Master of Science in Physics
M. Sc. (Physics) Semester I

Course Code	**PS01CPHY51**	Title of the Course	**Mathematical Physics**
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. This course on mathematical physics is one of the core courses of physics taught at the MSc level. Its basic objective is to provide training on the basic mathematical skills for quantitative analysis of physical problems and to find solutions to the problems in almost all branches of physics. 2. The course will also help the students to acquire the required mathematical skills and its applications to understand other courses of the MSc programme as well as post MSc programmes.

Course Content

Unit	Description	Weightage (%)
1.	*Linear Vector Space:* Definition and examples, scalar product, dual vectors and Cauchy-Schwartz inequality, real and complex vector spaces, metric spaces. *Quantum States:* State vectors and wave-functions, The Hilbert space of state vectors, Dynamical variables and linear operators and their algebra. Projection operators. The quantum condition, self-adjointness. Special operators such as Hermitian, unitary etc. and their properties, Eigenvalues and eigenvectors, Expansion of identity, Linear independence of vectors, generalized Eigen vectors, Orthogonalization.	25%
2.	*Complex Analysis:* Introduction, Analytic functions, Contour integrals, Laurent series, The Residue theorem, Methods of finding residues, Evaluation of definite integrals by use of the residue theorem, The point at infinity; residues at infinity, Mapping. *Green's Functions:* Green's function- definition. Three methods of constructing Green's function, Few examples.	25%
3.	*Integral transforms:* Fourier transform and its properties as well as applications such as Gaussian function, finite wave train, etc., Convolution theorem, momentum representation, Laplace transform and its properties, Laplace transforms of some elementary functions and derivatives including some applications in the problems of physics e. g.	25%

	step function, simple harmonic oscillator, earth's nutation, impulsive force, damped oscillator RLC analogy etc.	
4.	*Tensors:* Types of tensors and their algebra, Contraction and inner product, Metric tensors, Quotient rule, Dual and irreducible tensors, Christoffel symbols, covariant derivative, Geodesic equation. *Group Theory:* Definition and examples, group multiplication table, homomorphism and isomorphism, matrix representations – reducible and irreducible, classes and character, subgroups and cosets, Dihedral group, orthogonal groups and special unitary group.	25%

Teaching-Learning Methodology	Lectures using traditional blackboard teaching, Tutorials, class assignments as well as the ICT tools for effective delivery of the content.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to acquire	
1.	The knowledge of advanced mathematical methods to solve various physical problems. Students will have a better understanding of the abstract mathematical methods such as vector space and Hilbert space etc. which will help them to understand grasp abstract concepts of quantum mechanics.
2.	Skills to apply advanced topics in complex analysis to solve contour integrals which are very common in problems of physics. The methods of integral transforms to solve differential and integral equations through algebraic methods related to problems spread through various branches in physics will be mastered.
3.	Training to deal with tensor quantities that appear while dealing with anisotropic properties of matter and to understand the mathematical details of the general theory of relativity. Applications of group theory and its relationship with the discrete symmetries associated with molecules, crystals etc and continuous symmetries associated with matter, their interactions etc.

Suggested References:

Sr. No.	References
1.	Mathematical Methods for Physicist G. Arfken and Weber, Academic Press, 7th ed.2013
2.	Mathematical Physics P. K. Chattopadhyay, Wiley Eastern Limited, 1990).
3.	Vector Analysis Murray Spiegel (Schaum series) 2nd ed. 2017.
4.	Mathematical Methods in Physical Sciences M. L. Boas (Second edition, John Wiley & Sons, 1996).
5.	A text book of Quantum Mechanics P.M. Mathews and Venkatesan, TMH Publication (2010).
6.	Elements of Group Theory for Physicists A. W. Joshi, New Age Intl. Pub. (1997).
7.	Matrices and Tensors in Physics (3rd Ed) A. W. Joshi, New Age Intl. Pub. 2005
8	Mathematics for Physicists Philippe Dennery and Andre Kryswicki, Dover Publications, 1967,1995

On-line resources to be used if available as reference material

https://webhome.phy.duke.edu/

www.nrce.niepa.ac.in (mathematical Physics)

www.maths.ox.ac.uk

www.maths.lu.se

www.freebookcentre.net

*****