and reduction to standard form, method of characteristics, Riemann's method and applications.

Unit II: Elliptic equations; Laplace and poisson equations, properties of harmonic functions, mean value property, maximum-minimum principle, Green's function approach, Method of images, separation of variables.

Unit III: Parabolic equations; Heat equation, fundamental solution, separation of variables, similarity solution, maximum principle and comparison theorems.

Unit IV: Hyperbolic equations; wave equation, separation of variables, method of eigenfunction, D' Alembert's formula, Duhamel's principle.

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

Skill Development

Course Name: Introduction to Mathematical Statistics
Course Code: MTH 527
Credits: 02

Course Contents:

Unit-I:

Theory of Probability: Mathematical or Classical Definition of Probability, Limitation of Mathematical Probability, Statistical or Empirical Definition of Probability and its Limitations, Algebra of Sets, Limits of Sequence of Sets, Classes of Sets, Axiomatic Approach to Probability,

Basic Theorems on Probability, Conditional Probability, Independence of Events, Pairwise Independence, Mutual Independence, Extended Axiom of Addition and Continuity. Bayes Theorem.

Unit-II:

Random Variables and Mathematical Expectation: Random Variables, Distribution Function of Random Variable and its properties, Discrete Random Variable, Probability Mass Function. Continuous Random Variable, Probability Density Function. mathematical expectation of a random variable and its important properties, variance and covariance.

Prescribed Text Book:

- S.C Gupta and V.K. Kapoor. "Fundamentals of Mathematical Statistics", S. Chand & Sons.

Suggested Additional Reading:

Hogg and Craig, "Introduction to Mathematical Statistics" McGraw Hill.

Human Making

Course Name: Introduction to Rigorous and Precise Thinking
Course Code: MTH 528
Credits: 02

Course Contents:

Unit-I:

Theory of Probability: Mathematical or Classical Definition of Probability, Limitation of Mathematical Probability, Statistical or Empirical Definition of Probability and its Limitations, Algebra of Sets, Limits of Sequence of Sets, Classes of Sets, Axiomatic Approach to Probability, Basic Theorems on Probability, Conditional Probability, Independence of Events, Pairwise Independence, Mutual Independence, Extended Axiom of Addition and Continuity. Bayes Theorem.

Unit-II:

Random Variables and Mathematical Expectation: Random Variables, Distribution Function of Random Variable and its properties, Discrete Random Variable, Probability Mass Function. Continuous Random Variable, Probability Density Function. mathematical expectation of a random variable and its important properties, variance and covariance.

Prescribed Text Book:

- S.C Gupta and V.K. Kapoor. "Fundamentals of Mathematical Statistics", S. Chand & Sons.

Suggested Additional Reading:

Hogg and Craig, "Introduction to Mathematical Statistics" McGraw Hill.

The following courses are offered by Department of Mathematics for the students of M.Sc. Mathematics for **Monsoon Semester 2018.**

Semester-I **(Batch 2018-20)**			
S. No.	Course Name	Course Code	Faculty
1	Complex Analysis	IAM 401	Dr. S K Srivastava
2	Abstract Algebra	MTH 404	Dr. Ravinder Singh
3	Linear Algebra	MTH 403	Dr. Rakesh Kumar
4	Ordinary Differential Equations	MTH 401	All Faculty Members
Semester-III **(Batch 2017-19)**			
1	Lebesgue Measure & Integration	MTH 405	Dr. S K Srivastava
2	Topology	MTH 501	Dr. Ravinder Singh
3	Finite Element Methods	IAM 506	Dr. Rakesh Kumar
4	Discrete Mathematics	MTH 503	Guest Faculty
5.	Mechanics	MTH 504	Guest Faculty

Semester-I

Course Code: IAM-401

Course Name: Complex Analysis

Credit-4

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

Course Contents:

UNIT-I: Complex Numbers, Geometric description, Stereographic projection, Analytic functions, the Cauchy-Riemann equations, Multivalued functions, Branch point. [10 Lectures]

UNIT-II: Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic function [10 Lectures]

UNIT-III: The Liouville theorem, The Morera theorem, Maximum-Modulus theorem, Conformal transformations. [10 Lectures]

UNIT-IV: Taylor's series, Laurent's series, Singularities of complex functions, the Cauchy Residue theorem, Evaluation of integrals. [10 Lectures]

Prescribed text book:

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

Reference books:

1. K. Kodaira, Complex Analysis, Cambridge University Press, 2007.

2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw-Hill, 8th Edition, 2008.

Course Code: MTH-404

Course Name: Abstract Algebra

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%
   - i) Assignments 20%
   - ii) Class participation 5%

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.

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.

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.

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.

Prescribed Texts

(1) I.M. Isaac, Algebra: A Graduate Course, AMS (Graduate Studies in Mathematics), Indian Edition.

(2) Michael Artin, Algebra, Second Edition, PHI

(3) Nathan Jacobson, Basic Algebra, Vol. 1, Hindustan Publishing Corporation, Delhi

Additional Text

(1) David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley India

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Course Code: MTH 403
Course Name: LINEAR ALGEBRA
Credits: 04

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.

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: 25%
2. End Term Examination: 50%
1. 3. Continuous Internal Assessment: 25%
    i) Assignments 20%
    ii) Class participation 5%

Course Contents:

Unit I: Vector Spaces, Subspaces, Basis and dimension, Linear Transformations, Quotient spaces, Direct sum, The matrix of a linear transformation, Duality

Unit II: Eigenvalues and eigenvectors, Annihilating polynomials, Invariant subspaces, Triangulation and diagonalization.

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

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

Prescribed Text Book:

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

Suggested Additional Readings:

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

Course Code: MTH 401

Course Name: ORDINARY DIFFERENTIAL EQUATIONS

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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 elementary differential 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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Existence and uniqueness theory; dependence of solutions on initial conditions and on the function; existence and uniqueness theorems for systems and higher order equations.

Unit II: The theory of linear differential equations; homogeneous and non-homogeneous systems, nth order homogeneous and non-homogeneous linear differential equations.

Unit III: Sturm theory, Sturm-Liouville boundary value problems.

Unit IV: Nonlinear differential equations; phase plane, critical points and paths (linear and nonlinear systems), limit cycles and periodic solutions.

Prescribed Text Books:

1. Ross S.L. (1984). Differential Equations. Third Edition. John Wiley & Sons Inc.

Suggested Additional Readings:

1. W.E. Boyace and R.C. Diprima (2013). Elementary Differential Equations and Boundary Value Problems, Ninth Edition, Wiley.

Semester-III

Course Code:MTH-405

Course Name: Lebesgue Measure and Integration

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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 Course Objective: acquaint the students with the concept of measure, a means for comparing the size of sets and generalizing intuitive notions such as length and area, and moves on to describe the elements of the Lebesgue theory of integration. Lebesgue integration is a fundamental tool for advanced study in areas of mathematics such as functional analysis and potential theory, and provides the foundation for the axiomatic treatment of probability theory.

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 examination.

Evaluation Criteria:

i) Mid Term Examination: 25%

ii) End Term Examination: 50%

iii) Continuous Internal Assessment: 25%

ii)	Assignment	15%
iii)	Class participation	5%
iv)	Class tests	5%

Course Contents:

Unit I: Set theory, Topological ideas, sequence and limits, functions and mapping, cardinal number and Countability, properties of open sets and Cantor's like sets.

Unit II: Lebesgue outer measure, measurable sets, properties of measurable sets, Borel set and their measurability, characterizations of measurable sets, measurable functions and their properties.

Unit III: Borel measurable functions, convergence in measure, Lebesgue Integrals and integral of non-negative measurable functions.

Unit IV: The four derivates, Continuous and Non- differentiable functions, functions of bounded variation, Lebesgue's differentiation theorem, differentiation, integration and the Lebesgue set.

Prescribed Text Books:

1. P.K. Jain, V.P. Gupta and P. Jain (2012), Lebesgue measure and integration, Anshan Publishers, 2nd Edition.

Suggested Additional Readings:

1. P. R. Halmos, Measure Theory, Graduate Text in Mathematics, Springer-Verlag, 1979.
2. G. De Barra (2003), Measure theory and Integration, Horwood Publishing.

Course Code:MTH-501

Course Name: **Topology**

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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:

2. Mid Term Examination: 25%
3. End Term Examination: 50%
4. Continuous Internal Assessment: 25%
   - v) Assignments 20%
   - ii) Class participation 5%

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.

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

Unit-III:

Compact Spaces, the Image of a Compact Space under a Continuous Function, the Product of finitely many Compact Spaces, the Finite Intersection Property, Limit Point Compactness, Convergence in a Topological Space, Sequential Compactness, Local Compactness

Unit-IV:

First Countable Spaces, Second Countable Spaces, Lindelof's Theorem, Separable Spaces, Product of First and Second Countable Spaces, the Separation Axioms: the Regular Spaces, the Normal Spaces, T1, T2, T3 and T4 spaces

Prescribed Text Book:

(i) Topology By J. R. Munkres. Second Edition, Prentice Hall
(ii) General Topology By Stephen Willard, Dover

Suggested Additional Reading:

(i) General Topology By J. L. Kelley. Graduate Texts in Mathematics, Springer
(ii) Basic Topology By M. A. Armstrong. Undergraduate Texts in Mathematics, Springer

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Course Code: IAM 506

Course Name: Finite Element Methods

Credit: 04

Credits 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 Objective: The main purpose of this course is to acquaint the students with the analysis and applications of finite element methods.

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%

i. Subjective / Objective Assignment: 10 %
ii. Numerical Assignments using programming: 10 %
iii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Basic concepts of function spaces, 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.

Unit II: The energy norm, FEM for model problems; Laplace equation, Poisson equation, biharmonic problem, convection diffusion problem, heat conduction, essential and natural boundary conditions.

Unit III: Finite element space, types of elements (linear, quadratic, cubic) and shape functions, 1D elements, 2D elements (triangles, rectangles, quadrilaterals), 3D elements (tetrahedron, prisms, wedge, pyramidal), iso-parametric mapping.

Unit IV: Assembly of FEM equations and solutions, transport problem, plate problem, Stokes equation, eigenvalue and time dependent problems.

Prescribed Text Books:

1. C. Johnson (2009) Numerical solution of partial differential equations by finite element method. Dover publications, INC, New York.

2. M.G. Larson, F. Bengzon (2010). The finite element: Theory, implementation, and practice, Springer

Suggested Additional Readings:

1. S.C. Brenner, L.R. Scott (2008). The Mathematical Theory of Finite Element Methods, Springer.
2. J.N. Reddy (2006).An Introduction to Finite Element Method. McGraw Hill.
3. S.R. Singiresu (2005). The Finite Element Method in Engineering. Fourth Edition. Elsevier Inc.

Course Code: MTH 503

Course Name: Discrete Mathematics

Credits: 04

Credits 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 Objective: To introduce students to language and methods of the area of Discrete Mathematics. The 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 used in modern computer science (with the focus on algorithmic applications) and understand some basic properties of graphs and related discrete structures, and be able to relate these to practical examples.

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

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.

Unit II:
Boolean Functions and Boolean Expressions, Propositional Calculus, Pigeonhole principle: Simple form, Pigeonhole principle: Strong form, A theorem of Ramsey. Two basic counting principles, Permutations of sets, Combinations of Sets, Generating permutations, Inversions in permutations, Generating combinations,

Unit III:
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.

Unit IV:
Graph Theory:- Basic properties, Eulerian trails, Hamilton chains and cycles, bipartite multigraphs, Trees, The Shannon switching game, Digraphs and Networks, Chromatic number, Plane and planar graphs, A 5-color theorem.

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, third Edition, (Chapter 2, Chapter 3(3.1, 3.2, 3.3), Chapter 4(4.1, 4.2 ,4.3), Chapter 5(5.1 to 5.6), Chapter6(6.1, 6.2, 6.3), Chapter 7(7.1 to 7.4) and Chapter 11(11.1 to 11.6), Chapter 13(13.1 to 13.3).

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 Code: MTH 504

Course Name: Mechanics

Credits: 04

Credits 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 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.

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

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.

Unit II:
Lagrange's equation for non-holonomic systems with moving constraints, Lagrange's equations for impulsive motion, 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.

Unit III:
Ignorable coordinates, the Routhian function, the form of Hamiltonian function, modified Hamilton's principle, principle of least action, the Hamilton-Jacobi equation.

Unit IV:
Lagrange and Poission brackets, calculus of variation, the Brachistochrone problem, invariance of Lagrange and Poission 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.
3. K Sankara Rao, Classical Mechanics, Prentice Hall of India, 2005.

Courses -Monsoon Semester-2016

Name of School: School of Mathematics, Computers and Information Science

Name of Department: Department of Mathematics

Name of Programme of Study: M. Sc.-Mathematics

Courses for Semester-III

Sr. No	Course Code	Course Name	Credits	Pre-requisite	Instructor
1.	MTH 501	TOPOLOGY	4	MTH406	Dr. R. SINGH
2.	IAM 403	NUMERICAL ANALYSIS	4	NA	Dr. R. Kumar
3.	IAM 501	FUNCTIONAL ANALYSIS	4	NA	Dr. S. K. Srivastava
4.	IAM 550	PROJECT& SEMINAR BASED PRACTICAL TRAINING WITH INDUSTRY	4	NA	Dr. R. Singh, Dr. R. Kumar, Dr. S. K. Srivastava
5.	MTH 402	PARTIAL DIFFERENTIAL EQUATION	4	MTH 102	Dr. R. Kumar

Courses for Semester-I

Sr. No.	Course Code	Course Name	Credits	Pre-requisite	Instructor
1.	MTH 404	ABSTRACT ALGEBRA	4	NA	Dr. S. K. Srivastava
2.	MTH 403	LINEAR ALGEBRA	4	NA	Dr. R. Kumar
3.	IAM 402	ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	4	NA	Dr. R. Singh, Dr. R. Kumar, Dr. S. K. Srivastava
4.	IAM 401	COMPLEX ANALYSIS	4	NA	Dr. R. Singh

Semester-III

Course Code: MTH 501

Course Name: Topology

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

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

i)	Assignment	15%
ii)	Class participation	5%
ii)	Class tests	5%

Course Contents:

Unit-I:

Topological Spaces, Bases for Topology, The Subspace Topology, The Product Topology, The Quotient Topology. **[10 Lectures]**

Unit-II:

Closed Sets and LImit Points, Continuous Functions, Compact Spaces, Connected Spaces, Local Compactness, Local Connectedness. **[10 Lectures]**

Unit-III:

The Countability Axioms, The Separation Axioms, Homotopy of Paths. **[10 Lectures]**

Unit-IV:

Examples of Homotopy of Paths, Basic Results concerning Homotopy of Paths, The Fundamental Group, Calculation of the Fundamental Group in standard cases. **[10 Lectures]**

Prescribed Text Book:

- Topology By J. R. Munkres. Second Edition, Prentice Hall.

Suggested Additional Reading:

- Basic Topology By M. A. Armstrong. Undergraduate Texts in Mathematics, Springer.

Course Code: IAM 403

Course Name: NUMERICAL ANALYSIS

Credits: 04

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

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

i) Assignment 10%
ii) Class participation 10%
iii) Class tests 5%

Course Contents:

Unit I: Error analysis, polynomial interpolation theory: Newton divided differences, Hermite interpolation, interpolation by rational functions, piecewise polynomial interpolation, trigonometric interpolation.

[10 Hours]

Unit II: Approximation of functions: Weierstrass and Taylor theorems, minimax approximation, least square approximation, orthogonal polynomials, near minimax approximations. **[10 Hours]**

Unit III: Numerical Differentiation and Integration: Numerical Differentiation based on finite differences, Numerical Integration based on Uniform and non-Uniform Mesh spacing, Newton-Cotes formula, Romberg integration, Gauss-Radau and Gauss-Lobatto quadratures. **[10 Hours]**

Unit IV: Numerical methods for ordinary differential equations:existence, uniqueness and stability theory, Euler and modified Euler Method, Predictor-Corrector Methods, multistep methods, convergence and stability theory, single step and Runge-Kutta methods, Boundary value problems. **[10 Hours]**

Prescribed Text Books:

1. K. E. Atkinson: An introduction to numerical analysis, 2nd Edition, Wiley India Private Limited, 2008.
2. 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. J. Stoer & R. Bulirsch: Introduction to numerical analysis, 3rd Edition, Springer, 2002.
2. D. Kincaid & W. Cheney: Numerical analysis: Mathematics of scientific computing, American Mathematical Society, 2010.
3. S. S. Sastri; Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd., 2005.
4. Richard L. Burden, John Douglas Faires; Numerical Analysis, Cengage Learning, 2005.

Course Code: IAM-501

Course Name: Functional Analysis

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
1. End Term Examination: 50%
2. Continuous Internal Assessment: 25%
   i) Assignment 10%
   i) Class participation 10%
   ii) Class tests 5%

Course Contents:

Unit-I: Metric Space , Examples of Metric Spaces, Open set, Closed set, Neighbourhood, convergence, Cauchy sequence, completeness, completion of metric spaces. **[10 Lectures]**

Unit-II: Normed Linear Spaces, Banach Spaces, Properties of Normed Linear Spaces, Properties of Banach Spaces, Compactness and Finite Dimensions, Linear Operators, Bounded and Continuous Operators. **[10 Lectures]**

Unit-III: Linear Functional, Dual Space, Double Dual Space, Inner Product Spaces, Hilbert Spaces, Properties of Inner Product Spaces, Orthogonal Compliment, Direct Sum, Orthonormal Sets and sequences. **[10 Lectures]**

Unit-IV:, Representation of Functional on Hilbert Spaces, Self-Adjointness, Unitary Operators, Normal Operators, Hahn-Banach, Open mapping and closed Graph Theorems. **[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.
3. B. Limaye, "Functional Analysis", New Age International.
4. I. J. Maddox, "Elements of Functional Analysis", Cambridge University Press; 2 edition.

Course Code: MTH 402
Course Name: PARTIAL DIFFERENTIAL EQUATIONS
Credits: 04
Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

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

i) Assignment 10%
ii) Class participation 10%
iii) Class tests 5%

Course Contents:

Unit I: Mathematical models leading to partial differential equations, First and second order equations, Cauchy-Kowalewski's theorem (for first order), Classification of second order equations and reduction to standard form, method of characteristics, Riemann's method and applications. **[10 Hours]**

Unit II: Elliptic equations; Laplace and poisson equations, properties of harmonic functions, mean value property, maximum-minimum principle, Green's function approach, Method of images, separation of variables.

[10 Hours]

Unit III: Parabolic equations; Heat equation, fundamental solution, separation of variables, similarity solution, maximum principle and comparison theorems.

[10 Hours]

Unit IV: Hyperbolic equations; wave equation, separation of variables, method of eigenfunction, D' Alembert's formula, Duhamel's principle,

[10 Hours]

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.

Semester-I

Course Code: MTH-404

Course Name: **Abstract Algebra**

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

3. Mid Term Examination: 25%
4. End Term Examination: 50%
5. Continuous Internal Assessment: 25%

iii)	Assignment	10%
iv)	Class participation	10%
v)	Class tests	5%

Course Contents:

Unit-I:

Definition of Group, Examples Groups: Dihedral Groups, Matrix Groups and Quaternion Group, Homomorphisms and Isomorphisms, Direct Product of Groups, Subgroups: Definition and Examples, Centralizers, Normalizers, Kernels. **[10 Lectures]**

Unit-II: Cyclic Groups and Cyclic Subgroups, Quotients Groups: Definition and Examples. Cosets, Lagrange's Theorem, Normal Subgroups, Isomorphism Theorems, Symmetric Groups. **[10 Lectures]**

Unit-III: Group Actions, Stabilizers and Kernels of Group Action. Groups acting on themselves by Left Multiplication: Cayley's Theorem, Groups acting on themselves by Conjugation, Class Equation Sylow's Theorems. **[8 Lectures]**

Unit-IV: Basic Definitions of Rings. Examples of Rings: Polynomial Rings, Matrix Rings and Group Rings. Ideals, Ring Homomorphism , Quotient Rings, Integral Domains, Euclidean Domains, Principal Ideal Domains (P.ID.s), Unique Factorization Domains (U.F.D.s), Polynomial Ring over Field. **[12 Lectures]**

Prescribed Text Book:

- **M. Artin, "Algebra", Second Edition, PHI.**

Suggested Additional Reading:

1. D. S Dummit & R. M. Foote, "Abstract Algebra", Third Edition, Wiley India.
2. S. Lang, "Algebra", Third Edition, Sprinder.

Course Code: MTH 403
Course Name: LINEAR ALGEBRA

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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 examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%
   - i) Assignment 10%
   - ii) Class participation 10%
   - iii) Class tests 5%

Course Contents:

Unit I: Vector Spaces, Subspaces, Basis and dimension, Linear Transformations, Quotient spaces, Direct sum, The matrix of a linear transformation, Duality **[10 Hours]**

Unit II: Eigenvalues and eigenvectors, Annihilating polynomials, Invariant subcpaces, 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. **[10 Hours]**

Prescribed Text Book:

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

Suggested Additional Readings:

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

Course Name: ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS
Course Code: IAM 402
Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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 introductory-ODEs, PDEs and their applications.

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%
i. Subjective / Objective Assignment: 10 %
ii. Numerical Assignments using programming: 10 %
iii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Existence and uniqueness theory; dependence of solutions on initial conditions and on the function; existence and uniqueness theorems for systems and higher order equations.
[10Hours]

Unit II: The theory of linear differential equations; homogeneous and non-homogeneous systems, nth order homogeneous and non-homogeneous linear differential equations, Sturm theory, Sturm- boundary value problems.
[10Hours]

Unit III: Surfaces and curves in three dimensions, simultaneous differential equations, orthogonal trajectories, Pfaffian differential equations, First order PDEs, Cauchy's method of characteristics, compatible system of first order equations, Charpit's and Jacobi's methods.
[10 Hours]

Unit IV: Classification of second order PDEs, first General solution of higher order PDEs with constant and variable coefficients, Method of separation of variables.
[10 Hours]

Prescribed Text Books:

1. Ross S.L. (1984). Differential Equations. Third Edition. John Wiley & Sons Inc.
2. Ian N. Sneddon (2006), Elements of Partial Differental Equations, Dover Publications Inc.

Suggested Additional Readings:

1. W.E. Boyace and R.C. Diprima (2013). Elementary Differential Equations and Boundary Value Problems,
Ninth Edition, Wiley.
2. W.A. Strauss; Partial differential equations an introduction, John Wiley & Sons, 2008.

Course Code: IAM-401
Course Name: Complex Analysis
Credit-4

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised 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.)

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: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%

i. Subjective / Objective Assignment: 20 %
ii. Presentations and Class Tests: 5 %

Course Contents:

UNIT-I: Complex Numbers, Geometric description, Stereographic projection, Analytic functions, the Cauchy-Riemann equations, Multivalued functions, Branch point. [10 Lectures]

UNIT-II: Complex integration, Cauchy-Goursat theorem, Cauchy integral formula, Derivatives of analytic function [10 Lectures]

UNIT-III: The Liouville theorem, The Morera theorem, Maximum-Modulus theorem, Conformal transformations. [10 Lectures]

UNIT-IV: Taylor's series, Laurent's series, Singularities of complex functions, the Cauchy Residue theorem, Evaluation of integrals. [10 Lectures]

Prescribed text book:

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

Reference books:

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