ST. XAVIER'S COLLEGE (AUTONOMOUS), AHMEDABAD-9 FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS & ELECTRONICS

SEMESTER – V

SYLLABUS

OF

BSc PHYSICS (HONOURS)

BASED ON UNDERGRADUATE CURRICULUM FRAMEWORK (NEP – 2020)

(Effective from Academic Year 2023)

Curriculum Framework for Semester – V

Course	Title	Content		Credit
DSC-8 (Theory)	PHMC–551C Mathematical Methods and Quantum Mechanics	U1	Partial Differential Equations	4
		U2	2nd Order Ordinary Differential Equations	
		U3	Foundation of Quantum Mechanics	
		U4	3D problem in QM	
DSC-9 (Theory)	PHMC–552C Electrodynamics and Nuclear Physics	U1	Specia Techniques in Electrodynamics	4
		U2	Electromagnetic waves	
		U3	Nuclear Emissions	
		U4	Nuclear Structure	
DSC-10 (Laboratory)	PHMC–553CL Physics and Experiential Lab-V	14 Physics Experiments		4
		Experiential Lab: Hands on experiment.		
Minor-1 (Sub. Specific)	PHMN–551C Digital Circuit (Hybrid Mode SWAYAM)	U1	Combinational Circuit	4
		U2	Sequential Circuit	
		U3	Microprocessor 8085	
		U4	Laboratory	
Minor-2 (Theory + Lab)	ELMN551C Basic Electronics-IV	U1	Network Analysis by Laplace Transformation	2
		U2	Multivibrators, Clock and Timer	
		U3 U4	9 experiments and 3 Projects	2
SEC	PHSE551C Statistical Methods in Physics	U1	Basics of Statistical Methods in Physics	2
		U2	Lab: Statistical Data Analysis and Simulation	
Total Credits				**22**

* DSC: Discipline Specific Core

St. Xavier's College (Autonomous), Ahmedabad

Syllabus of Semester–V to be implemented from the Academic Year **2025-26.**

DEPARTMENT OF PHYSICS & ELECTRONICS

Skill Enhancement Course: Statistical Methods in

Course Code & Title	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Cr	Lecture hrs	Practical hrs		
PHSE551C Statistical Methods in Physics	1+1	15x1	30x1	10 + 2 from a recognized board	Science Stream Math-Group

Learning Objectives:

LO1	Understand fundamental statistical methods used in physics.
LO2	Apply Python for statistical analysis and data visualization.
LO3	Perform error analysis, curve fitting, and Monte Carlo simulations.
LO4	**Analyze real-world physics datasets using statistical techniques.**

Course Outcomes:

CO1	**Apply statistical tools** such as mean, variance, and probability distributions to analyze and interpret physics data.
CO2	**Implement Python-based solutions** for error analysis, data fitting, and statistical modeling using libraries like NumPy, SciPy, and Matplotlib.
CO3	**Conduct hypothesis testing** using methods like chi-square and t-tests to evaluate experimental results and assess their significance.
CO4	**Design and simulate simple physical systems** using random number generation and Monte Carlo techniques to explore statistical behavior in physical processes.

Unit – 1

Introduction to Statistics in Physics: Importance of statistics in physical sciences; Descriptive statistics: Mean, median, mode, variance, standard deviation

Probability Distributions: Binomial distribution; Poisson distribution; Gaussian (Normal) distribution

Error Analysis and Data Fitting: Types of errors: Systematic vs Random; Error propagation formulas; Least squares fitting and simple linear regression

Hypothesis Testing: Confidence intervals; Significance testing: p-values; Chi-square test for goodness-of-fit; t-tests for comparing means

Randomness and Monte Carlo Simulations: Random number generation in physics; Simulations of simple systems (e.g., radioactive decay, coin toss); Basic introduction to Monte Carlo techniques

Text Book:

1. R.J. Barlow – *Statistics* (Chapters 1, 2, 3, 6)
2. Bevington & Robinson – *Data Reduction and Error Analysis* (Chapters 1, 2, 6, 11)
3. Allen B. Downey – *Think Stats* (Chapters 1, 2, 4, 5, 7–10)

Reference Books:

1. Glen Cowan – *Statistical Data Analysis*
2. Sivia & Skilling – *Data Analysis: A Bayesian Tutorial*

Unit – 2: Laboratory Exercises:

Descriptive statistics and visualization of datasets

Generating and analyzing probability distributions. Python implementation: numpy, scipy.stats, visualization using matplotlib and seaborn

Simulating measurement errors and performing uncertainty propagation

Least squares fitting and regression on experimental data. Python-based curve fitting using scipy.optimize.curve_fit

Hypothesis testing using real-world physics datasets (Chi-square test, t-test). Python tools for hypothesis testing: scipy.stats

Monte Carlo simulation: Estimation of π using random numbers. Python implementation: numpy.random

Simulation of simple physical processes (e.g., radioactive decay, random walks)

Python Tools Used: NumPy; SciPy; Matplotlib; Seaborn