Semester II			
Core IX – Calculus of Variations and Integral Equations			
Code: 19PMAC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision:

To impart analytical ability in solving variational problems and integral equations also to formulate the laws of mechanics and basic physics.

Mission:

To formulate variational problems and analyze them to deduce key properties of system behavior.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the properties of geometrical problems	2	Un
CO-2	apply variational problems and isoperimetric problems.	2	Ap
CO-3	expose to the decomposition method.	2	E
CO-4	apply different types of integral equations.	2	Ap
CO-5	solve variational problems with constraints both algebraic and isoperimetric.	2,6	Ap
CO-6	derive the Euler - Lagrange equation for variational problems including the case of general variations.	2,5	Re, Ap
CO-7	derive conserved quantities from symmetries and use them to solve the Euler- Lagrange equations.	2,6	Re,Ap
CO-8	solve integral equations and analyze the relation between differential equations and Volterra integral equations	2	Ap

Semester II			
Core IX - Calculus of Variations and Integral Equations			
Code: 19PMAC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Calculus of Variations and Applications: Maxima and Minima - The Simplest case - Illustrative examples - Natural boundary conditions and transition conditions - The variational Notation - The more general case. **(Chapter 2: Sec: 2.1 - 2.6)**

Unit II

Constraints and Lagrange multipliers - Variable end points - Sturm-Liouville problems - Hamilton's principle - Lagrange's equations. **(Chapter 2: Sec: 2.7 - 2.11)**

Unit III

Integral Equations: Introduction - Relations between differential and integral equations -The Green's function - Alternative definition of the Green's function.

(Chapter 3: Sec: 3.1 - 3.4)

Unit IV

Linear equations in cause and effect - The influence function - Fredholm equations with separable kernels - Illustrative example.

(Chapter 3: Sec: 3.5 - 3.7)

Unit V

Hilbert-Schmidt theory- Iterative methods for solving equations of the second kind - Fredholm theory. **(Chapter 3: Sec: 3.8, 3.9, 3.11)**

Text Book

1. Francis B. Hildebrand, Methods of Applied Mathematics, second edition, Prentice-Hall of India private limited, 1968.

Books for Reference

1. L. Elsgolts; Differential Equations and the Calculus of Variations, University Press of the Pacific, 2003.
2. Mark Kot; A First Course in the Calculus of Variations, American Mathematical Society Providence Rhode Island, 2014.

Semester II			
Core X - Fuzzy Algebra			
Code :19PMAC25	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To establish thorough knowledge on the basic mathematical elements of the theory of fuzzy sets.

Mission

To provide an emphasis on differences and similarities between fuzzy sets and classical set theories.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	decide the difference between crisp sets and fuzzy sets.	6	Ev
CO-2	use the fuzzy set theory on statistical methods.	7	Ap
CO-3	compare statistical methods against fuzzy logic methods.	1,7	Ev
CO-4	apply fuzzy logic membership function.	2,6	Ap
CO-5	solve problems on fuzzy set theory.	2	Ap
CO-6	evaluate fuzzy statistics applications	2,7	Ap
CO-7	apply the methods of fuzzy sets and fuzzy logic in solving problems in the theory of fuzzy control.	1,7	Ap
CO-8	explain the theory of statistics fuzzy logic	5	Re, Un

Semester II			
Core X -Fuzzy Algebra			
Code:19PMAC25	Hrs/week:4	Hrs/Sem:60	Credits:4

Unit I

From Classical sets to Fuzzy sets- Fuzzy Sets – Basic concepts – Fuzzy sets versus Crisp sets - Additional Properties of Alpha cuts - Representation of fuzzy sets- Extension Principle for Fuzzy sets.

(Text book 1 - Chapter 1: Section 1.4, Chapter 2: Sections 2.1,2.2,2.3)

Unit II

Operations on Fuzzy sets - Types of operations - Fuzzy complements - Fuzzy intersections: t-Norms - Fuzzy Union: t-conorms- Combination of operations – Aggregation Operations**.**

(Text book 1 –Chapter 3: Sections 3.1,3.2,3.3,3.4,3.5,3.6)

Unit III

Fuzzy Subgroups – Union of two Fuzzy Subgroups- Fuzzy Subgroup Generated by a Fuzzy Subsets – Fuzzy Normal Subgroups,Fuzzy Conjugate Subgroups and Fuzzy Characteristic Subgroups – Fuzzy Sylow Subgroups.

(Text book 2 –Chapter 2: Sections 2.1,2.2,2.3,2.4)

Unit IV

Fuzzy Ideals and their operations –Some Elementary Properties- Union of Fuzzy Subrings-Fuzzy Subring Generated by a Fuzzy Subsets – Fuzzy Ideals and Homomorphisms.

(Text book 2 – Chapter 3: Sections 3.1, 3.2, 3.3,3.4)

Unit V

Fuzzy Prime Ideals, Fuzzy Maximal Ideals and Fuzzy Semi prime Ideals of Rings – Fuzzy Prime Ideals – Fuzzy Maximal Ideals – Fuzzy Semi prime Ideals

(Text book 2 – Chapter 4: Sections 4.1,4.2,4.3)

Text Books

1. Fuzzy Sets and Fuzzy Logic Theory and Applications, George J.Klir & Bo Yuan.
2. Fuzzy Algebra - volume 1 (Fuzzy Subgroups, Fuzzy Subrings and Fuzzy Ideals), By Rajesh Kumar.

Books for Reference

1. Paul P. Wang, Da Ruan and Etienne E. Kerre: Fuzzy Logic, Springer International Edition, 2009.
2. S. Nanda and N.R. Das: Fuzzy Mathematical Concepts, Narosa Publishing House, 2012.

Semester II			
Elective I A – Combinatorics			
Code:19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Vision

To introduce combinatorial techniques for solving enumeration problems.

Mission

To understand and demonstrate the basic concept of an algorithm and its applications in combinatorial mathematics.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recognize the properties and behavior of permutations and combinations.	1, 6	Un
CO-2	solve problems involving strings, combinations, distributions and partitions.	2	Cr
CO-3	understand the ideas of permutations and combinations.	1,6	Un
CO-4	apply, implement and interpret the theory of combinatorics to relevant probability and statistics problems.	2	Ap
CO-5	understand the addition and multiplication principles of counting.	3	Un
CO-6	apply diverse counting strategies to solve varied problems involving combinations and distributions	2,3	Ap
CO-7	identify, formulate and solve combinatorial problems.	2	Ap
CO-8	apply combinatorial ideas to practical problems	1,6	Ap

Semester II			
Elective I A – Combinatorics			
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Unit I

Permutations and Combinations:

Introduction, rules of sum and product, Permutations and Combinations, Distributions of distinct objects, distributions of non - distinct objects.

(Chapter 1: Sections: 1.1 -1.6)

Unit II

Generating Functions:

Generating functions for combinations, enumerators for permutations, Distributions of distinct objects into non- distinct cells, partitions of integers.

(Chapter 2: Sections: 2.1 -2.5)

Unit III

Recurrence Relations:

Linear Recurrence relations with constant coefficients, Solution by the technique of generating functions, Recurrence relation with two indices.

(Chapter 3: Sections: 3.1 -3.3, 3.5)

Unit IV

The Principle of Inclusion and exclusion:

The principle of Inclusion and Exclusion, the general formula, Derangements, Permutations with restrictions on relative positions.

(Chapter 4: Sections: 4.1 -4.5)

Unit V

Polya's Theory of Counting:

Equivalence classes under a permutation group, Equivalence classes of functions, Weights and inventories of functions, Polya's fundamental theorem.

(Chapter 5: Sections: 5.3 -5.6)

Text Book

1. C. L. Liu: Introduction to Combinatorial Mathematics, McGraw Hill publications, 1968.

Books for Reference

1. Normal L. Biggs, Discrete Mathematics, Oxford University Press, Oxford, 2002.
2. J.Hein, Discrete Structures, Logic and Computability, Jones and Barlett, 2002.