Syllabus template

Semester: IV	
Programme: Mathematics	
Course: Vector Integration & Probability Theory [Chem+ Microbio+Biotech]	
Paper code: B2MT230411T	**Credits: 4**
Hours/week: 4	
Category: Core/MDC/SEC/VAC: Minor	
Theory / Practical / Composite: Theory	
No of Modules: NA	
Course Overview: This course provides a comprehensive foundation in multivariable calculus through vector integration techniques and an introduction to probability theory, emphasizing both theoretical concepts and practical applications. It equips students with tools for analysing vector fields in physics and engineering, as well as probabilistic modelling for uncertainty in real-world scenarios. The curriculum balances rigorous proofs, computational problems, and interpretive discussions, with a focus on problem-solving. Prerequisites typically include single-variable calculus and basic linear algebra**.**	
Course Outcome: On successful completion of this course, the student will be able to:	
1. Recall definitions and key properties of line, surface, volume integrals, Green's, Stokes', and Gauss Divergence theorems.	
2. Explain geometric/physical meaning of vector line, surface & volume integrals and the three major theorems.	
3. Evaluate line, surface, and volume integrals directly and by applying Green's, Stokes', and Gauss theorems.	
4. Select and justify the most appropriate theorem for simplifying a given vector integral problem.	
5. Compare efficiency of theorem-based vs. direct computation methods in physical contexts (flux, circulation).	
6. Construct original vector field problems that require combined use of the theorems to model physical situations.	
7. State definitions of sample space, events, Kolmogorov axioms, independence, random variables, pmf/pdf/cdf, and standard distributions (Binomial, Poisson, Uniform, Normal).	
8. Distinguish frequency, classical, and axiomatic interpretations of probability; explain conditional probability, Bayes' rule, and independence concepts.	
9. Compute probabilities using event operations, conditional probability, Bayes' theorem, and independence; find expectations, variances, and moments of standard distributions.	
10. Differentiate pairwise vs. mutual independence; compare properties of discrete and continuous random variables and their transformations. Assess limitations of classical probability and suitability of axiomatic approach for realistic experiments.	
11. Build probabilistic models for multi-stage or dependent experiments and derive their distributions or moments.	
Prerequisites:	
SYLLABUS	

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I. Vector Integration	Line, Surface and Volume integrals, Green's theorem in a plane, Stokes theorem and related problems, Gauss Divergence Theorem [no proof] and its physical applications.	**20 classes**	**CO1, CO2, CO3, CO4 CO5, CO6.**	**K1, K2, K3, K4, K5, K6.**
II. ProbabilityTheory	Experiments: Deterministic and Non-deterministic; Sample space connected to different random experiments, examples [finite, countably infinite and uncountable]. Events: Elementary and compound events, examples. Formation of new events through different algebraic operations on them[union, intersection, complement]. Definitions of sure event ; impossible event, mutually exclusive events along with examples. Idea of pair-wise disjoint /mutually exclusive, mutually exhaustive events for a class of events, examples. Introduction to the idea of probability: different interpretations: Frequency interpretation; Classical interpretation [criticism or shortcomings of this approach, problems] Kolmogorov's Axiomatic approach[Kolmogorov's	**32 classes**	**CO7, CO8, CO9, CO10 CO11, CO12.**	**K1, K2, K3, K4, K5, K6.**

	probability axioms]. Properties of probability function. Boole’s and Bonferroni’s inequality Conditional Probability. definition, examples, multiplication rule of probability, Bayes’ theorem, related problems. Independence of two events. extension to a finite/ countably infinite collection of events, pairwise and mutual independence, problems. Trials. Independent trials [Bernoulli] Introduction to random variables: Distribution function. Properties. Classification of random variables: discrete and absolutely continuous random variables. Probability mass function and probability density function and properties. Transformation of one dimensional random variable (discrete and absolutely continuous) and related problems. Examples of Discrete and Absolutely Continuous random variables: Binomial, Poission , Uniform, Normal. Moments for univariate distributions. Raw and central. Properties , Expectation and variance and related problems .			

Text Books
1. Vector Analysis: Chakraborty & Ghosh.
2. A Textbook of Vector Analysis: Shanti Narayan & P.K.Mittal.
3. Mathematical Probability: Banerjee, De, Sen.
4. Introduction to Probability Theory: Sheldon Ross.
Suggested readings
1. Calculus: T.M.Apostol, Vol-II.
2. Basic Probability Theory: Robert B Ash.
Web Resources
1.
2.
3.
4.
Evaluation: Theory CIA: 20+5+5=30; Semester Exam: 70.
Paper Structure for Theory Semester Exam Module: 7 questions each carrying 10 marks need to be answered out of 12/13 questions.

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Recall definitions and key properties of line, surface, volume integrals, Green's, Stokes', and Gauss Divergence theorems.	**K1**
CO2	Explain geometric/physical meaning of vector line, surface & volume integrals and the three major theorems.	**K2**
CO3	Evaluate line, surface, and volume integrals directly and by applying Green's, Stokes', and Gauss theorems.	**K3**
CO4	Select and justify the most appropriate theorem for simplifying a given vector integral problem.	**K4**
CO5	Compare efficiency of theorem-based vs. direct computation methods in physical contexts (flux, circulation).	**K5**
CO6	Construct original vector field problems that require combined use of the theorems to model physical situations.	**K6**
CO7	State definitions of sample space, events, Kolmogorov axioms, independence, random variables, pmf/pdf/cdf, and standard distributions (Binomial, Poisson, Uniform, Normal).	**K1**
CO8	Distinguish frequency, classical, and axiomatic interpretations of probability; explain conditional probability, Bayes' rule, and independence concepts.	**K2**
CO10	Compute probabilities using event operations, conditional probability, Bayes' theorem, and independence; find expectations, variances, and moments of standard distributions.	**K3**

CO11	Differentiate pairwise vs. mutual independence; compare properties of discrete and continuous random variables and their transformations. Assess limitations of classical probability and suitability of axiomatic approach for realistic experiments.	**K4, K5**
CO12	Build probabilistic models for multi-stage or dependent experiments and derive their distributions or moments.	**K6**