Master of Science in Mathematics and Computing

Program Outcomes:

PO-1: Apply mathematics and computing fundamental and domain concepts to find out the solution of defined problems and requirements. **(Computational Knowledge)**

PO-2: Use fundamental principle of Mathematics and Computing to identify, formulate research literature for solving complex problems, reaching appropriate solutions. **(Problem Analysis)**

PO-3: Understand to design, analyze and develop solutions and evaluate system components or processes to meet specific need for local, regional and global public health, societal, cultural, and environmental systems. **(Design/Development of Solutions)**

PO-4: Use expertise research-based knowledge and methods including skills for analysis and development of information to reach valid conclusions. **(Conduct Investigations of Complex Computing Problems)**

PO-5: Adapt, apply appropriate modern computing tools and techniques to solve computing activities keeping in view the limitations. **(Modern Tool Usage)**

PO-6: Apply mathematics and computing knowledge to access and solve issues relating to health, safety, and societal, environmental, legal, and cultural issues within local, regional and global context. **(Societal and Environmental Concern).**

Program Specific Outcomes:

PSO-1: Understand the mathematical concepts and applications in the field of algebra, analysis, computational techniques, optimization, differential equations, engineering, finance and actuarial science.

PSO-2: Handle the advanced techniques in algebra, analysis, computational techniques, optimization, differential equations, engineering, finance and actuarial science to analyze and design algorithms solving variety of problems related to real life problems.

PSO-3: Adopt changing scientific environment in the process of sustainable development by using mathematical tools.

PSO-4: Learn skills and expertise in the field of research and developments through seminar and dissertation.

Programme:	**M. Sc.**	**Semester :**	**I Sem**
Name of the Course:	**Real Analysis and General Topology**	**Course Code:**	**MMA 1101**
Credits :	**5**	**No of Hours :**	**50**
Max Marks:	**100**		

Course Description:

This course covers the fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, and the interchange of limit operations**.** Topological spaces, examples, closure of a set, derived set, subspace topology, Bases, finite product topology, subbases, Metric spaces, example.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Apply the knowledge of concepts of real analysis in order to study theoretical development of different mathematical techniques and their applications.
CO2	Identify challenging problems in real variable theory and find their appropriate solutions
CO3	Deal with Sequence & Series and generalize the concepts of sequences and series, and continuous functions.
CO4	Deal with the concept of Uniform convergence & uniform continuity.
CO5	Use theory of Riemann-Stieltjes integral in solving definite integrals arising in different fields of science and engineering.
CO6	Understand measure theory and integration from theoretical point of view and apply its tools in different fields of applications. Extend their knowledge of Lebesgue theory of integration by selecting .
CO7	Understand the concepts of topological spaces and the basic definitions of open sets, neighborhood, interior, exterior, closure and their axioms for defining topological space.
CO8	Understand the concepts of topological spaces and the basic definitions of open sets, neighborhood, interior, exterior, closure and their axioms for defining topological space.
CO9	Understand the concept of Bases and Sub bases, create new topological spaces by using subspace

CO10	Understand how points of space are separated by open sets, Housdroff spaces and their properties.

Syllabus:

Unit I

Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Continuity, uniform continuity, differentiability, mean value theorem. Uniform convergence. Riemann-Stieltjes Integral: Definition and Existence of Integral, Properties of Integral, Integration and Differentiation, Improper integral, Integration of Vector-valued functions, Monotonic functions, types of discontinuity, functions of bounded variation.

Unit II

Function of Several Variables: Linear transformation, Differentiation, The contraction principle, The inverse Function Theorem, The Implicit Function Theorem, Derivative of Higher orders, Langrage's Multiplier Method.

Unit III

Measure Theory: Set functions, Measurable Sets, Construction of Lebesgue Measure, Measure Spaces, Measurable Functions, Simple Functions, Lebesgue Integration, Lebesgue's Monotone Convergence Theorem, Fatou's theorem, Lebesgue Dominated Convergence Theorem, Comparison with Riemann Integral, Function of class L2.

General Topology

Unit IV

Topological Spaces: Open sets, closed sets, neighbourhoods, bases, subbases, limit points, closures, interiors, continuous functions, homeomorphisms. Subspace topology, product topology, metric topology, order topology, Quotient Topology.

Unit V

Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Heine-Borel Theorem, Local compactness. Separation axioms; their Characterizations and basic properties. Urysohn's lemma, Tietze extension theorem.

REFERENCE BOOKS

1. S. C. Malik, S. Arora, Mathematical Analysis, New Age International.
2. Walter Rudin Principle of Mathematical Analysis, McGraw-Hill.
3. T. Apostol, Mathematical Analysis, Narosa Publishers.
4. H. L. Roydon, Real Analysis, Macmillan Publication, New York

5. K. Ross, Elementary Analysis: The Theory of Calculus, Springer.
6. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd.
7. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd.
8. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill.
9. G De Barra, Measure theory and integration, New Age Publication
10. Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House.
11. P.R. Halmos, Measure Theory, Graduate Text in Mathematics, Springer-Verlag.
12. A K Malik, S.R. Singh, S.K. Gupta, S.C. Malik, Measure Theory and Integration, IK International Publishing House .

CO-PO & PSO Correlation

Course Name : Real Analysis and General Topology										
	Program Outcomes						**PSOs**			
Course	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**	**1**	**1**	**1**			**1**	**1**		**1**
CO2:	**2**	**2**	**1**	**1**		**1**	**1**	**1**	**1**	
CO3:	**1**	**1**		**1**			**1**			**1**
CO4:		**1**			**1**			**1**		**1**
CO5:		**1**		**1**					**1**	
CO6:		**1**		**1**			**1**			
CO7:	**1**		**1**		**1**				**1**	
CO8:		**1**					**1**			**1**
CO9:										
CO10:										

Note: 1: Low 2: Moderate 3: High

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

School of Science, Department of Mathematics

Programme:	**M. Sc.**	**Semester :**	**I Sem**
Name of the Course:	**Advanced Differential Equation**	**Course Code:**	**MMA1102**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

Evaluate first order differential equations including separable, homogeneous, exact, and linear. Show existence and uniqueness of solutions. Solve second order and higher order linear differential equations. Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits. Solve differential equations using variation of parameters. Solve linear systems of ordinary differential equations.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand of Initial value problems, Existence and Uniqueness theorem
CO2	Understand Series solution around an ordinary point and a regular singular point.
CO3	Understand Frobeinus method and power series method.
CO4	Understand Hermite Polynomials, Legendre polynomials, Jacobi Polynomials, Bessel, Legendre equation.
CO5	Understand Green's functions, second order boundary value problems
CO6	Study the behavior of different mathematical expressions arising in science and engineering
CO7	Understand Fourier series, Linear and quasi linear equations
CO8	Understand Green's function and solutions of boundary value problems.

Syllabus:

Section A: Ordinary Differential Equations

Initial value problems, Existence and Uniqueness theorem, Series solution around an ordinary point and a regular singular point, the method of Frobeinus and power series method, Hermite Polynomials, Legendre polynomials, Jacobi Polynomials, Bessel, Legendre equation, special functions (Hyper Geometric, Legendre and Bessel's Function), Self adjoint Eigen value problems, Green's functions, Second order boundary value problems, Sturm Liouville's problems.

Section B: Partial Differential Equations

Fourier series, Linear and quasi linear equations, Partial Differential Equations of second order with constant and variable coefficients, Classification and reduction of second order equations to canonical form, Cauchy's, Neumann and Dirichlet's problems, Solutions of PDE using Separation of variables, Fourier transform and Laplace transform , Solution of Laplace and Poisson's equations in two and three dimensions, Solution of wave equation and unsteady heat equation in homogeneous, non-homogeneous cases., Green's function and solutions of boundary value problems.

REFERENCE BOOKS

1. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand
2. S G Deo, V Raghavendra, RasmitaKar, V Lakshmikantham, Ordinary Differential Equations, Tata McGraw-Hill Education
3. E. A. Coddington and N. Levinson. Theory of Ordinary Differential Equations. Tata Mc Graw-Hill
4. P. Prasad and R. Ravindran, Partial Differential Equations, New Age International Publishers.
5. K. Sankar Rao, Introduction to Partial Differential Equation, PHI, 2011
6. I. N. Sneddon, Elements of partial differential equations, McGraw-Hill, Newyork.
7. L.C. Evans, Partial Differential Equations, American Mathematical Society.
8. T. Amaranath, An elementary course in partial differential equations, Narosa Publication.
9. Fritz John, Partial Differential equations, Springer
10. G.F. Simmons, Differential equations with Applications an historical Notes, Tata McGraw Hill,
11. Ioannis P Stavroulakis, Stepan A Tersian, Partial Differential Equations: An Introduction with MATHEMATICA and MAPLE, World scientific, Singapore, 2004.
12. Ghosh &Maity, Introduction to Differential Equation.

CO-PO & PSO Correlation

Course Name: Advanced Differential Equation										
	Program Outcomes						**PSOs**			
Course	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	1			1			2			
CO2:			1		2			1		
CO3:		2		1			1			1
CO4:	1		1	1				2		
CO5:		1			1				1	
CO6:	1		1				1			1
CO7:		2		1	1					
CO8:	2		1					1		

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**I Sem**
Name of the Course:	**Discrete Mathematical Structure**	**Course Code:**	**MMA 1103**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course defines and illustrate types of sets, relations. Introduce Hasse diagram. Understand the types of relations and functions, special functions and composition of functions. Understand Boolean functions, recurrence relation. Familiarize with different types of graphs, connectivity, trees.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Demonstrate understanding of and the ability to verify types of sets and operations of Set.
CO2	Understand the types of relation, properties of relation, composition of relation.
CO3	Understand Hasse Diagram, Concept of a function, Special function, Properties of functions, Composition of Functions.
CO4	Apply the knowledge of techniques involved Partial and total orderings, Partially ordered Sets, Lattices.
CO5	Understand Boolean functions, Logic gates, Relationship with Statement Logic, De Morgan's Law, Dual Statement, Boolean function.
CO6	Understand Linear Recurrence Relations (Difference Equations), Solution by Characteristics Roots, Generating Functions.
CO7	Familiarize with different types of graphs, connectivity and properties.
CO8	Understand trees and their properties.

Syllabus:

Unit- I Basic of Set Theory, Relations, Functions

Basic of Set Theory: Concept of a Set, Operations with Sets, Computer Operations with Sets, The Cardinality of a set, recursively defined Sets, multi sets.

Relations and function: Relations and Diagraphs, Computer Representations of Relations, Properties of Relations, Operations on Relations. The connectivity relations, Equivalence relations, equivalence class, Hasse Diagram, Concept of a function, Special function, Properties of functions, Composition of Functions,

Lattices: Partial and total orderings, Partially Ordered Sets, Lattices, Modular and Distributive Lattices.

Unit- II Mathematical logic and Boolean Algebra

Mathematical logic: Statements, Connectives, Statements Variables and Formulas, Tautologies, Equivalences and Implications, Disjunctive and Conjunctive Normal Forms, Inference Theory in Statement Logic, Indirect Proof, Switching Circuit

Boolean Algebra: Boolean Matrices, Boolean Product, Boolean Algebras, Boolean functions, Logic gates, Relationship with Statement Logic, De Morgan's Law, Dual Statement, Boolean function.

Unit-III Combinatorics, Recurrence Relation and Generating Functions

Combinatorics: Permutations and Combinations, Permutations and Combinations with repetitions ordered and unordered Partition, Pigeonhole Principle,

Recurrence Relation and Generating Functions: Sterling Numbers of First and Second kind, Partition Function, Linear Recurrence Relations (Difference Equations), Solution by Characteristics Roots, Generating Functions.

Unit –IV Graph Theory

Graph Theory: Basic Concept of Graph Theory, Paths, Cycles and Connectivity, Types of Graph, Eulerian and Hamiltonian Graphs, Planner Graphs, Matrix representation of graph, Graph colouring, Subgraph, Isomorphic Graphs, Operations of Graph and Representation of Graph.

Unit-V Trees:

Trees and their properties, Rooted trees, Spanning Trees, Binary Trees, Binary Search Trees, Minimal Spanning Tree. Algorithms for minimal spanning tree, Shortest path algorithms.

REFERENCE BOOKS

1. C. L. Liu, Elements of Discrete Mathematics by.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications.
3. Swapan Ku. Sarkar, A Textbook of Discrete Mathematics.
4. B. Kolman and R. C. Busby, Discrete Mathematical Structures for Computer Science.
5. J. P. Trembley and R. P. Manohar, Discrete Mathematical Structures with Application to Computer Science.
6. G Shankar Rao, Discrete mathematical Structures, New Age International Publishers.
7. Frank Harary, Graph Theory.
8. Narsingh Deo, Graph Theory with application to engineering and computer science.
9. Susanna S Epp, Discrete mathematics with applications
10. D P Acharya, Fundamental's approach to Discrete mathematics.

CO-PO&PSO Correlation

Course Name : Discrete Mathematical Structure

	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	2	1	1		1	1	1		1	
CO2:		1	2				2			1
CO3:		1	1		1		1			1
CO4:		2	2			1	2			1
CO5:	2		1	1	1	1	2	1		1
CO6:	1					1	1			1
CO7:	1		2		1	1	2			2
CO8:	1			1			1	1		

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**II Sem**
Name of the Course:	**Complex Analysis**	**Course Code:**	**MMA 1201**
Credits :	**5**	**No of Hours :**	**50**
Max Marks:	**100**		

Course Description:

This is an introductory course to Complex Analysis at an undergraduate level. Complex Analysis, in a nutshell, is the theory of differentiation and integration of functions with complex-valued arguments z = x +i y , where i = (-1) 1/2 . While the course will try to include rigorous proofs for many - but not all - of the material covered, emphasize will be placed on applications and examples. Complex Analysis is a topic that is extremely useful in many applied topics such as numerical analysis, electrical engineering, physics, chaos theory, and much more, and you will see some of these applications throughout the course. In addition, complex analysis is a subject that is, in a sense, very complete. The concept of complex differentiation is much more restrictive than that of real differentiation and as a result the corresponding theory of complex differentiable functions is a particularly nice one - as you will hopefully agree at the end of the course..

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Explain Continuity and Discontinuity of various functions in different contexts..
CO2	Differentiate Uniform continuity from continuity and related theorems.
CO3	Understand the meaning of derivative of a function
CO4	Acquire skill in applying the various techniques of differentiation and applications.
CO5	Explain convergence of a series.
CO6	Illustrate the convergence properties of power series.
CO7	Acquire the basic knowledge of Circular and Hyperbolic Functions of a Complex Variable
CO8	Familiarized with real and imaginary parts of a circular and hyperbolic functions of a complex variable

CO9	Distinguish between the various methods for separating complex numbers in various forms into real and imaginary parts
CO10	Understand how to separate a complex function into its real and imaginary parts.

Syllabus:

Unit-I

Analytic functions, Cauchy-Riemann equations. complex integration, Cauchy-Goursat Theorem, Cauchy's integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem, The fundamental theorem of algebra.

Unit-II

Maximum modulus principle, Schwarz lemma, Open mapping theorem, The argument principle, Rouche's theorem Inverse function theorem.

Unit-III

Bilinear transformations, their properties and classifications, Definitions and examples of Conformal mappingsm, Mobius transformations.

Unit-IV

Taylor's theorem, Laurent's series, Isolated singularities, Meromorphic functions calculus of residues, Cauchy's residue theorem, Evaluation of integrals, Branches of many valued functions with special reference to arg z, logz and za.

Unit-V

Spaces of analytic functions, Hurwitz's theorem, Montel's theorem, Riemann mapping theorem.

Reference Books

1. L.V.Ahlfors, Complex Analysis , McGraw - Hill.
2. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House.
3. R.V. Churchill and Brown, Complex variables and applications, McGraw Hill.
4. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House.
5. Murray Speigel, Complex Variables, Shaum's Outline Series
6. Walter Rudin, Real and Complex Analysis, McGraw-Hill Book Co.

7. S. Lang, Complex Analysis, Addison Wesley.
8. D. Sarason , Complex Function Theory, American Mathematical Society.
9. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford.
10. Liang-shin Hahn & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London.
11. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
12. Mark J.Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University press, South Asian Edition, 1998.
13. E. Hille, Analytic Function Theory , Gonn & Co., 1959.
14. W.H.J. Fuchs, Topics in the Theory of Functions of one Complex Variable, D.Van Nostrand Co.,.
15. C. Caratheodory, Theory of Functions (2 Vols.) Chelsea Publishing Company, 1964.
16. M. Heins, Complex Function Theory, Academic Press, 1968.
17. S. Saks and A. Zygmund, Analytic Functions, Monografic Matematyczne, 1952.
18. E.C Titchmarsh, The Theory of Functions, Oxford University Press, London.
19. W.A. Veech, A Second Course in Complex Analysis, W.A. Benjamin, 1967.

CO-PO & PSO Correlation

Course Name : Complex Analysis										
Course Outcomes Program Outcomes							**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:		**2**					**3**			
CO2:	**1**							**2**		
CO3:			**2**				**2**			
CO4:		**2**		**1**						**1**
CO5:	**1**		**3**					**1**		
CO6:		**2**					**1**			
CO7:	**1**				**1**			**1**		
CO8:		**2**							**2**	
CO9:			**1**				**3**			
CO10:		**1**				**1**		**2**		

Note: 1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**II Sem**
Name of the Course:	**Advanced Algebra**	**Course Code:**	**MMA 1202**
Credits :	**5**	**No of Hours :**	**50**
Max Marks:	**100**		

Course Description:

Advance Algebra is meant to follow Algebra and precede Geometry. Topics studied include properties of solving linear equations and inequalities, absolute value functions, graphing, systems of linear equations and inequalities, properties of exponents, quadratic equations, polynomials, rational equations, exponential and logarithmic functions, radicals, probability and statistics, and sequences and series.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the properties of Vector spaces over fields, Subspaces, Bases and dimension. And determine the rank of a matrix & dimension of vector space.
CO2	Understand the System of linear equations and applying Gauss elimination method for solution of linear equation and find the solution of system of linear equation.
CO3	Understand the Linear transformations, Representation of linear transformation by matrices, Rank-nullity theorem.
CO4	Find the Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation etc. and Use Cayley Hamilton theorem.
CO5	Solve systems of linear equations by matrix reduction (Gaussian method) and understand the Invariant subspaces.
CO6	Calculate the Orthonormal Basis by Gram-Schmidt orthonormalization process and define the self-adjoin operators, definite forms and understands the Groups, subgroups, normal subgroups, quotient groups, homomorphism, automorphisms, cyclic groups, permutation groups.
CO7	Prove Sylow's theorems and their applications & find the number of subgroup of finite group by Sylow's theorem and understand Rings, ideals,
CO8	Understand the concept of Polynomial rings & Check whether the polynomial is irreducible or not.

CO9	Understand the Field theory & prove the Fundamental theorem of Galois theory.
CO10	Find the solution of polynomial equations by radicals, Insolvability of the general equation of degree 5 by radicals.

Syllabus:

Unit-I Linear Algebra

Vector spaces over fields, Subspaces, Bases and dimension. Matrices, Rank, System of linear equations, Guass elimination. Linear transformations, Representation of linear transformation by matrices, Rank-nullity theorem, Linear functionals, Annihilator, Double dual, Transpose of a linear transformation. Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley Hamilton theorem, Invariant subspaces. Direct sum decompositions, Invariant direct sums, The primary decomposition and the Rational form, The Jordan form. Inner product spaces, Orthonormal basis, Gram-Schmidt orthonormalization process, self-adjoint operators, definite forms.

Unit-II Group Theory

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, automorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow's theorems and their applications; Normal and Subnormal series, Composition series, Jordan Holder theorem, Solvable groups, Nilpotent groups.

Unit-III Ring Theory

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal idealdomain, Euclidean domain. Polynomial rings and irreducibility criteria.

Unit-IV Field theory

Fields, finite fields, Extension fields, Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extensions, Perfect fields, Finite fields, Primitive elements, algebraically closed fields, Automorphisms of extensions, Galois extensions, Fundamental theorem of Galois theory.

Unit-V Solution of polynomial equations by radicals, Insolvability of the general equation of degree 5 by radicals.

Reference Books

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education(India), 2003.

2. S. Lang: Linear Algebra, Springer Undergraduate Texts in Mathematics, 1989.
3. S. Kumeresan: Linear Algebra: A Geometric Approach, Prentice Hall of India,
4. Rao, Bhimasankaram, Linear Algebra, Hindustan Book Agency.
5. P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul, Basic Abstract Algebra, Cambridge University press
6. I. N. Herstein, Topics in Albegra, Wiley Eastern Ltd.
7. J.B. Fraleigh , A first course in Algebra Algebra, Narosa,1982.
8. Joseph Gallian, Contemporary abstract algebra, Cengage Learning,
9. M. Artin: Algebra, Prentice Hall of India, 2005.
10. VivekSahai and VikasBist: Algebra, Narosa Publishing House, 1999
11. M. Cohn, Algebra, Vols. I,II&III, John Wiley & Sons, 1982,1989,1991.
12. N.Jacobson, Basic Algebra, Vols. I , W.H. Freeman, 1980 (also published by Hindustan Publishing Company).
13. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol.II-Rings, Narosa Publishing House
14. D.S.Malik, J.N.Mordeson, and M.K.Sen, Fundamentals of Abstract Algebra, Mc Graw-Hill, International Edition,1997.
15. QuaziZameeruddin and SurjeetSingh : Modern Algebra
16. I. Stewart, Galois theory, 2nd edition, chapman and Hall, 1989.
17. J.P. Escofier, Galois theory, GTM Vol.204, Springer, 2001.

CO-PO & PSO Correlation

Course Name : Advanced Algebra

	Program Outcomes						**PSOs**			
Cours	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	1	1		1		1	1	1	1	1
CO2:		1		1	1			1		1
CO3:		1	1				1			
CO4:	1								1	
CO5:		1			1	1		2		
CO6:	1			2					1	1
CO7:			1				1			
CO8:							1		1	2
CO9:	1		1							
CO10:										

Note: 1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

OPJU UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**II Sem**
Name of the Course:	**Principles Of Numerical Computations**	**Course Code:**	**MMA 1203**
Credits :	**5**	**No of Hours :**	**50**
Max Marks:	**100**		

Course Description:

This course will focus on different types of error. Student will learn about how to find the roots using different iteration methods , how to find numerical solution of system of linear equations. Student will explore Convergence condition of Gauss-Seidel method, Successive-Over- Relaxation (SOR) method. Students will understand eigenvalues and eigenvectors of real Matrix. Students will acquire the concept of Finite differences, Interpolation familiar with basic concepts of Numerical differentiation; Numerical integration and Understand Higher Order Equations.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand different types of error and different iterative methods to find the root.
CO2	Understand the ideas of Aitken's method and Steffensen's iteration; Bairstow's method.
CO3	Acquire the concept of finding numerical Solution of System of Linear Equations.
CO4	Develop competency Convergence condition of Gauss-Seidel method, Successive-Over- Relaxation (SOR) method.
CO5	Understand eigenvalues and eigenvectors of real Matrix.
CO6	Acquire the concept of Finite differences, Interpolation
CO7	Acquire the basic ideas of Numerical differentiation; Numerical integration.
CO8	Acquire the basic ideas of numerical Solution of Initial Value Problems for ODE.
CO9	Understand the convergence and stability
CO10	Understand Higher Order Equations

Syllabus:

Unit-I

Errors, Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; Rate of convergence, Solution of Non-linear Equations: Modified Newton-Raphson method; Aitken's method and Steffensen's iteration; Bairstow's method,

Unit-II

Numerical Solution of System of Linear Equations: Triangular factorization methods, Jacobi's Method, Matrix inversion method, Operation counts, Iterative methods, Convergence condition of Gauss-Seidel method, Successive-Over-Relaxation (SOR) method. Eigenvalues and Eigenvectors of Real Matrix: Power method for extreme eigenvalues and related eigenvectors, Jacobi's method for symmetric matrix (algorithm only), Given's method and Hosueholder's reflections; QR method.

Unit-III

Finite differences, Interpolation: error of polynomial interpolation, Lagrange, Newton interpolations; Hermite and spline interpolation, Numerical differentiation; Numerical integration: Trapezoidal and Simpson rules; error bound for numerical differentiation and numerical integration.

Unit-IV

Numerical Solution of Initial Value Problems for ODE: First Order Equation: Runge-Kutta methods, Multistep predictor-corrector methods, Adams-Bashforth method, Adams-Moulton method, Milne's method, Convergence and stability. Higher Order Equations: Stiff differential equations, Two-point Boundary Value Problems for ODE: Finite difference methods, Shooting method.

Unit-V

Finite difference method: Solution of partial differential equations by finite difference method. Partial difference quotients, Discretization error, Idea of convergence and stability, Explicit and Crank Nicolson implicit method of solution of one dimensional heat conduction equation: convergence and stability, Standard and diagonal five point formula for solving Laplace and Poisson equations.

Reference Books

1. S. R. K. Iyengar, R. K. Jain, M. K. Jain Numerical Methods for Scientific and Engineering Computation, New Age Publication

2. Samuel D. Cante and Carl de Boor: Elementary Numerical Analysis, McGraw Hill.
3. D. Aitkinson: Numerical Analysis, John Wiley and Sons, 2009
4. A. Gourdin & M. Boumahrat, Applied Numerical Methods.
5. Ralston and Rabinowitz, A first course in Numerical Analysis.
6. Isacson and Keller, Analysis of Numerical methods.
7. M. K. Jain, Numerical solution of differential equations.
8. G. D. Smith, Numerical solution of partial differential equations.
9. Prem K. Kytbe, An introduction to boundary element methods.
10. B.P. Demidovich and J. A. Maron , Computational Mathematics
11. Berzin and Zhidnov, Computing methods.
12. A. R. Mitchell, The finite elements method in partial differential equations.

CO-PO&PSO Correlation

Course Name : Principles of Numerical Computations

	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	2	1				1	1		1	
CO2:		1	3				2			1
CO3:		1	2				1			
CO4:	1	2	2			1	1			2
CO5:	1	1			1	2				1
CO6:						1	1			1
CO7:	1		2			1	2			
CO8:										
CO9:		1				1			1	
CO10:	1		1		1	2	1			1

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Functional Analysis**	**Course Code:**	**MMA 2101**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course defines and illustrate several normed spaces. Introduce linear operators and derive their properties. Elaborate basic theorems like open and closed mapping theorem, implicit function theorem and spectral theorem. Elicits the concepts of Normed linear spaces, Banach spaces and Hilbert spaces. Provides a working knowledge of spectral theory in bounded self adjoint linear operator and demonstrate significant applications of the theory of functional analysis.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Explain the fundamental concepts of functional analysis and their role in modern mathematics.
CO2	Utilize the concepts of functional analysis, for example continuous and bounded operators, normed spaces, Hilbert spaces.
CO3	Understand and apply fundamental theorems from the theory of normed and Banach spaces including the Hahn-Banach theorem, the open mapping theorem, the closed graph theorem and uniform boundedness theorem.
CO4	Analyzing the results of Adjoint, Self-Adjoint, Normal and Unitary Operators defined on Hilbert spaces and the concept of projection on Hilbert and Banach spaces.
CO5	Applying the concepts of eigen spectrum on normed linear spaces and spectral radius on Banach spaces
CO6	Study the behavior of different mathematical expressions arising in science and engineering

Syllabus:

Unit I: Spaces

Linear spaces and linear operators; Normed linear spaces and inner product spaces; Banach spaces, Hilbert Spaces and basic properties; More about inner product spaces; Heine Borel theorem, Bessel's inequality; Fourier expansion, Parseval's formula and Riesz Fischer theorem; Projection theorem.

Unit II: Operators

Bounded linear operators; Space of bounded linear operators and Dual space; Riesz representation theorem; Adjoint of an operator; Self adjoint, normal and unitary operators; Dual of some sequence spaces and function spaces; Compact operators.

Unit III: Some Important Theorems

Closed graph theorem, open mapping theorem, and uniform boundedness principle; Hahn Banach extension theorem and its consequences. Hilbert spaces- The orthogonal projection, Nearly orthogonal elements, Riesz's lemma, Riesz's representation theorem

Unit IV: **Spectral Theory**

Eigen spectrum and approximate Eigen spectrum; Resolvent set and spectrum; Spectral results for self adjoint, normal and unitary operators; Spectral representation for compact self adjoint operators; Singular value representation of compact operators.

Reference Books:

1. M.T. Nair, Functional Analysis: A first Course, Prentice Hall of India, New Delhi, 2002 (Second Printing: 2008)
2. B.V.Limaye, Functional Analysis, New Age International Limited, Publishers, New Delhi, 1996.
3. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 2001.
4. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Kogakusha, Ltd., New Delhi, 1963.
5. C. Goffman and G. Pedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1995.

CO-PO & PSO Correlation

Course Name : Functional Analysis										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**3**	**2**			**1**		**2**	**1**	**1**	
CO2:	**2**	**2**	**1**	**1**			**1**		**2**	
CO3:	**1**		**1**		**1**		**1**		**1**	2
CO4:	**1**	**1**	**1**				**1**	**1**	**1**	1
CO5:		**2**	**1**		**1**			**2**		2
CO6:		**1**		**2**	**2**			**1**	**1**	3

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Mathematical Methods**	**Course Code:**	**MMA 2102**
Credits :	**3**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

The objective of the course is to acquaint the students with the knowledge of mathematical techniques frequently applied in various branches of engineering and sciences. Also, one of the objectives of this course is to equip the students with the mathematical background required for the development of such techniques.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understanding regarding different kind of integral transforms.
CO2	Understand Fourier transform and its properties and will be able to solve the examples based on it.
CO3	Have deep understanding of Laplace Transformation and its real life application.
CO4	Solve initial value problem and boundary value problem using Laplace Transform.
CO5	Derive Fourier series representation of Periodic functions
CO6	To distinguish between 'inertia frame of reference' and 'non-inertial frame of reference'.
CO7	To know how to impose constraints on a system in order to simplify the methods to be used in solving physics problems
CO8	To know what central, conservative and central-conservative forces mathematically understand the conservative theorems of energy, linear momentum and angular Momentum.
CO9	To know the importance of concepts such as generalized coordinates and constrained motion.
CO10	To find the linear approximation to any dynamical system near equilibrium and also know how to derive and solve the wave equation for small oscillations.

Syllabus:

Unit I: Integral Transforms

General definition of Integral transforms, Kernels, etc. Development of Fourier integral, Fourier transforms – inversion, Illustration on the use of integral transforms, Laplace, Fourier, Hankel and Mellin transforms to solve ODEs and PDEs - typical examples. Discrete orthogonality and Discrete Fourier transform. Wavelets with examples, wavelet transforms.

Unit II: Calculus of Variations

Integral Equations: Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series resolvent kernel and transform methods, Convergence for Fredholm and Volterra types. Reduction of IVPs BVPs and eigenvalue problems to integral equations. Characteristic numbers and eigen functions, Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods.

Unit III: Linear Integral Equations

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Unit IV: Classical Mechanics

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

Reference Books:

1. I N. Sneddon: The use of integral transforms: Tata Mc Graw Hill Publishing Company Ltd.
2. I. M. Gelfand, S. V. Fomin: Calculus of Variations, Dover Books, 2000.

3. M. L Krasnov: Problems and Exercices in Integral Equations, MIR publisher, 1971. 22

4. M. L. Krasnov: Problems and Exercices in the calculus of variations, Central Books Ltd 19753.

5. L. G. Chambers: Integral Equations: A Short Course, International Text Book Company Ltd. 1976 4. H. Hochstad, Integral Equations, John Wiley & Sons, 1989.

6. Edwin F Beckenbach: Modern Mathematics For Engineers: Second series, Mc Graw Hill Book Company.

7. H. Goldstein: Classical Mechanics, Second Edition Narosa publishing house, New Delhi.

CO-PO & PSO Correlation

Course Name : Mathematical Methods										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:		**2**					**3**			
CO2:	**1**							**2**		
CO3:			**2**				**2**			
CO4:		**2**			**2**					**1**
CO5:	**1**		**3**					**1**		
CO6:		**2**					**1**			
CO7:	**1**			**1**				**1**		
CO8:		**2**							**2**	
CO9:			**1**				**3**			
CO10:		**1**				**1**		**2**		

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Differential Geometry and Tensor Analysis**	**Course Code:**	**MMA 2106**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will focus on the geometry of curves and surfaces in 3-dimensional Euclidean space. Student will learn about such things how to find the shortest distance between two points, how to measure curvature, and how to find and use the shortest paths on a surface. Student will explore the relationship between the length of a curve and the area bounded by it (the isoperimetric inequality), applications to soap bubbles, and the relationship between the curvature and the topology of a surface (the Gauss-Bonnet theorem). This course is to make students familiar with basic concepts of differential geometry so as to deal with geometry of curves and spaces using the methods of differential calculus.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the basic concepts and results related to space curves, tangents, normal and surfaces.
CO2	Explain the geometry of length, curvature, and torsion associated to planar and spatial curves
CO3	Explain the physical properties of length, curvature, and torsion associated to planar and spatial curves
CO4	Define, use, and articulate the differences between normal curvature, geodesic Curvature
CO5	Explain the concept of Gaussian curvature, and mean curvature
CO6	Discuss Gauss Bonnet theorem and its implication for a geodesic triangle
CO7	Understand the surfaces of revolution with constant negative and positive Gaussian curvature
CO8	Learn Christoffel symbols and their expression in terms of metric coefficients and their derivatives

Syllabus:

Unit I: Space curves, Tangent, Contact of curve and surface, Osculating plane, Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Existence and Uniqueness theorems, Bertrand curves. Involute, Evolutes.

Unit II: Ruled surface, Developable surface, Tangent plane to a ruled surface. Necessary and sufficient condition that a surface ʒ=f(ʒ, η) should represent a developable surface. Conoids, Inflexional tangents, Singular points, Indicatrix. Metric of a surface, First, second and third fundamental forms, Weingarten equations. Fundamental magnitudes of some important surfaces, Orthogonal trajectories.

Unit III: Normal Curvature, Meunier's theorem. Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussian curvature, Umbilics, Radius of curvature of any normal section at an umbilic on $z = f(x, y)$. Radius of curvature of a given section through any point on $z = f(x, y)$. Lines of curvature, Principal radii, Relation between fundamental forms. Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asyinptotic line. Gauss's formulae, Gauss's characteristic equation, Mainardi-Codazzi equations. Fundamental existence theorem for surfaces, Parallel surfaces, Gaussian and mean curvature for a parallel surface, Bonnet's theorem on parallel surfaces.

Unit IV: Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic curvature and Torsion, Normal angle, Gauss-Bonnet Theorem.

Unit V: Tensor Analysis—Basics of Elements of Riemannian geometry, Concept of manifold, Kronecker delta. Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, Relative tensor. Riemannian space. Metric tensor, Indicator, Permutation symbols and Permutation tensors. Christoffe1 symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Field of parallel vectors, Reimann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein Tensor and their properties, Flat space, Isotropic point, Schur's theorem.

Reference Books:

1. A. Pressley – Elementary Differential Geometry, Under-graduate Mathematics Series, Springer.

2. T. J. Willmore – An Introduction to Differential Geometry, Oxford University Press.

3. D. Somasundaram – Differential Geometry: A First Course, Narosa, 2005.

4. R J.T. Bell, Elementary Treatise on Co-ordinate geometry of three dimensions, Macmillan India Ltd., 1994.
5. Mittal and Agarwal, Differential Geometry, Krishna publication, 2014.
6. C E Weatherborn: Tensor calculus
7. Barry Spain, Tensor Calculus, Radha Publ. House Ca1cutta,1988.
8. J.A. Thorpe, Introduction to Differential Geometry, Springer-Verlog , 2013.
9. Weatherbum, Reimanian Geometry and Tensor Clculus, Cambridge Univ. Press, 2008.
10. Thorpe, Elementary Topics in Differential tieometry, Springer Verlag, N.Y. (1985).
11. S R.S. Millman and G.D. Parker, Elements o1' Differential Geometry, Prentice Hall, 1977.
12. Barrett O' Neil : Elementary Differential Geometry. Academic Press, New
13. D. J. Struik : Lectures on Classical Differential Geometry, Addison Wesley, Reading, Massachusetts, 1961.
14. Nirmala Prakash: Differential Geometry- an integrated approach. Tata McGraw-Hill, New Delhi, 1981.
15. J.L. Bansal: Tensor Analysis
16. P.G.Bergman: Introduction to Theory of Relativity.

CO-PO & PSO Correlation

Course Name : Differential Geometry and Tensor Analysis										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	3	2		1			3	2		1
CO2:		2	2	1	1		2	1		
CO3:	3	1	1		1		2	1		1
CO4:	2	2	1	1	1		1	1		
CO5:		2	2		1		1	1		1
CO6:		2	2		2		1	2		2
CO7:		1	1				2	2		3
CO8:	2	2	2	1	1		2	2		3

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Probability and Statistics**	**Course Code:**	**MMA 2107**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will focus on the probability theory and descriptive measure. Student will learn about the discrete random variables and continuous Random variables. Student will understand the moments generating function. Students will able to determine the solutions of coefficient of skewness and coefficient of kurtosis and able to explain sampling and know Point and Interval Estimation This course is to make students familiar with basic concepts of probability and Statistics and determine solutions to regression and correlation analysis.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Identify, analyze and subsequently solve descriptive measures
CO2	Understand the basic probability theory
CO3	Understand the discrete random variables and continuous Random variables.
CO4	Understand the moments generating function.
CO5	Determine the solutions of coefficient of skewness and coefficient of kurtosis.
CO6	Explain sampling and know Point and Interval Estimation
CO7	Understand the hypothesis testing.
CO8	Determine solutions to regression and correlation analysis.

Syllabus:

Unit I: Statistics :

Descriptive measures: Measures of central tendency; Measures of dispersion; Measures of skewness and Measures of kurtosis, Curve fitting: Method of group averages, Method of least squares

Unit II: Probability

Basic probability theory; Axiom of probability; Some elementary theorems; Conditional probability; Bayes' theorem. Discrete Random variables; Discrete probability distribution; Continuous Random variables; Continuous probability distribution; Expectation; Variance; Standard deviation; Moments; Moments generating function; Coefficient of skewness and coefficient of kurtosis; Binomial, Poisson, Normal and Exponential Distribution.

Unit III: Sampling, Estimation and Testing of Hypothesis

Sampling: Sampling Distribution of the Mean, Sampling Distribution of the Variance, chi-square, t and F distribution

Point and Interval Estimation: Point Estimation Methods by Method of Moments and Maximum Likelihood. Confidence Intervals for mean and variance of various distribution, Maximum Likelihood Estimators of Certain Functions of Parameters.

Hypothesis Testing: Tests of Statistical Hypotheses for Single-Sample Case and Multiple-Sample Case, Tests Concerning Means, Tests Concerning Differences Between Means, Tests Concerning Variances, Tests Concerning Proportions.

Unit IV: Regression Analysis

The analysis of means: a review of basics and an introduction to linear models, simple linear regression: linear regression with one independent variable, multiple linear regression, problems with observations: outliers and influence, unequal variances, correlated errors, introduction to nonlinear models, generalized linear models

REFERENCE BOOKS:

1. Statistical Methods by N G Das, McGraw Hill

3. Fundamentals of Statistics by S. C. Gupta, Himalaya Publishing House
4. Random Phenomena Fundamentals of Probability and Statistics for Engineers by Babatunde A. Ogunnaike
5. Probability and Statistics for Engineers, 5th Edition by Richard L. Scheaffer, Madhuri S. Mulekar, James T. McClave. Brooks/Cole, Cengage Learning.
6. Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross, Elsevier Academic Press.
7. Introduction to Probability and Statistics for Science, Engineering, and Finance by Walter A. Rosenkrantz, CRC Press
8. John E. Freund's Mathematical Statistics with Applications Irwin Miller Marylees Miller, Eighth Edition, PEARSON Publication
9. John E. Freund's, Regression Analysis (Statistical Modeling of a Response Variable) 2nd Edition, Academic Press

CO-PO&PSO Correlation

Course Name: Probability and Statistics										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	2	1	1		1	1	1		1	
CO2:		1	3				2			1
CO3:		1	2				1			1
CO4:		2	2			1	2			2
CO5:	2				1	2	2			1
CO6:	2					1	1			1
CO7:	1		2		1	1	2			2
CO8:	1		1		1	2	1			1

Note: 1: Low 2: Moderate 3: High

OPJU UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Graph Theory**	**Course Code:**	**MMA 2108**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will introduce the fundamental aspects of graphs and multigraphs, Eulerian circuits, Vertex, degrees and counting. Student will acquire a good understanding of the handshake lemma, Havel-Hakimi Theorem, Directed graph. Students will know vertex coloring: proper coloring, k-colorable graphs, chromatic number and understand Independence number, Clique covering, Clique covering number, perfect graphs. Students will obtain solutions of Ford-Fulkerson Labeling algorithm.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Describe basic definitions of graphs and multigraphs
CO2	Understand the ideas of Eulerian circuits, Vertex, degrees and counting .
CO3	Understand the handshake lemma, Havel-Hakimi Theorem, Directed graph.
CO4	Understand Matching and covering.
CO5	Know vertex coloring: proper coloring, k-colorable graphs, chromatic number.
CO6	Understand Independence number, Clique covering, Clique covering number, perfect graphs.
CO7	Investigate Vertex cuts, separating sets, bonds; vertex and edge connectivity, block-cut point tree
CO8	Obtain solutions of Ford-Fulkerson Labeling algorithm.

Syllabus:

Unit I: Fundamental concepts of graphs

Basic definitions of graphs and multigraphs; adjacency matrices, isomorphism, girth, decompositions, independent sets and cliques, graph complements, vertex coloring, chromatic number, important graph like cubes and the Petersen graph Paths, cycles, and trails; Eulerian circuits Vertex degrees and counting; large bipartite subgraphs, the handshake lemma, Havel-Hakimi Theorem, Directed graph.

Unit II: Matching and covering

Bipartite matching, vertex cover, edge cover, independent set, M-alternating path, Maximum Matching Problem, Hall's Theorem, König-Egeváry Theorem, Gallai's Theorem.

Unit III: Coloring of Graphs

Vertex coloring: proper coloring, k-colorable graphs, chromatic number, upper bounds, Cartesian product of graphs, Structure of k-chromatic graphs, Mycielski's Construction, Color-critical graphs, Chromatic Polynomial, Clique number, Independent (Stable) set of vertices, Independence number, Clique covering, Clique covering number. Perfect graphs: Chordal graphs, Interval graphs, Transitive Orientation, Comparability graphs. Edge-coloring, Edge-chromatic number, Line Graphs.

Unit IV: **Connectivity and Network flow**

Vertex cuts, separating sets, bonds; vertex and edge connectivity, block-cut point tree. Menger's Theorem: undirected vertex and edge versions.

Ford-Fulkerson Labeling algorithm, flow integrality, Max-flow/Min-cut Theorem, proof of Menger's Theorem.

Reference Books:

1. J. A. Bondy and U. S. R. Murty: Graph Theory and Applications (Freely downloadable from Bondy's website; Google-Bondy)

2. D. B. West: Introduction to Graph Theory: Prentice-Hall of India/Pearson, 2009 (latest impression).

3. R.Diestel: Graph Theory,Springer(low price edition) 2000.

4. F. Harary Graph Theory, Addition Wesley Reading Mass.

5. N. Deo: Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India, 1987.

6. K. R. Parthasarathy: Basic Graph Theory, Tata McGraw-Hill, New Delhi, 1994..

CO-PO&PSO Correlation

Course Name : Graph Theory										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**2**	**1**				**1**	**1**		**1**	
CO2:	**1**		**3**		**1**		**2**	**1**		**1**
CO3:		**1**	**1**				**1**			**1**
CO4:		**2**	**1**			**1**				**2**
CO5:	**2**				**1**					**1**
CO6:	**2**					**1**	**1**	**1**		**1**
CO7:	**1**		**2**		**1**	**1**	**2**			**2**
CO8:	**1**		**1**			**2**	**1**	**1**		**1**

Note: 1: Low 2: Moderate 3: High

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

School of Science, Department of Mathematics

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of theCourse:	**Number Theory**	**Course Code:**	MMA 2109
Credits :	**4**	**No of Hours :**	
Max Marks:	**100**		

Course Description:

This course is an introduction to the fundamentals of number theory, with a survey of additional topics that are accessible once the basics are in place. The course is intended to introduce concepts of number theory from a rigorous point of view, and then show students some of the applications of the material they have just learned. Not as deep as, as but generally broader as a one-semester course for math majors at universities. The course is core material: axioms for the number system, divisibility and the GCD, factorization, Euclidean algorithm, linear Diophantine equations, the multiplicative functions sum and number of divisors. Congruences, systems and the Chinese Remainder Theorem, reduced residue systems and Euler's totient function. Euler and Fermat theorems, primality testing, order and primitive roots. Representations of numbers in base *b*, periodic expansions, irrational numbers and cardinality.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand Primes, Divisibility, primality testing and factorization methods.
CO2	Understand Euclidean Algorithm, Extended Euclidean algorithm
CO3	Acquire the concept of Congruences, Ring of Integers mod n, Chinese Remainder Theorem and understand arithmetic Functions, Fermat's little theorem, Primitive roots.
CO4	Understand Mobius Inversion formula, properties of Mobius function.
CO5	Acquire the concept of recurrence functions, Fibonacci numbers and their elementary properties
CO6	Understand Quadratic Residues, Quadratic Reciprocity Law, Binary Quadratic Forms

CO7	Understand Gauss Lemma, Jacobi symbol and its properties and Pell's Equation, Diophantine Equation
CO8	Understand Algebraic Number Fields and the Ring of Integers, Units and Primes.

Syllabus

Unit I:

Primes, Divisibility, primality testing and factorization methods, Euclidean Algorithm, Extended Euclidean algorithm, Congruences, Ring of Integers mod n, Chinese Remainder Theorem, Linear congruences, Congruences with prime-power modulus

Unit II:

Arithmetic Functions, Fermat's little theorem, Primitive roots, examples and their properties, perfect numbers, the Mobius Inversion formula, properties of Mobius function, convolution of arithmetic functions, group properties of arithmetic functions, recurrence functions, Fibonacci numbers and their elementary properties.

Unit III:

Quadratic Residues, Quadratic Reciprocity Law, Binary Quadratic Forms, Continued Fractions, Wilson's theorem, Euler function and its applications, Group of units, primitive roots, Möbius Inversion formula, Euler’s criterion, Legendre symbol and its properties, Gauss Lemma, Jacobi symbol and its properties.

Unit IV:

Pell's Equation, Diophantine Equation, Some applications of number theory in algebraic coding theory. Cryptography: some simple cryptosystem, Enciphering matrices, Idea of public key cryptography.

Unit V:

Algebraic Number Fields and the Ring of Integers, Units and Primes, Factorisation, Quadratic and Cyclotomic Fields, Dirichlet L Function, Diophantine Equations, Elliptic Curves.

Reference Books:

1. Burton, David M. Elementary Number Theory. Allyn and Bacon, 1976.

2. Ireland, Kenneth F., and Michael I. Rosen, A classical Introduction to Modern Number Theory, Springer 1990.

3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer, UTM, 2007.

4. Neal Koblitz, A Course in Number Theory and Cryptography, Springer, Verlag - New york Inc., May 2001.

5. I. Niven, H. S. Zuckerman, H. L. Montgomery, \An Introduction to the Theory of Numbers", Wiley-India Edition, 2008.

6. T. M. Apostol, \Introduction to Analytic Number Theory", Springer International Student Edition, 2000.

7.Cassels, J.W.S., Frolich, A., Algebraic Number Theory, Cambridge

CO-PO & PSO Correlation

	Course Name : Number Theory									
	Program Outcomes (POs)						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**		**1**		**1**		**2**			
CO2:			**1**		**2**			**1**		
CO3:		**1**					**1**			**1**
CO4:	**1**	**2**		**1**				**2**		
CO5:		**1**			**1**				**1**	
CO6:	**1**		**2**	**1**			**1**			**1**
CO7:		**1**			**1**				**1**	
CO8:	**1**			**2**				**1**		**1**

Note: 1: Low 2: Moderate 3: High.

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Fluid Dynamics**	**Course Code:**	**MMA 2110**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will introduce the fundamental aspects of fluid flow behaviour and to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery. Student will acquire a good understanding of the fundamental equation of viscous compressible fluid and enable to study Bernoulli equations, Momentum theorems and its applications. Student can understand the motion of solid bodies in fluid and sound knowledge of boundary layer theory.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Define the fundamental aspects of fluid flow behaviour.
CO2	Classify the flow patterns of a fluid (gas or liquid) depend on its characteristic.
CO3	Derive Euler's equation, Bernoulli's equation and Discuss the case of steady motions under conservative body forces.
CO4	Apply concepts of mass, momentum and energy conservation to flows
CO5	Analyze the steady state kinetic energy equation for fluid flow systems and estimate pressure drop in fluid flow systems.
CO6	Understand the concept of elements of thermodynamics
CO7	Explain Entropy-Maxwell's Thermodynamics relation.
CO8	Understand concept of Magneto hydrodynamics and derived Maxwell's electromagnetic field equation, Define and illustrate Viscous Flow, apply to solve problems, Acquire the knowledge of boundary layer and apply to solve problems.

Syllabus:

Unit I: Kinematics of fluids in motion
Tensor notations; real fluids and ideal fluids; velocity of a fluid at a point; streamlines and path lines; steady and unsteady flows; the velocity potential; the vorticity vector; local and particle rates of change; the equation of continuity; acceleration of a fluid; conditions at a rigid boundary; general analysis of fluid motion.

Unit II: Equations of motion of a fluid
Pressure at a point in a fluid at rest; pressure at a point in a moving fluid; conditions at a boundary of two inviscid immiscible fluids; Euler's equation of motion; Bernouli's theorem; discussion of the case of steady motion under conservative body forces; potential theorems; flows involving axial symmetry; some special two-dimensional flows; impulsive motion.

Unit III: Two-dimensional and Three dimensional flows
Meaning of two dimensional flow; the stream function; the complex potential for two dimensional irrotational incompressible flows; uniform stream, line sources and line sinks; line doublets; line vortices; two-dimensional image systems; the theorem of Blasius. Sources, sinks and doublets; images in a rigid infinite plane; images in solid spheres; axi-symmetric flows; Stokes's stream functions.

Unit IV: Viscous flow
Stress components in a real fluid; relation between Cartesian components of stress; translation motion of fluid element; the rate of strain quadric and principal stresses; stress analysis in fluid motion; relation between stress and rate of strain; the coefficient of viscosity and laminar flow; the Navier stokes equations of motion of a viscous fluid; solvable problems in viscous flows; steady flow in tubes of uniform cross-section; definition of vorticity; energy dissipation due to viscosity; steady flow past a fixed sphere; Prandtl's boundary layer.

Unit V: Gas dynamics
Compressible effects in real fluids; the elements of wave motion; the speed of sound in a gas; equations of motion of a gas; subsonic, sonic and supersonic flows; isentropic gas flow; reservoir discharge through a channel of varying section; shock waves; use of characteristic coordinates; flow round a sharp convex corner.

Reference Books:

1. Textbook of Fluid Dynamics by F. Chorlton, CBS Pub. and Distributors
2. Fluid Dynamics by Dr. M. D. Raisinghania, S Chand
3. Boundary Layer Theory by H. Schlichting McGraw Hill

CO-PO & PSO Correlation

Course Name : Fluid Dynamics										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	3	1	1				3	1		2
CO2:	2	2	2		2	1	3	1		2
CO3:	3	1	1	1	1	1	2	1	1	2
CO4:	2	2					2	2		3
CO5:	3	2	2	2			1	2		3
CO6:	2	2	1	1			2	2		2
CO7:	2	1	2	2			2	2		3
CO8:	3	2	2	2	2	2	3	3	2	3

Note: 1: Low 2.: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Wavelet Analysis**	**Course Code:**	**MMA 2111**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will introduce the construction of wavelets with some specific examples. Students will learn some basic Fourier analysis. Students will identify the limitations of classical Fourier analysis. To establish the theory necessary to understand and use wavelets and related constructions. Students will learn what wavelets are, and how they are used to represent and transform sound and image files.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Learn thoroughly Fourier analysis and to give a theoretical background to wavelets.
CO2	Understand the terminology that are used in the wavelets literature.
CO3	Comprehend in the field of Basic Hilbert space theory Fourier series, Fourier transform and some commonly used wavelet systems.
CO4	Understand the wavelet basis and characterize continuous and discrete wavelet transforms
CO5	Understand and identify various wavelets.
CO6	Evaluate the time- frequency resolution properties of wavelets
CO7	Students will learn about the characterization of wavelets in L2(R) and the most powerful technique MRA (Multiresolution Analysis).
CO8	Learn the construction of wavelets and Daubechies wavelets construction through MRA.

Syllabus:

Unit I:

Introduction, An overview. From Fourier analysis to Wavelet analysis. Origin of Wavelets, Classification of Wavelets., Haar Wavelet, Dyadic Wavelet, Dilates and Translates of Haar Wavelets, L2 norm of a function. Different ways of constructing wavelets. Orthonormal bases generated by single function. Wavelet frames for $L^2(R)$. Local sine and cosine bases and the construction of some wavelets.

Unit II:

Piecewise Constant, Representation of a Function, Ladder of Subspaces, Scaling Function of Haar Wavelet, Demonstration, Piecewise constant approximation of functions, Vector Representation of Sequences, Properties of Norm Parseval's Theorem.

Unit III:

Equivalence of functions & sequences, Angle between Functions & their Decomposition. Additional Information on Direct-Sum, Introduction to Filter Bank. Haar Analysis, Filter Bank in Z-domain, Haar Synthesis, Filter Bank in Z-domain.

Unit IV:

Moving from Z-domain to frequency domain, Frequency Response of Haar Analysis, Low pass Filter bank, Frequency Response of Haar Analysis, High pass Filter bank.

Unit V:

The unitary operators and the smooth projections. Multiresolution analysis and construction of wavelets. Construction of compactly supported wavelets and estimates for its smoothness. Orthogonal wavelet packets. Band limited wavelets. Orthogonality. Completeness. Franklin wavelets and spline wavelets on the real line.

Reference Books:

1. Michael W. Frazier: An Introduction to Wavelets Through Linear Algebra, Springer, 1999.
2. Stephane Mallat: A Wavelet Tour of Signal Processing, Academic Press, Elsevier, 1998, 1999, Second Edition.
3. Barbara Burke Hubbard: The World according to Wavelets - A Story of a Mathematical Technique in the making: Second edition, Universities Press (Private) India Limited 2003.
4. P. P. Vaidyanathan: Multirate Systems and Filter Banks, Pearson Education, Low Price Edition.
5. David F. Walnut: An Introduction to Wavelet Analysis, Springer
6. C K Chui: An Introduction to Wavelets
7. E. Hernandez and G. Weiss: A first course on Wavelets.

CO-PO & PSO Correlation

Course Name : Wavelet Analysis										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	2	2			2		2	2		1
CO2:	1	1					3	1		2
CO3:	2	2	2	1	1		1	2		2
CO4:	2	1	1	1	1		1	2		1
CO5:	3		2				3	2		2
CO6:	2		2	2			2	1		3
CO7:	3	2	2	2	2		3	2	2	2
CO8:	2	2	1	1	2		2	2	2	3

Note: 1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Mechanics**	**Course Code:**	**MMA 2112**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

To demonstrate knowledge of functional and extremum path and the application of the knowledge in solving some fundamental problems. To demonstrate the knowledge and understanding of the fundamental concepts in the dynamics of system of particles and Lagrangian and Hamiltonian formulation of mechanics. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	To distinguish between 'inertia frame of reference' and 'non-inertial frame of reference'.
CO2	To know how to impose constraints on a system in order to simplify the methods to be used in solving physics problems.
CO3	Have deep understanding of Laplace Transformation and its real life application.
CO4	To know the importance of concepts such as generalized coordinates and constrained motion.
CO5	To find the linear approximation to any dynamical system near equilibrium and also know how to derive and solve the wave equation for small oscillations
CO6	To find the Lagrangian and Hamiltonian formulation of Classical Mechanics
CO7	To state the conservation principles involving momentum, angular momentum and energy and understand that they follow from the fundamental equations of motion.
CO8	To have a deep understanding of Newton's laws and Students learn about motion of a particle under central force field..

Syllabus:

Unit I:

Variational Principle and Lagrange's equations; Hamilton's Principle, some techniques of calculus of variations, Derivation of Lagrange equations from Hamilton's principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.

Unit II:

Legendre transformations and the Hamilton equations of motion. Cyclic coordinates and conservation theorems. Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.

Unit III:

The equations of canonical transformation. Examples of canonical transformation. The symplectic approach to canonical transformations. Poisson brackets and other canonical invariants.

Unit IV:

Equations of motion. Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum, Poisson bracket relations, symmetry groups of mechanical systems. Liouville's theorem.

Reference Books

1. Classical Mechanics: By H. Goldstein, Second Edition Narosa publishing house, New Delhi.
2. Lectures in Analytic Mechanics: F. Gantmacher, MIR Publishers, Moscow, 1975.
3. Classical Mechanics: Narayan Chandra Rana and Pramod Sharad Chandra Jog, Tata Mc Graw Hill.

CO-PO & PSO Correlation

Course Name : Mechanics										
Course Outcomes Program Outcomes							PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:		2					3			
CO2:	1							2		
CO3:			2		1		2			
CO4:		2		1						1
CO5:	1		3					1		
CO6:		2					1			
CO7:	1							1		
CO8:		2				1			2	

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Analytical Dynamics and Gravitation**	**Course Code:**	**MMA 2113**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will This course introduce the basic of Classical Mechanics and the calculus of variation. Students will be able to describe Hamiltonan's principle.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Derive the energy equation of conservative field.
CO2	Gain the knowledge about the coordinate system (Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems).
CO3	Understand the fundamental lemma of Calculus of variation.
CO4	Apply the concept of calculus of variation in solving the Brachistochrone problem
CO5	Understand the concept of Lagrange brackets and Poisson brackets and its properties.
CO6	Understand the equation required in Gravitation
CO7	Understand the concept of work done by self-attracting systems.
CO8	Understand the Equipotential surfaces.

Syllabus:

Unit I:

Generalized coordinates Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation of conservative fields.

Unit II:

Hamilton's variables, Hamilton canonical equations. Cyclic coordinates Routh's equations, Jacobi-Poisson Theorem. Fundamental lemma of calculus of variations.

Motivating problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachistochrone problem, Geodesic.

Unit III:

Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

Unit IV:

Gravitation: Attraction and potential of rod, spherical shells and sphere. Laplace and Poisson equations. Work done by self-attracting systems. Distributors for a given potential. Equipotential surfaces.

Reference Books:

1. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
2. I. M. Gelfand and S.V.Fomin Calculus of variation, prentice Hall.
3. S.L. Loney, An elementary treatise on Statics, Kalyani Publishers, N. Delhi 1979.
4. A.S.Ramsey, Newtonian Gravitation. The English Language Book Society and the Cambridge University Press.
5. N.C. Rana & P.S.Chandra Joag, Classical Mechanics. Tata McGraw Hill 1991.
6. Lours N. Hand and Janel, D. Finch, Analytical Mechanics, Cambridge University Press

CO-PO & PSO Correlation

Course Name : Analytical Dynamics and Gravitation										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	3	2					2	2		2
CO2:	1	1					3	1		1
CO3:	2	2	2	1	1		1	2		2
CO4:	3	1	1	1	1		1	2	1	2
CO5:	2		2				3	2		1
CO6:	2		2	2			2	1		2
CO7:	3	1	2	1	1		3	2		2
CO8:	2	2	1	1	2		2	2		3

Note: 1: Low 2: Moderate 3: High

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UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Algebraic Geometry**	**Course Code:**	**MMA 2114**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course is a basic requirement for higher study in geometry, algebraic number theory or algebra. This course will introduce the basic objects in algebraic geometry: affine and projective varieties, and the maps between them. The focus will be on explicit concrete examples. It is a classical subject with a modern face that studies geometric spaces defined by polynomial equations in several variables.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Study the geometric objects defined algebraically
CO2	Demonstrate the knowledge of the basic affine and projective geometries.
CO3	Become familiar with explicit examples including plane curves, quadrics.
CO4	Become familiar with cubic surfaces, Segre and Veronese embeddings.
CO5	Acquire the knowledge of finitely generated commutative rings.
CO6	Know the basic theorem related to fields of fractions.
CO7	Learn the basic statements about algebraic varieties in precise abstract algebraic language.
CO8	Prove the statements about algebraic varieties.

Syllabus:

Unit I:

Prime ideals and primary decompositions, Ideals in polynomial rings, Hilbert Basis theorem.

Unit II:

Noether normalisation lemma, Hilbert's Nullstellensatz, Affine and Projective varieties

Unit III:

Zariski Topology, Rational functions and morphisms, Elementary dimension theory,

Unit IV:

Smoothness, Curves, Divisors on curves, principal divisors especially on curves and surfaces

Unit V:

Bezout's theorem, Riemann-Roch for curves, Line bundles on Projective spaces.

Reference Books:

1. K. Hulek, "Elementary Algebraic Geometry", Student Mathematical Library 20, American Mathematical Society, 2003.
2. I. R. Shafarevich, "Basic Algebraic Geometry 1: Varieties in Projective Space", Springer, 2013.
3. J. Harris, "Algebraic geometry", Graduate Texts in Mathematics 133, Springer Verlag, 1995.
4. M.Reid, "Undergraduate Algebraic Geometry",London Mathematical Society Student Texts 12, Cambridge University Press, 1988.
5. K. E. Smith et. al., "An Invitation to Algebraic Geometry", University text, Springer Verlag, 2000.

6. R.Hartshorne, "Algebraic Geometry", Graduate Texts in Mathematics 52, Springer

CO-PO & PSO Correlation

Course Name : Algebraic Geometry										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	2	1					2	1		1
CO2:	2	2	1	1			2	1		1
CO3:	2	1	1	1			1	1		1
CO4:	3	1	2	1			2	2		2
CO5:	2	2	1	1	1		2	1		1
CO6:	2	1	1	1			2	2		2
CO7:	3	1	2	1			2	1		2
CO8:	2	1	1	1			2	1		3

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Algebraic Topology**	**Course Code:**	**MMA2115**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

Homotopy theory. Homotopy theory studies homotopy classes of maps from spheres to topological spaces, which is a natural generalization of the fundamental group, while their behaviors are very different from each other. The topics we will cover include: Whitehead's theorem, cellular approximation, excision theorem, Hurewicz theorem, long exact sequence of fiber bundles, connections with cohomology, Leray-Hirsch theorem and Gysin sequence.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the Homotopy Theory
CO2	Learn the basic properties of Deck Transformations
CO3	Understanding and analyzing the group actions
CO4	Prove the Seifert-Van Kampen Theorem
CO5	Describe the Simplexes
CO6	Understand the Singular Chain Complexes
CO7	Understand the Short Exact Sequences
CO8	Understand the Excision Theorem

Syllabus:

Unit I: Homotopy Theory: Simply Connected Spaces, Covering Spaces, Universal Covering Spaces, Deck Transformations, Path lifting lemma, Homotopy lifting lemma,

Unit II: Group Actions, Properly discontinuous action, free groups, free product with amalgamation,

Unit III: Seifert-Van Kampen Theorem, BorsukUlam Theorem for sphere, Jordan Separation Theorem.

Unit IV: Homology Theory: Simplexes, Simplicial Complexes, Triangulation of spaces, Simplicial Chain Complexes, Simplicial Homology, Singular Chain Complexes, Cycles and Boundary, Singular Homology, Relative Homology.

Unit V: Short Exact Sequences, Long Exact Sequences, Mayer-Vietoris sequence, Excision Theorem, Invariance of Domain.

Reference Books

1. J. R. Munkres, “Topology”, Prentice-Hall of India, 2013.
2. A. Hatcher, “Algebraic Topology”, Cambridge University Press, 2009.
3. G. E. Bredon, “Topology and Geometry”, Graduates Texts in Mathematics 139, Springer, 2009.

CO-PO & PSO Correlation

Course Name : Algebraic Topology										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4 5**	**5**	**6**	**1**	**2**	**3**	**4 5**
CO1:	**1**	**1**		**1**			**1**		**1**	
CO2:			**1**	**1**			**1**		**1**	
CO3:		**1**			**1**					**1**
CO4:				**1**				**1**		
CO5:	**1**		**1**			**1**			**1**	
CO6:	**1**		**1**				**2**		**2**	
CO7:					**2**					**1**
CO8:										

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Discrete Dynamical System**	**Course Code:**	**MMA 2116**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course describes the fundamental concepts related to modeling time dependent phenomena. Students extend their knowledge of calculus to solve problems in difference (and maybe differential) equations. To elaborate the elements of analysis of discrete dynamical systems and to consider particular systems with complex (chaotic) behavior. Students will think analytically when creating a mathematical model from a description of the process and analyze it using mathematical and numerical methods, both manually and using technology.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Convert a dynamical system to dimensionless form
CO2	Interpret the behavior of a dynamical system in terms of a real-world application.
CO3	Recognize bifurcation points and type.
CO4	Know the ideas of the Cantor middle-thirds set.
CO5	Recognize when a dynamical system exhibits chaotic behaviour.
CO6	Generate fractals and recognize the common examples of fractals.
CO7	Find the topological dimension of sets and fractal dimensions.
CO8	Know the elements of chaos include detailed studies of quadratic maps, Cantor sets, symbolic dynamics, conjugacy, fractals, and the Julia and Madelbrot sets

Syllabus:

Unit I:

Phase Portraits, Periodic Points and Stable Sets, Sarkovskii's Theorem, Hyperbolic, Attracting and Repelling Periodic Points.

Unit II:

Families of Dynamical Systems, Bifurcation, Topological Conjugacy. The Logistic Function.

Unit III:
Cantor Sets and Chaos, Period-Doubling Cascade. Symbolic Dynamics.

Unit IV:
Newton's Method. Numerical Solutions of Differential Equations. Complex Dynamics, Quadratic Family, Julia Sets, Mandelbrot Set.

Unit V:
Topological Entropy, Attractors and Fractals, Theory of Chaotic Dynamical systems.

Reference Books:

1. M W Hirsch, S Smale and R L Devaney Differential equations, Dynamical systems and an Introduction to Chaos, Elsevier Academic Press.

2. R L Devaney An introduction chaotic Dynamical System, Addison-Wesley.

3. A. Katok and B. Hasselblatt, Introduction to the Modern theory of Dynamical Systems, Cambridge University of Press.

CO-PO & PSO Correlation

Course Name : Discrete Dynamical System										
	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	2	1					2	1		1
CO2:	2	1	1	1		1	3	1		1
CO3:	2		2				2	2		1
CO4:	1	1	1	1			2	1		2
CO5:	3	2	2	1	1		2	1		1
CO6:	2	2	2	2	3		2	2		2
CO7:	1	1	1				1			3
CO8:	3	2	2	2	2		3	2	1	3

Note: 1: Low 2: Moderate 3: High

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OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**III Sem**
Name of the Course:	**Fuzzy Sets and its applications**	**Course Code:**	**MMA 2117**
Credits :	**4**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course provides the fundamentals of classical set theory and fuzzy set theory. The decomposition theorems of fuzzy sets and the extension principle will be introduced, as well as the use of nonlinear integrals as aggregation tools to deal with fuzzy data. As an indispensable tool in fuzzy decision making, ranking and ordering fuzzy quantities will be discussed.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand Basic concepts of fuzzy sets, Membership functions
CO2	Understand Types of operations
CO3	Understand Fuzzy numbers, triangular, trapezoidal fuzzy numbers
CO4	Understand Crisp versus fuzzy relations, projections and cylindric extensions
CO5	Understand fuzzy equivalence relations
CO6	Understand Fuzzy measures, evidence theory, possibility theory, fuzzy sets and possibility theory
CO7	Know possibility theory versus probability theory, applications
CO8	Understand fuzzy clustering, different clustering algorithms.

Syllabus

Unit I:

Primes, Divisibility, primality testing and factorization methods, Euclidean Algorithm, Extended Euclidean algorithm, Congruences, Ring of Integers mod n, Chinese Remainder Theorem, Linear congruences, Congruences with prime-power modulus

Unit II:

Arithmetic Functions, Fermat's little theorem, Primitive roots, examples and their properties, perfect numbers, the Mobius Inversion formula, properties of Mobius function, convolution of arithmetic functions, group properties of arithmetic functions, recurrence functions, Fibonacci numbers and their elementary properties.

Unit III:

Quadratic Residues, Quadratic Reciprocity Law, Binary Quadratic Forms, Continued Fractions, Wilson's theorem, Euler function and its applications, Group of units, primitive roots, Möbius Inversion formula, Euler’s criterion, Legendre symbol and its properties, Gauss Lemma, Jacobi symbol and its properties.

Unit IV:

Pell's Equation, Diophantine Equation, Some applications of number theory in algebraic coding theory. Cryptography: some simple cryptosystem, Enciphering matrices, Idea of public key cryptography.

Unit V:

Algebraic Number Fields and the Ring of Integers, Units and Primes, Factorisation, Quadratic and Cyclotomic Fields, Dirichlet L Function, Diophantine Equations, Elliptic Curves.

REFERENCE BOOKS:

1. Burton, David M. Elementary Number Theory. Allyn and Bacon, 1976.

2. Ireland, Kenneth F., and Michael I. Rosen, A classical Introduction to Modern Number Theory, Springer 1990.

3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer, UTM, 2007.

4. Neal Koblitz, A Course in Number Theory and Cryptography, Springer, Verlag - New york Inc., May 2001.

5. I. Niven, H. S. Zuckerman, H. L. Montgomery, \An Introduction to the Theory of Numbers", Wiley-India Edition, 2008.

6. T. M. Apostol, \Introduction to Analytic Number Theory", Springer International Student Edition, 2000.

7.Cassels, J.W.S., Frolich, A., Algebraic Number Theory, Cambridge

CO-PO & PSO Correlation

	Course Name: **Fuzzy Sets and its applications**									
	Program Outcomes (POs)						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**		**1**		**1**		**1**			
CO2:	**1**		**2**					**1**	**2**	
CO3:		**1**		**1**			**1**			**1**
CO4:	**2**				**1**			**2**		
CO5:		**1**		**2**					**1**	
CO6:	**1**		**2**	**1**			**1**			**1**
CO7:	**2**	**1**			**1**				**1**	
CO8:	**1**		**1**	**2**				**1**		

Note: 1: Low 2: Moderate 3: High.

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OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Operations Research**	**Course Code:**	**MMA 2206**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will introduce the formulation of LPP. Students will learn how to solve the LPP by different methods. Students will evaluate duality in Linear Program. Primal-dual relationship. dual simplex algorithm, sensitivity and Transportation Problems. Students will obtain solutions of Assignment Problems and Travelling Salesman Problem/ Routing Problem. Students will Learn the idea of Inventory problems, Inventory parameters, Variables in inventory problems and understand the Economic lot size formula and its properties, Problems.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Learn optimization, Formulation of linear Optimization problems, Graphical method and Simplex method.
CO2	Evaluate duality in Linear Program. Primal-dual relationship. dual simplex algorithm, sensitivity and Transportation Problems.
CO3	Obtain solutions of Assignment Problems and Travelling Salesman Problem/ Routing Problem.
CO4	Network minimization and integer Programming and Dynamic Programming (DP).
CO5	Learn the idea of Inventory problems, Inventory parameters, Variables in inventory problems
CO6	Understand the Economic lot size formula and its properties, Problems.

Syllabus:

Unit I: Linear Programming

Introduction to optimization, Formulation of linear Optimization problems, Convex set. Linear Programming model, Graphical method, Simplex method, Finding a feasible basis – Big M and two phase Simplex method, Duality in Linear Program. Primal-dual relationship & economic interpretation of Duality, Dual Simplex Algorithm, Sensitivity analysis.

Unit II: Allocation Problems and Competitive Strategy

Transportation Problems, North east corner, Least cost Vogel's approximation method, Method of multipliers, Assignment Problems, Travelling Salesman Problem/ Routing Problem, Game Theoretic Problems

Unit III: Network minimization and integer Programming

Network minimization, shortest route algorithms for acyclic networks, maximal flow problems, matrix definition of LP problem, revised simplex method, bounded variables, decomposition algorithm, parametric linear programming, Integer programming problem: Formulation, Branch & Bound and Cutting Plane methods. Dynamic Programming (DP). Non-linear Programming: Lagrange multipliers and Kuhn - Tucker conditions, convex optimization

Unit IV: Inventory Problems

Introduction, Inventory problems, Inventory parameters, Variables in inventory problems, Controlled and uncontrolled variables, Classification of inventory models, Deterministic elementary inventory models, Economic lot size formula and its properties, Problems.

REFERENCE BOOKS:

1. Edvin K. P. Chong & Stanislab H. Zak: An Introduction to Optimization, John Wiley.
2. Leunberger: Linear and Nonlinear Programming, Springer.

3. S.S. Rao: Engineering Optimization: theory and practices, New Age International Pvt. Ltd.

4. K. Deb: Optimization for Engineering Design, Prentice Hall, India Reference Book:

5. Taha, H.A.: Operations Research 5th ed. (Macmillan)

6. Panneerselvam, R.: Operations Research (Prentice hall of India)

7. S.D. Sharma: Operations Research

8. Kanti Swarup, P.K. Gupta and Manmohan: Operations Research.

CO-PO&PSO Correlation

Course Name : Operations Research										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**2**	**1**	**1**			**1**	**1**		**1**	
CO2:	**1**		**3**		**1**			**1**		**1**
CO3:		**1**	**1**				**1**			**1**
CO4:		**2**	**2**			**1**				**2**
CO5:	**2**				**1**					**1**
CO6:	**2**					**1**	**1**	**1**		**1**

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Magnetohydrodyanamics**	**Course Code:**	**MMA 2207**
Credits :	**3**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

This course will introduce the concept of Magneto-hydrodynamics and derived Maxwell's electromagnetic field equation. To describe the main properties of this system of equations and the details of the derivation of ideal and resistive MHD equations. Describe and explain the domains of validity of one-fluid MHD and demonstrate the basic properties of ideal MHD. Discuss MHD waves. Derive the Energy principle and apply the Energy principle to the Rayleigh-Taylor instability. Students will describe Viscous flow, Newtonian/Non Newtonian Fluid and study about boundary layer and apply to solve problems.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the concept of rotational and irrotational flow, stream functions, velocity potential, sink, source, vortex etc
CO2	Analyze simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier-Stoke's equation of motion.
CO3	Understand the electromagnetic induction mechanism which has its origin in the movement of fluids that are good electrical conductors and phenomenon of flow separation and boundary layer theory.
CO4	Translate a magnetic hydrodynamic problem in an appropriate mathematical form.
CO5	Interpret the solutions of the equations established in physical terms. Understand the concept of thermal conductivity.
CO6	Understand the basic concepts and the equations of flow of viscous fluids learn about the fundamental equations of the flow and energy.

Syllabus:

Unit I:

Electrostatics and electromagnetic units –derivation of Gauss law Faraday's law-Ampere's law and solenoidal property—conservation of charges electromagnetic boundary conditions. Dielectric materials.

Unit II:

Maxwell electromagnetic field equations. Constitutive equations of fluid motion, Stokes hypothesis. Maxwell stress tensor. Fundamental equations of Magnetofluid-dynamics. Magnetofluid-dynamic approximations. Magnetic field equation, Frozen in fluid, Alfven transverse waves. MHD boundary conditions. Inspection and Dimensional analysis, π-products.

Unit III:

Alfven's theorem- Frozen-in-phenomenon-illustrative examples Kelvin's circulation theorem- Bernoulli's Equations-Analogue of Helmholtz vorticity Equation-Ferraro's law of isorotation. Alfven waves: Lorentz force as a sum of two surface forces- cause for Alfven waves Applications-Alfven wave equations in incompressible fluids- equipartition of energy – experiments on Alfven waves- dispersion relations- Alfven waves in compressible fluids- slow and fast Waves-Hodographs.

Unit IV:

Flow Problems: Hartmann flow- Hartmann –Couette flow- Temperature distribution for these flows. Reynolds number, Mach number, Prandtl number, Magnetic Reynolds number, Magnetic pressure number, Hartmann number, Magnetic parameter, Magnetic Prandtl number and Nusselt number. Hartmann plane Poiseuille flow and plane Couette flow including temperature distribution. MHD flow in a tube of rectangular cross-section. MHD pipe flow. MHD flow in annular channel. MHD flow between two rotating coaxial cylinders.

Reference Books:

1. J.L. Bansal, Magnetofluiddynamics of viscous fluids, JPH Jaipur.
2. T. G. Cowling: Magnetohydrodynamics, Interscience, 1957.
3. K. R. Cramer and S.I.Pat, Magnetofluiddynamics for Enginners and Applied physicist, Mc Graw Hill, N.Y., 1973.

4. P A. Davidson, An Introduction to Magnetohydrodynamics, Cambridge University Press, U.K., 2001.
5. J. A. Shercliff, A Textbook of Magnetohydrodynamics, pergamon press, 1965
6. V. C. A. Ferraro and C. Plumpton : An Introduction to Magneto-Fluid Mechanics, Oxford University Press, 1961.
7. G. W. Sutton and A. Sherman: Engineering Magnetohydrodynamics, McGraw Hill, 1965.
8. Alan Jeffrey: Magnetohydrodynamics, Oliver & Boyd, 1966.
9. D. J. Griffiths: Introduction to Electrohydrodynamics, Prentice Hall, 1997.
10. P. H. Roberts: An Introduction to Magnetohydrodynamics, Longman, 1967.
11. H. K. Moffat: Magnetic field generation in electrically conducting fluids, Cambridge University Press, 1978.

CO-PO & PSO Correlation

Course Name : Magnetohydrodyanamics										
	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	3	2					2	1		1
CO2:	3	2	2	2			3	2		2
CO3:	2	2	2	2	2	1	2	2		2
CO4:	2	1	1				1	1		1
CO5:	2		1	1	1		2	2		1
CO6:	3	2	2	2	2	2	3	2	2	3

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Finite Element Method**	**Course Code:**	**MMA 2208**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

Finite element methods provide a general and powerful framework for solving ordinary and partial differential equations. In this course, we study the analysis, implementation and application of finite element methods. The following topics are studied in this course: piecewise polynomial approximation, quadrature and triangulation in one, two and three space dimensions, variational principles, energy minimization, Galerkin's method, Petrov-Galerkin, bilinear forms and linear forms, abstract formulation, Sobolev spaces, V-ellipticity, Lax-Milgram, Cea's lemma, error estimates in the energy norm, examples of finite elements including standard continuous and discontinuous Lagrange elements, BDM elements, RT elements, Nedelec elements and Crouzeix-Raviart elements, Dirichlet, Neumann and Robin boundary conditions, affine mapping from a reference element, the local-to-global mapping, assembling the linear system, efficient implementation of finite element methods, application to Poisson's equation, convection-diffusion, linear elasticity and ordinary differential equations.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the role and significance of shape functions in finite element and formulations and use linear, quadratic, and cubic shape functions for interpolation
CO2	Understand the direct and formal (basic energy and weighted residual) methods for deriving finite element equations, Understand global, local, and natural coordinates.
CO3	Understand the formulation of one-dimensional elements (truss and beam).
CO4	Understand the formulation of two-dimensional elements (triangle and quadrilateral continuum and shell elements).
CO5	Understand the formulation of three-dimensional elements (tetrahedral and brick elements).
CO6	Select appropriate space (planar (plane stress or strain), axisymmetric, or spatial), idealization (type of element), and modeling techniques.

Syllabus:

Unit I: Calculus of Variations: Variational formulation - Rayleigh-Ritz minimization, Weighted Residual Approximations: Point collocation, Galerkin and Least Squares method. Use of trial functions to the solution of ODE and PDE.

Unit II: Finite Element Procedures: Finite Element Formulations for the solutions of ordinary and partial differential equations: Calculation of element matrices, assembly and solution of linear equations.

Unit III: Finite Elements: One dimensional and two dimensional basis functions, Lagrange and serendipity family elements for quadrilaterals and triangular shapes, coordinate transformation, integration over a Master Triangular and Rectangular elements.

Unit IV: Application of Finite element Method: Finite element solution of Laplace and Poisson equations over rectangular and nonrectangular and curved domains. Applications to some problems in fluid mechanics and in other engineering problems

Reference Books:

1. O. C. Zienkiewiez and K. Morgan: Finite Elements and approximation, John Wieley, 1983 28.

2. P.E. Lewis and J.P. Ward: The Finite element method- Principles and applications, Addison Weley, 1991.

3. L. J. Segerlind: Applied finite element analysis (2nd Edition), John Wiley, 1984

4. J. N. Reddy: An Introduction to the Finite Element Method, McGraw Hill, NY, 2005.

5. I. J. Chung: Finite Element Analysis in Fluid Dynamics, McGraw Hill Inc., 1978

CO-PO & PSO Correlation

Course Name : Finite Element Method										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:		2					3			
CO2:	1			1				2		
CO3:			2				2			
CO4:		2			1					1
CO5:	1		3					1		
CO6:		2				1	1			

Note: 1: Low 2: Moderate 3: High

O P JINDAL UNIVERSITY

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School of Science, Department of Mathematics

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Geometric Function Theory**	**Course Code:**	**MMA 2209**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

Geometric function theory is a branch of complex analysis that seeks to relate analytic properties of conformal maps to geometric properties of their images. The subject has deep connections with other areas of mathematics such as potential theory, hyperbolic geometry, and dynamical systems. The course aims to introduce students to geometric function theory in a broad sense, and to define concepts and present techniques required in modern applications such as the theory of the Schramm-Loewner evolution.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	To learn basics of Geometric function Theory.
CO2	Study of Area theorem, growth, distortion theorems, coefficient estimates for univalent functions.
CO3	Study of special classes (Starlile, Convex, Close to Convex,…) of univalent functions. Lowner's theorem and its applications.
CO4	Study of de Banges proof of Bieberbach conjecture and generalization of the area theorem, Grunsky inequalities.
CO5	Study of exponentiation of the Grunsky inequalities, Logarithmic coefficients.
CO6	Study of Subordination and Sharpened form of Schwarz Lemma References.

Syllabus:

Unit I: Area theorem, growth, distortion theorems, coefficient estimates for univalent functions special classes of univalent functions. Lowner's theory and its applications; outline of de Banges proof of Bieberbach conjecture.

Unit II: Generalization of the area theorem, Grunsky inequalities, exponentiation of the Grunsky inequalities, Logarithmic coefficients.

Unit III: Subordination and Sharpened form of Schwarz Lemma References.

Reference Books:

1. P. Duren, Univalent Functions, Springer, New York, 1983
2. A. W. Goodman, Univalent Functions I & II, Mariner, Florida, 1983
3. Ch. Pommerenke, Univalent Functions, Van den Hoek and Ruprecht, Göttingen, 1975.
4. M. Rosenblum, J. Rovnyak, Topics in Hardy Classes and Univalent Functions, Birkhauser Verlag, 1994.
5. D. J. Hallenbeck, T. H. MacGregor, Linear Problems and Convexity Techniques in Geometric Function Theory, Pitman Adv. Publ. Program, Boston-London-Melbourne,1984.
6. I.Graham, G. Kohr, Geometric Function Theory in One and Higher Dimensions, Marcel Dekker, New York, 2003.

CO-PO & PSO Correlation

Course Name : Geometric Function theory										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:		**2**			**1**		**3**			
CO2:	**1**							**2**		
CO3:			**2**				**2**			
CO4:		**2**			**1**				**1**	**1**
CO5:	**1**		**3**					**1**		
CO6:		**2**				**2**	**1**			

Note: 1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Mechanics of Solids and Wave Propagation**	**Course Code:**	**MMA 2210**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will introduce to solve advanced solid mechanics problems using classical methods. To equip the students with the tools necessary to solve mechanics problems, which involves static analysis of a component to find the internal actions (forces and moments), and determine stresses, strains and deformation due to internal actions. Describe the wave propagation, reflection and transmission of waves in different medium.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the theory of elasticity including strain/displacement.
CO2	Understand the concept of Hooke's law and its relationships.
CO3	Analyze solid mechanics problems using classical methods and energy methods.
CO4	Solve stresses and deflections of beams under unsymmetrical loading.
CO5	Obtain stresses and deflections of beams on elastic foundations and solve torsion problems in bars and thin walled members.
CO6	Understand the propagation of waves in different medium and its properties.

Syllabus:

Unit I:

Introduction to Continuum Mechanics, Basic definitions of Solid Mechanics, Principles of Elasticity, Fundamentals of Tensor Calculus, Body and Surface forces, Effects of force: tension, Compression and shear, Computation of traction vector and Principal axes.

Unit II

Analysis of stress, principal stresses, principal planes, maximum shearing stresses, Mohr's circle diagram, equations of deformation and strain, strain in form of displacement, compatibility concept, need and physical significance, stress-strain relation, Generalized Hook's Law, different types of symmetry, density function, Airy's stress function, wave propagation in unbounded elastic medium.

Unit III

Study of propagation of waves in elastic, visco-elastic and poro-elastic medium, Waves in anisotropic medium, thermo elastic medium, study of surface waves (Raleigh & Love waves) in Elastic and visco-elastic medium including layered medium, reflection and transmission of waves in elastic medium.

Reference Books:

1. Kazimi, SMA., (2013) Solid Mechanics, McGraw Hill Education (India) Pvt Ltd.

2. Love, A.E.H. A Treatise on Mathematical Theory of Elasticity, Cambridge University Press, New York.

3. Sokolnikoff, I.S., (1956) Mathematical Theory of Elasticity, McGraw Hill Book Co., New York.

4. Biot, M.A. (1965) Mechanics of Incremental Deformations, John Wiley & Sons, New York.

5. Ewing, W.M., (2018) Elastic Waves in Layered Media, Creative Media Partners, LLC.

6. Achenbach, J.D., (2012) Wave Propagation in Elastic Solids, North Holland, Elsevier.

CO-PO & PSO Correlation

Course Name : Mechanics of Solids and Wave Propagation										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	2	1					2	1		1
CO2:	2	2	1	1			1	1		1
CO3:	2	1	1	1			1	1		2
CO4:	2	2	2	2	1		2	2		1
CO5:	2	1	1	1	1		2	1		2
CO6:	2	2	1	1			1	1		2

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Theory of Relativity and Cosmology**	**Course Code:**	**MMA 2211**
Credits :	**3**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:
This course will introduce the students to the field of general relativity. To provide conceptual skills and analytical tools necessary for astrophysical applications of the theory. This course intends to present the scope and aims of relativistic cosmology at present, and to show that there are still a series of significant and interesting problems that are presently unsolved, and in some cases have not even been seriously addressed.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Become familiar with the fundamental principles of the general theory of relativity.
CO2	Know the meaning of basic concepts like the equivalence principles, inertial frames and time dilation.
CO3	Understand the concept of constant relative motion of different bodies in different frames of reference.
CO4	Solve Einstein's field equations for static spherically symmetric problems and for isotropic and homogeneous cosmological models.
CO5	Explain the cosmological principle, Hubble's law, Weyls Postulate and Steady State Cosmological Models.
CO6	Understand and apply the knowledge of gravitational waves in curved space time. Show how the Friedman-Robertson-Walker metric is an exact solution to the Einstein.

Syllabus:

Theory of Relativity:
Unit I: Transformation of coordinates. Tensors. Algebra of Tensors. Symmetric and skew symmetric Tensors. Contraction of tensors and quotient law. Reimannian metric, Parallel transport, Christoffel Symbols. Covariant derivatives. Intrinsic derivatives and

geodesics, Reiemann Christoffel curvature tensor and its symmetry properties. Bianchi identities and Einstein tensor.

Unit II: Review of the special theory of relativity and the Newtonian Theory of gravitation. Principle of equivalence and general covariance, geodesic principle. Newotonian approximation. Schwarzchild external solution and its isotropic form. Planetary orbits and analogues of Kepler's laws in general relativity. Adavance or perihelion of a planet. Bending of light rays in gravitational field. Gravitational redshift of spectral lines. Radar echo delay.

Unit III: Energy- momentum tensor of a perfect fluid. Schwarzchild internal solution. Boundary conditions. Energy momentum tensor of an electromagnetic filed. Eistein-Maxwell equations. Reissner-Nordstrom solution.

Cosmology:

Unit IV: Mach's principal. Einstein modified field equations with cosmological term. Static Cosmological models of Einstein and De-Sitter, their derivation, properties and comparison with the actual universe.

Unit V: Hubble's law. Cosmological principle's Wey'Is postulate. Derivation of Robertson-Walker metric. Hubble and deceleration parameters. Redshift. Redsshift versus distance relation. Anuglar size versus redshift relation and source counts in Robertson- Walker space-time. Friedmann models. Fundamental equations of dynamical cosmology. Critical density. Closed and open Universes. Age of the universe. Matter dominated era of the universe. Einstein-deSitter model. Particle and even horizons. Eddington-Lamaitre models with I-trem. Perfect cosmological principle. Steady state cosmology.

Reference Books:

1. C.E. Weatherburn: An Introduction to Riemannian Geometry and the tensor Calculus, Cambridge University Press, 1950.
2. J. V. Narlikar : An Introduction to Relativity, Cambridge University Press (Indian edition by Macmillan company of India Ltd.) 2010
3. J.V. Narlikar: General Relativity and Cosmology, The Machmillann Company of India Ltd. 1978.
4. B.F. Shutz: A first course in general relativity, Cambridge University Press, 1990.
5. A.S. Eddington, The Mathematical Theory of Relativity, Cambridge University Press, 1965.

6. S. Weinberg Gravitation and Cosmology: Principle and applications of the general theory of relativity, John Wiley & Sons, Inc. 1972.
7. J.V. Narlikar: Introduction to Cosmology, Cambridge University Press, 1993.
8. Ray d'Inverno : Introducing Einstein's Relativity, Clarendon Press, 1996
9. James B. Hartle: Gravity: An Introduction to Einstein's General Relativity, Pearson Education, 2003

CO-PO & PSO Correlation

Course Name : Theory of Relativity and Cosmology										
	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**2**	**1**					**2**	**2**	**1**	**2**
CO2:	**3**	**2**	**1**	**1**			**2**	**1**		**2**
CO3:	**2**	**2**	**1**	**1**			**3**	**2**	**1**	**2**
CO4:	**3**	**1**	**1**	**1**			**2**	**2**	**2**	**2**
CO5:	**3**	**2**	**2**	**2**	**1**		**2**	**1**	**1**	**3**
CO6:	**2**	**2**	**1**	**1**	**1**		**2**	**1**	**1**	**3**

Note: 1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Operator Theory**	**Course Code:**	**MMA 2212**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course provides the fundamentals of classical set theory and fuzzy set theory. The decomposition theorems of fuzzy sets and the extension principle will be introduced, as well as the use of nonlinear integrals as aggregation tools to deal with fuzzy data. As an indispensable tool in fuzzy decision making, ranking and ordering fuzzy quantities will be discussed.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Introduced to some topics of operator theory and to the fundamentals of Banach algebra theory and prove the spectral theorem for normal operators.
CO2	Describe the Fredholm operators and its properties and define Hilbert Space Operators, Parts of Spectrum, Orthogonal Projections, Invariant Subspaces, Reducing Subspaces, Shifts, Decompositions of Operators.
CO3	Understand the Compact linear operators, Spectral properties of compact bounded linear operators & prove the spectral theorem and functional calculus for compact normal operators and define Spectral projections and prove the spectral decomposition theorem.
CO4	Prove the spectral theorem for a bounded normal operator and describe the Measures of operators. Perturbation classes, strictly singular operators, Spectral theory of integral operators.
CO5	Prove the Hilbert Schmidt theorem & Mercer's theorem and understand the , integral operators as inverse of differential operators. Sturm-Liouville systems and understand the Basic theory of unbounded self adjoint operators, unbounded Fredholm operators and its properties.
CO6	Prove the Spectral theorem for an unbounded self adjoint operators.

Syllabus:

Unit I

Banach algebras, Gelfand theory, C*- algebras the GNS construction, spectral theorem for normal operators, Fredholm operators and its properties, semi-Fredhlom operators, product of operators.

Unit II

Hilbert Space Operators, Parts of Spectrum, Orthogonal Projections, Invariant Subspaces, Reducing Subspaces, Shifts, Decompositions of Operators. Compact linear operators, Spectral properties of compact bounded linear operators, spectral theorem and functional calculus for compact normal operators.

Unit III

Spectral projections, spectral decomposition theorem, spectral theorem for a bounded normal operator, Measures of operators. Perturbation classes, strictly singular operators, Spectral theory of integral operators: Hilbert Schmidt theorem, Mercer's theorem, Trace formula for integral operators, integral operators as inverse of differential operators. Sturm- Liouville systems.

Unit IV

Unbounded operators: Basic theory of unbounded self adjoint operators, unbounded Fredholm operators and its properties, essential spectrum, unbounded semi-Fredholm operators, Spectral theorem for an unbounded self adjoint operators.

Reference Books

1. M. Schechter, Principles of Functional Analysis, AMS,2th Edn., 2002.
2. I. Gohberg& S. Goldberg, Basic operator Theory, Birkhauser,1981.
3. M. Ahues, A. Largillier B.V. Limaye, Spectral Computations for Bounded Operators, Chapman & Hall/CRC, 2001.
4. J. B. Conway, A course in Functional Analysis, Springer-Verlag, 2th Edn., 1990.
5. B.V. Limaye, Functional Analysis, New Age Publishers, 2th Edn., 2006.

6. F. Riesz& B. SzNagy, Functional Analysis, Dover Publications, 1990.

7. W. Rudin, Functional Analysis, McGraw Hill, 2th Edn., 2006.

8. V. S. Sunder, Functional analysis' spectral theory, Birkhauser,1998.

CO-PO & PSO Correlation

Course Name : Operator Theory										
	Program Outcomes						**PSOs**			
Cours	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**	**2**							**1**	**1**
CO2:		**1**				**2**		**1**		
CO3:	**1**		**1**	**2**					**1**	**1**
CO4:	**1**	**1**	**1**					**1**		
CO5:	**1**	**2**		**2**			**1**			**1**
CO6:										

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**An Introduction to Commutative Algebra**	**Course Code:**	**MMA 2213**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This is an introductory course in Commutative Algebra where most basic tools on commutative rings and modules over commutative rings are developed. This course is essential for anyone who wants to do research in areas such as commutative algebra, algebraic geometry, algebraic number theory etc.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the basic definition and properties of Commutative rings, ideals, operations on ideals.
CO2	Understand the prime and maximal ideals, nil radicals, Jacobson radicals, extension and contraction of ideals.
CO3	Describe the Modules, free modules, projective modules, exact sequences, tensor product of modules.
CO4	Understanding the restriction and extension of scalars, localization and local rings, extended and contracted ideals in rings of fractions.
CO5	Describe the Noetherian modules, Artinian modules, Primary decompositions and associate primes, Integral extensions.
CO6	Understand various theorems associated with the Noetherian modules, Artinian modules.

Syllabus:

Unit I: Commutative rings, ideals, operations on ideals, prime and maximal ideals, nil radicals, Jacobson radicals, extension and contraction of ideals

Unit II: Modules, free modules, projective modules, exact sequences, tensor product of modules.

Unit III: Restriction and extension of scalars, localization and local rings, extended and contracted ideals in rings of fractions.

Unit IV: Noetherian modules, Artinian modules, Primary decompositions and associate primes, Integral extensions.

Unit V: Valuation rings, Discrete valuation rings, Dedekind domains, Fractional ideals, Completion, Dimension theory.

Reference Books

1. M. F. Atiyah, I. G. Macdonald, "Introduction to Commutative Algebra", AddisonWesley Publishing Co., 1969.

2. R. Y. Sharp, "Steps in Commutative Algebra", London Mathematical Society Student Texts, 51. Cambridge University Press, 2000.

3. D. S. Dummit, R. M. Foote, "Abstract Algebra", Wiley-India edition, 2013.

CO-PO & PSO Correlation

Course Name : An Introduction to Commutative Algebra										
	Program Outcomes						PSOs			
Cours	1	2	3	4	5	6	1	2	3	4
CO1:	1		1			1	1		1	
CO2:							1			
CO3:			2	1	2		1	2	1	2
CO4:	1	1								
CO5:				1			1		1	
CO6:			1		1					

Note: 1: Low 2: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Bio Mathematics**	**Course Code:**	**MMA 2214**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will be an introduction to mathematical modelling and data analysis for biological and biomedical systems. Examples include: the formation of animal coat patterns, the spread of diseases through the community, the interaction between pathogens and the immune system of the body, the growth of tumours, nerve cell signalling, population dynamics, pharmacokinetics and bacterial growth. The emphasis in this course is on the development of the governing model equations and on computer simulations of the model equations rather than on mathematical methods for solving the model equations.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Formulate discrete and differential equation models that represent a range of biological problems, including identifying assumptions that are appropriate for the problem to be solved.
CO2	Choose and apply computational tools to perform parameter estimation and to solve discrete and differential equation models.
CO3	Interpret model and data output in terms of the original biological problem, and use results to direct a follow-up experiment.
CO4	Perform appropriate data manipulations, and graphically display model output and data clearly and accurately.
CO5	Gain an improved understanding of mathematical models as they are used in Biology.
CO6	Students will derive and interpret the results of models of population growth, species interactions, demography, natural selection, and disease dynamics.

Syllabus:

1. **Unit I:** Biofluid dynamics; Blood flow & arterial diseases
2. **Unit II:** Transport in intestines & lungs; Diffusion processes in human systems
3. **Unit III:** Mathematical study of nonlinear Volterra equations
4. **Unit IV:** Stochastic & deterministic models in population dynamics
5. **Unit V:** Epidemics.

Reference Books

1. James D. Murray, Mathematical Biology: 1. An Introduction Third Edition, Springer

2. J. C Mishra, Biomathematics Modelling and Simulation, World Scintific

CO-PO & PSO Correlation

Course Name : Bio Mathematics										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**	**1**					**1**	**2**	**1**	**1**
CO2:	**2**	**2**	**1**	**1**			**2**	**1**		**1**
CO3:	**2**	**1**	**1**	**1**			**1**	**2**	**1**	**1**
CO4:	**2**	**1**	**1**	**1**			**2**	**2**	**2**	**1**
CO5:	**2**	**2**	**2**	**2**	**1**		**1**	**1**	**1**	**2**
CO6:	**2**	**2**	**1**	**1**	**1**		**2**	**1**	**1**	**2**

Note: 1: Low 2.: Moderate 3: High

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Statistical Ecology**	**Course Code:**	**MMA 2215**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will introduce the ideas of Linear Growth dNt/dt = C, Interpretation and limitation. Students will learn the Exponential Model Properties, Interpretation, Scope and Limitation, logistic Growth Model and evaluate Geompertz Curve, Life tables and. Leslie matrix Models. Student will Know the Procedures and understand concept of Biodiversity. Students will able to Understand the Richness indices, Simpson's index, Shannon's index and also Know lognormal distribution in ecology.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the ideas of Linear Growth dNt/dt = C, Interpretation and limitation.
CO2	Understand the Exponential Model Properties, Interpretation, Scope and Limitation, logistic Growth Model and evaluate Geompertz Curve, Life tables and. Leslie matrix Models.
CO3	Know the Procedures and understand concept of Biodiversity, need to protect it.
CO4	Understand the Richness indices, Simpson's index, Shannon's index.
CO5	Evaluate Rare fraction Curves, Real life examples for computing these indices and use of geometric distribution.
CO6	Know lognormal distribution in ecology.

Syllabus:

Unit I: Population Dynamics

1.1. Introduction: Ecology, Statistical Ecology.

1.2. Linear Growth dNt/dt = C, Interpretation and limitation.

1.3. Exponential Model: Solving dNt/dt = KNt, K > 0, K < 0 cases. Properties, Interpretation, Scope and Limitation.

1.4. Logistic Growth Model: Density dependence, solving differential equation, Theta-Logistic Model

1.5. dNt/dt = a.Nt(K-Nt) Properties, Carrying Capacity, Interpretation, Scope and Limitation.

Unit II:

2.1. Geompertz Curve: Solving Differential equation dNt/dt = a. log (K/N t), Asymptotically stable Equilibrium, Properties, Interpretation, Scope and Limitation. Fitting the above growth models to data by linearization and regression. Harvesting model: different types of Harvesting

2.2. Life tables: Force of mortality stable population and stationary population. Cohort, columns of life table, interrelation between columns interpretation, construction of life table, uses and application.

2.3. Leslie matrix Models: fecundity and survival matrix, nt =Mt n0, future projections, stable age distribution, interpretation of largest sign value of M.

Unit III: Smoothing Procedures

3.1. Poisson forest, Aggregated, Regular spatial point pattern, estimation of population density by quadrate sampling, nearest neighbor distances (Point to individual, individual to individual), i-th order nearest neighbor distance. λ =n/Π Xi2, MLE for Poisson forest, Bias and S.E. of λ estimate.

3.2. Line Transect Method: Drawing random line transect, exponential detection function, Maximum likelihood estimator (MLE) of population density, other detection functions.

3.3. Capture – recapture models: Closed population, Open population, Peterson estimator for single recapture, multiple captures, iterative method to find MLE of N, Population size.

3.4. Removal Method: Zippin's estimator for closed population.

Unit IV: Diversity Indices

4.1. Concept of Biodiversity, need to protect it.

4.2. Richness indices, Simpson's index, Shannon's index.

4.3. Rare fraction Curves, Real life examples for computing these indices.

Unit V: Distribution Models

5.1. Use of geometric distribution, lognormal distribution in ecology.

REFERENCE BOOKS

1. Pielou, E. C. (1977): An Introduction to Mathematical Ecology, Wiley.
2. Seber, G.A.F. (1982): The estimation of animal abundance and related parameters, C. Griffin.
3. Ludwig, J.A. and Reynold J.F.: Statistical Ecology, A primer on methods and computing.
4. Gore, A. P. and Prajpe, S. A.: A First Course on mathematical and Statistical Ecology.

CO-PO&PSO Correlation

Course Name : Statistical Ecology										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	**1**	**1**	**2**			**1**	**1**		**1**	
CO2:	**1**		**3**		**1**		**1**	**1**		**1**
CO3:		**1**	**1**				**1**			
CO4:		**2**	**2**			**1**				
CO5:	**2**				**1**					**1**
CO6:	**2**		**1**		**1**	**1**	**1**	**1**		

1: Low 2: Moderate 3: High

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School of Science, Department of Mathematics

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Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Special Functions**	**Course Code:**	**MMA 2217**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course Complex Analysis and Special Functions provides an introduction to complex analysis which is theory of complex functions with complex variable. The course includes complex functions and differentiation, complex integration, power series expansion of complex function and special functions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	**Course Outcome**
CO1	To study a necessary condition for convergence, the associated series of logarithms, absolute convergence, uniform convergence.
CO2	To study Euler and Mascheroni constant, the Gamma function, a series for $\Gamma'(z)/\Gamma(z)$, evaluation of $\Gamma(1)$ and $\Gamma'(1)$, the Euler product for $\Gamma(z)$, the difference equation $\Gamma(z + 1) = z\Gamma(z)$, evaluation of certain infinite products.
CO3	To study Euler's integral for $\Gamma(z)$, the Beta function, the value of $\Gamma(z)\,\Gamma(1 - z)$, the factorial function, Legendre's duplication formulae, Gauss' multiplication theorem, a summation formula due to Euler.
CO4	To learn the hypergeometric function and its parameters, elementary series manipulations, simple transformations.
CO5	To study Bessel function, Bessel's equation and its solutions.
CO6	To study Hankel functions. Equations reducible to Bessel's equation. Modified Bessel's functions.

Syllabus:

Unit I

Infinite products: Introduction, definition of an infinite product, a necessary condition for convergence, the associated series of logarithms, absolute convergence, uniform convergence.

Unit II

The Gamma and Beta functions: The Euler and Mascheroni constant, the Gamma function, a series for $\Gamma'(z)/\Gamma(z)$, evaluation of $\Gamma(1)$ and $\Gamma'(1)$, the Euler product for $\Gamma(z)$, the difference equation $\Gamma(z + 1) = z\Gamma(z)$, evaluation of certain infinite products, Euler's integral for $\Gamma(z)$, the Beta function, the value of $\Gamma(z)\,\Gamma(1 - z)$, the factorial function, Legendre's duplication formulae, Gauss' multiplication theorem, a summation formula due to Euler.

Unit III

The hypergeometric function: The function $F(a,b; c; z)$, a simple integral form, $F(a,b,c,1)$ as a function of the parameters, evaluation of $F(a,b,c,1)$, the contiguous function relations, the hypergeometric differential equation, $F(a,b,c,z)$ as a function of its parameters, elementary series manipulations, simple transformations.

Unit IV

Series solution of differential equations. Method of Frobenius. Legendre Polynomials and Functions. Legendre equation and its solution. Generating function. Legendre series. Associated Legendre functions. Properties of associated Legendre functions.

Unit V

Bessel function, Bessel's equation and its solutions. Generating function. Integral representation. Recurrence relations. Hankel functions. Equations reducible to Bessel's equation. Modified Bessel's functions. Recurrence relations for modified Bessel's functions.

Reference Books

1. E.D. Rainville, Special functions, Chelsa Publishing Company, New York, 1960.

2. W.W. Bell, Special Functions for scientists and engineers, Dover Publications, New York, 2004.

3. G.E. Andrews, R. Askey, R. Roy, Special Functions, Encyclopedia of Mathematics and its Applications 71, Cambridge University Press, Cambridge.1999.

CO-PO&PSO Correlation

Course Name : Special Function										
	Program Outcomes						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:		2		1			3			
CO2:	1							2		
CO3:			2		1		2		2	
CO4:		2		1						1
CO5:	1		3					1		
CO6:		2				1	1			

1: Low 2: Moderate 3: High

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Name of the Course:	**Cryptography and Network Security**	**Course Code:**	**MMA 2218**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:
This Course focuses towards the introduction of network security using various cryptographic algorithms. Underlying network security applications. It also focuses on the practical applications that have been implemented and are in use to provide email and web security.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Describe basic definitions and the Concepts of Security: The need for security
CO2	Understand Cryptographic Techniques..
CO3	Understand Computer-based Symmetric Key Cryptographic Algorithms.
CO4	Understand Asymmetric Key Cryptography, An overview of Asymmetric Key Cryptography.
CO5	Understand Digital Signatures, Knapsack Algorithm, Some other algorithms.
CO6	Understand Internet Security Protocols
CO7	UnderstandE-mail Security, Wireless Application Protocol (WAP) Security, Security in GSM
CO8	Understand Digital Certificates, Private Key Management.

Syllabus

Unit I

Introduction to the Concepts of Security: The need for security, Security Approaches, Principles of Security, Types of Attacks. Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques, Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Key Range and Key Size, Possible Types of Attacks.

Unit II

Computer-based Symmetric Key Cryptographic Algorithms: Algorithm Types and Modes, An overview of Symmetric Key Cryptography, DES, International Data Encryption Algorithm (IDEA), RC5, Blowfish, AES, Differential and Linear Cryptanalysis.

Unit III

Computer-based Asymmetric Key Cryptography: Brief History of Asymmetric Key Cryptography, An overview of Asymmetric Key Cryptography, The RSA Algorithm, Symmetric and Asymmetric Key Cryptography Together, Digital Signatures, Knapsack Algorithm, Some other Algorithms.

Unit IV

Public Key Infrastructure: Digital Certificates, Private Key Management, The PKIX Model, Public Key Cryptography Standards, XML, PKI and Security. Internet Security Protocols: Basic Concepts, Secure Socket Layer, SHTTP, Time Stamping Protocol, Secure Electronic Transaction, SSL versus SET, 3-D Secure Protocol, Electronic Money, E-mail Security, Wireless Application Protocol (WAP) Security, Security in GSM.

Reference Books

1. Cryptography and Network Security Principles And Practice Fourth Edition, William Stallings, Pearson Education.
2. Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall PTR.

3. Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall.
4. Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

CO-PO & PSO Correlation

	Course Name: **Cryptography and Network Security**									
	Program Outcomes (POs)						**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:			**1**		**1**				**1**	
CO2:	**1**	**1**	**2**	**1**			**2**	**1**		
CO3:				**1**				**2**		**1**
CO4:	**1**	**1**	**2**		**1**		**1**		**1**	
CO5:				**2**	**1**			**1**		**2**
CO6:	**1**	**1**	**2**				**1**			
CO7:				**2**	**1**				**1**	
CO8:		**1**	**1**		**2**		**2**			**1**

Note: **1: Low 2: Moderate 3: High.**

Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Theory of Computation**	**Course Code:**	**MMA 2219**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will introduce the Regular languages models, closure, decidability, minimality of automata, iteration theorems. Students will understand the Recursive and recursively enumerable sets models and the Properties. Students will learn the pushdown automata, and their equivalence also understand Richness indices, Simpson's index, Shannon's index.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the Regular languages models, closure, decidability, minimality of automata, iteration theorems.
CO2	Understand the Recursive and recursively enumerable sets models.
CO3	Understand the Properties: closure, decidability, undecidability/ noncomputability, notion of reductions.
CO4	Know the Context-free languages models.
CO5	Understand the pushdown automata, and their equivalence.
CO6	Understand the Richness indices, Simpson's index, Shannon's index.

Syllabus:

Unit I:

Regular languages models: finite state machines (deterministic and non-deterministic), regular grammars, regular expressions, equivalence of deterministic and non-deterministic machines and of the three models.

Properties: closure, decidability, minimality of automata, iteration theorems.

Unit II:

Recursive and recursively enumerable sets models: turing machines, grammars, recursive functions, their equivalence. Church's thesis.

Properties: closure, decidability, undecidablity/ noncomputability, notion of reductions.

Unit III:

Context-free languages models: grammars (including different normal forms), pushdown automata, and their equivalence.

Properties: closure, iteration theorems, parsing.

Reference Books

1. Moret: The Theory of Computation, Pearson Education India
2. Dexter Kozen,:Theory of computation, Birkhäuser, 2006
3. Zohar Manna,: Mathematical Theory of Computation, Courier Dover Publications, 2003
4. A.M. Natarajan, P. Balasubramani : Theory of computation, New Age International, 2007
5. Dr. O. G. Kakde : Theory of Computation, Firewall Media, 2007

CO-PO&PSO Correlation

Course Name: Theory of computation										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	1	1	2			1	1		1	
CO2:			2		1			1		
CO3:	1	1	1				1			
CO4:		2	1			1		1		
CO5:										
CO6:	2		1			1	1	1		

Note: 1: Low 2: Moderate 3: High

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Programme:	**M. Sc.**	**Semester :**	**IV Sem**
Name of the Course:	**Financial Mathematics**	**Course Code:**	**MMA 2220**
Credits :	**3**	**No of Hours :**	**30**
Max Marks:	**100**		

Course Description:

This course will introduce the value of money; basic investment strategies and fundamental concepts of no-arbitrage and basic revision of probability theory (random variables, expectation, variance, covariance. Students will Evaluate correlation; Binomial distribution, normal distribution. Students will understand the Central limit theorem and transformation of distributions and the binomial tree market model. Students will learn stochastic analysis and how to evaluate time value of money, compound interest rates and present value of future payments.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand the value of money; basic investment strategies and fundamental concepts of no-arbitrage and basic revision of probability theory (random variables, expectation, variance, covariance.
CO2	Evaluate correlation; Binomial distribution, normal distribution
CO3	Understand the Central limit theorem and transformation of distributions.
CO4	Understand the binomial tree market model; valuation of contracts; No-arbitrage pricing theory via risk neutral probabilities and via portfolio strategies.
CO5	Learn stochastic analysis: Brownian motion, Ito integral, It's Formula.
CO6	Evaluate time value of money, compound interest rates and present value of future payments.

Syllabus:

Unit I:

Introduction to financial markets and financial contracts; value of money; basic investment strategies and fundamental concepts of no-arbitrage.

Unit II:

Basic revision of probability theory (random variables, expectation, variance, covariance, correlation; Binomial distribution, normal distribution; Central limit theorem and transformation of distributions).

Unit III:

The binomial tree market model; valuation of contracts; No-arbitrage pricing theory via risk neutral probabilities and via portfolio strategies.

Unit IV:

Introduction to stochastic analysis: Brownian motion, Ito integral, Ito Formula, stochastic differential equations; Black-Scholes model and Option pricing within Black-Scholes model. Black-Scholes PDE

Unit V:

ime value of money, compound interest rates and present value of future payments. Interest income. The equation of value. Annuities. The general loan schedule. Net present values. Comparison of investment projects.

Reference Books

1. S.M. Ross, An introduction to Mathematical Finance, Cambridge University Press.

2. A. J. Prakash, R. M. Bear, K. Dandapani, G.L. Gahi, T.E. Pactwa and A.M. Parchigari, The return Generating Models in Global Finance, Pergamon Press.

3. J. Hull, Options, Futures, and Other Derivatives (Pearson Prentice Hall, Upper Saddle River, 2015.

4. S. M. Ross, Applied Probability: Models with Optimization Applications, Holdenday.

5. S. Roman, Introduction to the Mathematics of Finance Springer, New York, 2004.

CO-PO & PSO Correlation

Course Name: Financial Mathematics

	Program Outcomes						PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1:	2	1	2			1	1		1	
CO2:	1		3		1	3	2	1		
CO3:		1	1				1			1
CO4:		2	1			1				
CO5:	2	1			1	1				
CO6:	2					1	1	1		1

Note: 1: Low 2: Moderate 3: High