Centre for High Energy Physics
Faculty of Science
University of the Punjab, Lahore
Course Outline

Program	BSCP	**Course Code**	CPHY 371	**Credit Hours**	3
Course Title	**Mathematical Method for Physics I**				

Course Introduction

The Mathematical Methods course offers a thorough investigation of the mathematical methods necessary for resolving challenging issues in several disciplines, including physics. The course covers complex variables, analyticity, Cauchy's integral theorems, Taylor and Laurent series, residues, algebraic operations, coordinate transformations, covariant and contravariant tensors, metric tensors, Christoffel symbols, geodesics, Riemann tensor, infinite dimensional vector spaces, Fourier series and transforms, and Riemann tensor. The course seeks to increase students' awareness of the mathematical underpinnings of the physical world and provide them with a varied arsenal of mathematics to solve complicated issues.

Learning Outcomes

The course introduces the subject of Mathematical Methods at graduate level. Its objectives are as following.

1. Learning vector analysis in curvilinear coordinate systems and tensor analysis.
2. Studying finite and infinite dimensional vector spaces.
3. Studying Fourier series and transforms.
4. Studying the theory of complex variable and analysis.

Course Content

Week 1	Tensor Analysis, Tensor
	Coordinate transformation, Cartesian tensors
Week 2	Tensor algebra
	Covariant and Contravariant tensors
Week 3	Metric tensor, Christoffel symbols
	Equation of geodesic
Week 4	Riemann tensor
	Infinite Dimensional Vector Spaces, Convergence issue
Week 5	Hilbert space, space of square-integrable functions
	Generalized functions, Dirac delta function (1D and 3D)
Week 6	Dirac delta function (1D and 3D) and its properties
	Fourier Series and Transforms
Week 7	Fourier series and its complex form
	Applications of Fourier series
Week 8	Fourier transforms, Fourier integral theorem

	Applications of Fourier transforms
Week 9	Laplace transforms
	Applications of Laplace transforms
Week 10	Complex Variables, Complex functions
	Analytic functions; Properties of analytic functions; Derivative of analytic functions
Week 11	Cauchy-Riemann equations
	Applications of Cauchy-Riemann equations
Week 12	Laplace equation
	Line integral in the complex plane
Week 13	Surface Integral
	Volume Integral
Week 14	Cauchy's integral theorem, Cauchy's integral formula
	Taylor and Laurent series
Week 15	Residues, The residues theorem
	The residues theorem and its applications
Week 16	Poles on the real axis
	Branch points and integrals of multivalued functions

Textbooks and Reading Material

1. Foundations of Mathematical Physics, S. Hassani, *Allyn and Bacon* (1999).
2. Mathematical Methods for Physics (4^{th}edition), G. Arfken, *Academic Press, NY* (1995).
3. Vector Analysis (3^{rd}edition), K. L. Mir, *IlmiKitabKhana, Lahore* (2001).
4. Advanced Engineering Mathematics (8^{th}Edition), E. Keyszig, *J. Wiley* (2001).
5. Mathematical Physics, E. Butkov, *Addison-Wesley* (1973).

Teaching Learning Strategies

The instructor is required to make use of Mathematica /Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.