Semester	II
Course	Major
Paper Title / Code	Math Methods 2 (C1PH230212T) & Clab 2 (C1PH230212P)
No. of Credits	4 (Theory-3, Lab-1)
Theory / Practical / Composite	Composite
Minimum No. of preparatory hours per week a student has to devote	4
Number of Modules	2
Syllabus	Module A: Math Methods 2 [36L] Second order linear homogeneous and non-homogenous ODEs. Phase plane methods for system of ODEs. [10 L] Series solution of ODEs: Power series method. Legendre Polynomials. Frobenius Method. [10 L] The matrix Eigenvalue Problem: Determination of eigenvalues and eigenvectors, applications. Symmetric, Skew symmetric and Orthogonal matrices, diagonalisation and quadratic forms of matrices, Hermitian and Unitary matrices. [8 L] Complex Variables: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions, Harmonic functions. Examples of analytic functions. [8 L]

	<u>Module B: Computation - lab 2</u> [24L] Array computing in Python: Introduction to the numpy, scipy and matplotlib modules. Making use of Numerical libraries for Reading and Writing Data files, Visualisation and plotting, Distribution functions, 2D solutions of the equations of mathematical physics, root finding for nonlinear equations, determination of eigenvalues, interpolation and curve fitting. [12 L] Implementation of the following algorithms: 1. Basic root finding techniques: Bisection and Newton Raphson 2. Linear Least squares method. 3. Matrix inversion Testing output against known solutions and/or comparing them with output from library functions. [12 L]
Learning Outcomes	(1) Apply the powerful method of series solution of second order differential equations (simple cases) (module A) (2) Lead into special functions and their polynomial representation (module A) (3) Understand the Matrix Eigenvalue problem (module A) (4) Learn and apply the concept of analyticity of complex functions (module A) (5) Learn about the advantages of matrix computation (module B) (6) Learn to find numerical roots to nonlinear algebraic equations and curve fitting (module B) (7) Getting prepared for Quantum Mechanics, Advanced Mathematical formulations of Physics, parallelising code for computational efficiency, and find patterns in data. (module B)

<table>
<tr><td>Reading/Reference Lists</td><td colspan="2">Module A

1. Mathematical Methods in Physical Sciences, M. L. Boas, Wiley
2. Elementary Differential Equations & Boundary Value Problems, W. E. Boyce, R. C. Diprima, D. B. Meade, Wiley
3. Advanced Engineering Mathematics, E. Kreyszig, Wiley
4. Fundamentals of Complex Analysis with Applications to Engineering, Science, and Mathematics, E. B. Saff and A. D. Snider, Pearson
5. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson and S. J. Bence, CUP
6. Differential Equations, Shepley L. Ross, Willey India

Module B
1. Online Refs: Langtangen, Kong et al
2. Numpy beginners guide, Idris Alba, 2015, Packt Publishing
3. Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
4. Computational Physics Mark Newman, CreateSpace Independent Publishing Platform (2012)
5. Computational Physics: Problem Solving with Python, 3rd Edition, Rubin Landau, Manuel J. Paez, Cristian C. Bordeianu
6. Learning Scientific Programming with Python, Christian Hill, CUP
7. Scientific Computing in Python (Revised edition, Python3), Abhijit Kar Gupta, Techno World</td></tr>
<tr><td>Evaluation</td><td>Theory
CIA: 15
Semester Exam: 45</td><td>Practical (if applicable)
CA: 30
Semester Exam: 10</td></tr>
<tr><td>Paper Structure for Theory Semester Exam</td><td colspan="2">5 Q out of 7 Q, each 3 Marks + 3Q out of 4Q each 10 Marks : 45</td></tr>
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