

**UNIVERSITY OF MADRAS**  
**B.Sc. DEGREE COURSE IN PHYSICS**  
**SYLLABUS WITH EFFECT FROM 2020-2021**

**BPS-DSC04**

**CORE-IV: MATHEMATICAL METHODS IN PHYSICS**

Lecture: 60 Hours

Tutorial: 15 Hours

Credits:4

**Course Objective:**

To familiarize students with essential mathematical methods for solving advanced problems in theoretical physics.

**Learning Outcomes:**

Upon completion of the course, the student should be able:

- To use advanced mathematical methods and theories on various mathematical and physics problems.
- To develop the skill of problem-solving ability.
- Use Matrices to solve simultaneous equations
- Solve quantum mechanical problems using special functions and polynomials.
- Apply Fourier series to simple circuits.
- To understand electromagnetic theory with Vector Calculus

**UNIT I: VECTOR CALCULUS**

**(12 Hours)**

Scalar and Vector Fields - Gradient of a Scalar function - Divergence of a Vector function - Curl - Line Integral, Surface Integral and Volume Integral (Simple Problems) - Gauss Divergence Theorem - Stoke's Theorem and Green's Theorem (Statement and Proof)- Spherical Polar Coordinates - Expressions for Gradient, Divergence, Curl and Laplacian Operator in Cartesian and Spherical Polar Coordinates.

**UNIT II: SPECIAL FUNCTIONS**

**(12 Hours)**

Special Functions - Beta and Gamma Functions - Definitions - Symmetry Property of Beta function - Evaluation of Integrals using Beta function - Transformation of Beta function - Evaluation of Gamma Function - The value of  $\Gamma_{1/2}$  - Transformations of Gamma function (Other forms) - Relation between Beta and Gamma functions - Simple Problems in beta and gamma functions - Series Solutions for Bessel, Legendre and Hermite Differential Equations.

**UNIT III: MATRICES**

**(12Hours)**

Special Types of Matrices - Symmetric and Skew-symmetric Matrices -Hermitian and Skew-Hermitian Matrices - Orthogonal Matrices - Unitary Matrices -Properties - Characteristics Equation - Determination of Eigen values and Eigen vectors - Properties - Statement and Proof of Cayley - Hamilton Theorem - Simple Problems - Inverse of Matrix by CH Theorem - Diagonalization of 2x2 Real Symmetric Matrices.

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**UNIT IV: COMPLEX VARIABLES**

**(12 Hours)**

Basics of Complex Numbers and their Graphical Representation - Euler's Formula, De-Moivre's Theorem - Functions of Complex Variables - Limit, Continuity and Differentiability - Analytic Function - Definition - Cauchy-Riemann Conditions - Examples of Analytic Functions (Analyticity) - Cauchy-Riemann Conditions in Polar Form

**UNIT V: FOURIER SERIES**

**(12 Hours)**

Fourier Series in the interval  $(-\pi$  to  $\pi)$  - Definition – Dirichlet's Conditions (Statement Only) - Determination of Fourier Coefficients - Even and Odd Functions and their Fourier expansions. Sine and Cosine Periodic Functions - Simple Problems in Fourier Series in the interval  $(-\pi$  to  $\pi)$  - Applications of Fourier series - Half Wave Rectifier and Saw Tooth Wave.

**Books for Study:**

1. Mathematical Physics, H. K. Dass, S. Chand & Co. Ltd. (2010).
2. Mathematical Physics, Sathya Prakash, Sultan Chand & Sons, New Delhi, Fifth Revised and Enlarged Edition, 2006, (Reprint 2007).
3. Mathematical Physics, B. D. Gupta, Vikas Publishing house Pvt. Ltd. (2010)

**BOOKS FOR REFERENCE:**

1. Mathematical Methods for Physicists, G. Arfken, (5<sup>th</sup> Edition), Academic Press, (2000).
2. Mathematical Physics, B.S. Rajput, 8th Edition, Pragati Prakashan (1978).
3. Foundations of Mathematical Physics, Sadri Hassani, Second Edition, Springer
4. Mathematical methods for Physics and Engineering, K.F.Riley, M.P.Hobson & S.J.Bence, Cambridge University Press, 3<sup>rd</sup> Edition.
5. [http://phy.syr.edu/~trodden/courses/math methods.](http://phy.syr.edu/~trodden/courses/math%20methods/)
6. <http://www.mpiyks.dresden.mpg.de/~jochen/methoden/outline/html>
7. <https://freevideolectures.com/course/3288/electromagnetic-theory/4>
8. <https://freevideolectures.com/course/3288/electromagnetic-theory/2>
9. <https://freevideolectures.com/course/3288/electromagnetic-theory/1>
10. <https://freevideolectures.com/course/3288/electromagnetic-theory/3>
11. <https://nptel.ac.in/courses/111103070/>
11. <https://nptel.ac.in/courses/111107112/>