DEPARTMENT OF PHYSICS				*CLASS: I M.Sc. Physics*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
I	Major Core–1	21P1PMC1	Mathematical Physics – I	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

Course Objectives:

- To highlight the relationship of mathematical tools to understanding the dynamics of the physical world we live in.
- To impart knowledge on mathematical tools and techniques that could model real life physical systems.
- To demonstrate the use of vectors, matrices, transforms and specials functions spanning areas like Electromagnetic theory, Quantum Mechanical systems, communication electronics and optics.

Course Content:

Unit	Description	Hours	K-level	CLO
I	**Vectors :** Line integrals – Conservative vectors field – Surface integral – Volume integral – Stoke's theorem – Green's theorem in a plane – Gauss divergence theorem – Applications of Gauss theorem – Curvilinear coordinates – Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.	15	Up to K3	1
II	**Matrices :** Linear vector space – Linear dependent and independent vectors – Basics – Schmidt orthonormalization – Matrices as linear transformations – Eigen values and eigen vectors – Cayley Hamilton theorem and its applications – Diagonalisation – Similarity transformations – Special matrices – Orthogonal, Hermitian, Skew-Hermitian and Unitary matrices – Orthogonal and unitary transformations.	15	Up to K3	2
III	**Fourier Transforms:** Fourier transform – Infinite Fourier sine and cosine transforms – Properties of Fourier transforms – Linearity theorem – Similarity theorem – Shifting property – Modulation theorem – Convolution theorem – Parseval's Theorem – Derivative of Fourier transform – Fourier transform of a derivative.	15	Up to K4	3
IV	**Special functions - I :** Beta function: Symmetry property – Evaluation – Other forms – Gamma Function : Evaluation – other forms – Relation between beta and gamma functions – Miscellaneous propositions - Legendre differential equation – Generating function - Physical basis in Electrostatics - Linear electric multipoles - Rodrigues' formula – orthogonal property – Recurrence formulae - gravitational potential due to spheroidicity of earth.	15	Up toK4	4

V	**Special Functions - II :** Bessel's differential equation (No power series solution) – Recurrence formulae – Generating function – Orthonormality of Bessel functions – Application of Bessel's function to Fraunhoffer diffraction using circular aperture - Hermite polynomials (no power series solution) – generating function – recurrence formulae – Rodrigue's formula – orthonormality of Hermite polynomials.	15	Up toK3	5

Books for study:

1. Vectors analysis, M. R. Spiegel, Schaum's outline series, MHI, 1974.
   Unit I: Chapter 5, 6 and 7.
2. Engineering mathematics, M. K. Venkataraman , VthEdn., National Pub., 1999.
   Unit II: 4.1, 4.2, 4.5, 4.7, 5.1, 5.3, 6.2, 6.3, 7.1-7.6, 7.8.
3. Mathematical Physics with Classical Mechanics, Satya Prakash, VthEdn., Sultan Chand & Sons,2007.
   Unit III: 10.1 to 10.5
   Unit IV: 4.1 to 4.7, 4.9, 4.10, 7.11 to 7.15
   Unit V: 7.21, 7.25, 7.26, 7.29, 7.33 to 7.37
4. Mathematical Methods for Physicists, Arfken& Weber, VI Edition, Elsevier, 2011
   Unit IV : 12.1 (Pages 744 to 748), Example 7.3.1 (Page 758)
   Unit V : Example 11.1.1 (Page 680)

Books for References:

1. Mathematical methods in Physical Sciences, Mary L Boas, Wiley Eastern, III Edition, 2006
2. Mathematical methods for Physicists and Engineers, Riley, Hobson and Bence, Cambridge University Press, III Edition, 2018.

Web Resources:

1. https://oer.uoch.edu.pk/home/watch_lecture/1373/70674
2. https://math.libretexts.org/Bookshelves/Differential_Equations/Book%3A_Partial_Differential_Equations_(Walet)/10%3A_Bessel_Functions_and_Two-Dimensional_Problems
3. https://www.physics.uoguelph.ca/chapter-3-legendre-polynomials
4. https://online.stat.psu.edu/stat505/lesson/4/4.5

Pedagogy :

Chalk and talk, Presentation, Quiz, Seminar, Assignment

Course Designers :

S. Sivaramakrishnan
Dr. K. Neyvasagam

Course Plan:

Unit	Topics	Hrs	Mode
Unit I	Line integrals – Conservative vectors field - Surface integral – Volume integral	**3**	Chalk and talk, Presentation, Quiz and assignment
	Stoke's theorem	**3**	
	Green's theorem in a plane	**3**	
	Gauss divergence theorem – Applications of Gauss theorem	**3**	
	Curvilinear coordinates – Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.	**3**	
Unit II	Linear vector space – Linear dependent and independent vectors – Basics – Schmidt orthonormalization	**3**	Chalk and talk, Quiz and assignment
	Matrices as linear transformations – Eigen values and eigen vectors	**3**	
	Cayley Hamilton theorem and its applications – Diagonalisation – Similarity transformations	**3**	
	Special matrices – Orthogonal, Hermitian, Skew-Hermitian and Unitary matrices	**3**	
	Orthogonal and unitary transformations	**3**	
Unit III	Fourier transform – Infinite Fourier sine and cosine transforms	**3**	Chalk and talk, Quiz, assignment and seminar
	Linearity theorem – Similarity theorem – Shifting property – Modulation theorem – Convolution theorem – Parseval's Theorem	**5**	
	Derivative of Fourier transform	**4**	
	Fourier transform of a derivative	**3**	
Unit IV	Beta function: Symmetry property – Evaluation – Other forms	**3**	Chalk and talk, quiz, Seminar
	Gamma Function : Evaluation – other forms - Relation between beta and gamma functions – Miscellaneous propositions	**3**	
	Legendre differential equation	**3**	
	Generating function - Physical basis in Electrostatics - Linear electric multipoles	**1**	
	Rodrigues' formula	**1**	
	orthogonal property - gravitational potential due to spheroidicity of earth	**2**	
	Recurrence formulae	**2**	
Unit V	Bessel's differential equation (No power series solution) – Recurrence formulae	**3**	Chalk and talk, Quiz, Presentation, Seminar
	Generating function	**2**	
	Orthonormality of Bessel functions – Application of Bessel's function to Fraunhoffer diffraction using circular aperture	**3**	
	Hermite polynomials (no power series solution) – generating function – recurrence formulae – Rodrigue's formula – orthonormality of Hermite polynomials	**7**	

Course learning Outcomes:

On the successful completion of the course, the students will be able to

CLOs	Course Learning Outcomes	Knowledge Level
CLO–1	Apply the concept of vector calculus to solve the real world problem in Physics.	Up to K3
CLO–2	Solve Eigen value problems and appreciate its application to the field of Quantum Mechanics.	Up to K3
CLO–3	Analyse diffraction data and power spectrum of electronics circuits using Fourier transforms.	Up to K4
CLO–4	Analyse physical problems like electric monopoles, dipoles and analyzing the gravitational potential of the earth due to its spheroidicity by modeling the systems using Legendre Polynomials. Also solve Eulerian integrals as beta and gamma functions.	Up to K4
CLO–5	Apply Bessel's functions to Fraunhofer diffraction through a circular aperture. Also study the properties of Hermite polynomials.	Up to K3

Mapping of CLOs with PSOs :

#	PSO1	PSO2	PSO3	PSO4	PSO5
CLO1	3	3		2	1
CLO2	3	3		2	1
CLO3	3	3		2	1
CLO4	3	3		2	1
CLO5	3	3		2	1

Advance application –3, Intermediate level –2 , Basic level–1

Learning Outcome Based Education (LOBE) & Assessment
Summative Examination – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
1	CLO 1	Up to K3	2	K1& K1	1	K1	2 (K3&K3)	1 (K2)
2	CLO 2	Up to K3	2	K2 & K3	1	K2	2 (K1&K1)	1 (K3)
3	CLO 3	Up to K4	2	K3 & K4	1	K1	2 (K4&K4)	1 (K4)
4	CLO 4	Up to K4	2	K3 & K4	1	K3	2 (K4&K4)	1 (K4)
5	CLO 5	Up to K3	2	K2 & K3	1	K2	2 (K2&K2)	1 (K3)
No. of Questions to be asked			10			5	10	5
No. of Questions to be answered			10			5	5	3
Marks for each question			1			2	5	10
Total Marks for each section			10			10	25	30

Distribution of Section-wise Marks with K Levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice
K1	2	4	10	-	**16**	13.33
K2	2	4	10	10	**26**	21.67
K3	4	2	10	20	**36**	30.00
K4	2	-	20	20	**42**	35.00
Total Marks	10	10	50	50	**120**	100.00