University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK3DSEPHY205**				
Course Title	**MATHEMATICAL TOOLS FOR PHYSICS**				
Type of Course	**DSE**				
Semester	**III**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 Hrs	-	-	4 Hrs
Pre-requisites					
Course Summary	Mathematical tools serve as the backbone for solving complex physics problems. They encompass concepts such as curvilinear coordinate systems for describing non-linear geometries, differential equations for modeling dynamic systems, complex functions for analyzing oscillatory behavior, infinite and Fourier series for understanding periodic phenomena, matrices and linear vector spaces for handling transformations, and operators for representing physical observables and their interactions within a structured mathematical framework. These tools provide physicists with powerful techniques to describe, analyze, and predict various physical phenomena across diverse fields.				

BOOKS FOR STUDY:

1. Introduction to Electrodynamics by David J Griffith; 4th edition
2. Introduction to mathematical physics by Charlie Harper
3. Mathematical Methods in The Physical Sciences by Mary L Bose; 3rd edition
4. Calculus by Anton, Bivens and Davis; 10th edition
5. Matrices and tensors in physics by A W Joshi; 3rd edition
6. Quantum mechanics by V K Thankappan; 3rd edition

BOOKS FOR REFERENCE:

1. Mathematical Methods for Physicists by Arfken, Weber and Harris; 7th edition.
2. Calculus by Thomas; 13th edition
3. Differential equations with applications with Historical notes by George F Simmons; 3rd edition

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I	**Vector algebra and Orthogonal curvilinear coordinate system (Books 1 & 2)**		**12**	
	1	Orthogonal curvilinear coordinate systems: plane polar, Spherical polar and cylindrical coordinate systems- unit vectors, coordinate transformations.	3	1
	2	Infinitesimal line segment, scale factors, area elements, volume elements, line-surface-volume integrals with examples	3	1
	3	Gradient, divergence, curl and Laplacian in spherical polar and cylindrical coordinate systems (derivation excluded).	3	1
	4	Integral theorems- Stoke's theorem and Gauss divergence theorem (verification with examples only).	3	1
II	**Infinite series (Books 3 & 4)**		**11**	
	5	Infinite series – convergence test (Book 4)	2	2
	6	Maclaurin and Taylor series (Book 4)	3	2
	7	Convergence of Taylor series (Book 4)	1	2
	8	Fourier series – examples (Book 3)	3	2
	9	Fourier transform (qualitative discussion only) (Book 3)	2	2
III	**Complex functions (Books 2 & 3)**		**10**	
	10	Complex numbers, graphical representation (Book 3)	2	3
	11	Complex functions, arithmetic operation-conjugates, modulus (Book 3)	2	3
	12	Polar form, powers and roots (Book 3)	2	3
	13	Euler's formula, Demovre's theorem (Book 3)	1	3

	14	Analytical functions and Cauchy-Riemann Conditions, examples of analytic functions (Book 3)	3	3
IV	**Differential equations and Matrices (Book 2 &3)**		**15**	
	15	First order equations and linear second order differential equations with constant coefficients, homogeneous and inhomogeneous equations. (Book 2)	7	4
	16	Partial differential equation- variable separable solution (elementary ideas). (Book 2)	2	4
	17	Matrices: symmetric matrices, skew symmetric matrices, Hermitian-orthogonal-unitary matrices, rank, trace. (Book 2)	2	5
	18	Eigen value problems, eigen vectors. (Book 2)	2	5
	19	Diagonalization, similarity transformation, rotation matrices, function of a matrix. (Book 2)	2	5
V*	**Linear vector space and operators (Book 5 & 6)**		**12**	
	20	Group, field, linear vector space, linear independence of vectors, vector space of n-tuplets.	3	6
	21	Inner product, orthonormality and linear independence, bases and dimensions, norm.	2	6
	22	Schmidt's orthogonalization method.	1	6
	23	Operators-linear operators, eigen value and eigen functions of an operator.	2	6
	24	Hermitian operator, unitary operator, projection operator.	2	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries.	U, Ap	PSO-1, 2
CO-2	Express functions as infinite series and understand its applications in physics	U, Ap	PSO-1, 2
CO-3	Explain the fundamental ideas of complex numbers and	U, Ap	PSO-1, 2

	complex functions		
CO-4	Describe the methods used for solving differential equations, emphasizing the various approaches based on the type and characteristics of the equations.	U	PSO-1, 2
CO-5	Explain the classification of matrices and their corresponding operations, highlighting the distinctions among different types of matrices and the procedures involved in matrix operations	U, Ap	PSO-1, 2
CO-6	Explain linear vector space and different operations in linear vector space	U	PSO-1, 2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: MATHEMATICAL TOOLS FOR PHYSICS

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Explain the curvilinear coordinates which have applications in problems with spherical and cylindrical symmetries.	PO-1,2,3 PSO-1, 2	U, Ap	F, C	L	-
CO-2	Express functions as infinite series and understand its applications in physics	PO-1,2,3 PSO-1, 2	U, Ap	F, C	L	-
CO-3	Explain the fundamental ideas of complex numbers and complex functions	PO-1,2,3 PSO-1, 2	U, Ap	F, C	L	-
CO-4	Describe the methods used for solving differential equations,	PO-1,2,3 PSO-1, 2	U, Ap	F, C	L	-

	emphasizing the various approaches based on the type and characteristics of the equations.					
CO-5	Explain the classification of matrices and their corresponding operations, highlighting the distinctions among different types of matrices and the procedures involved in matrix operations	PO-1,2,3 PSO-1, 2	U, Ap	F, C	L	-
CO-6	Explain linear vector space and different operations in linear vector space	PO-1,2,3 PSO-1, 2	U	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-
CO-2	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-
CO-3	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-
CO-4	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-
CO-5	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-
CO-6	2	3	-	-	-	-	-	3	2	1	-	-	-	-	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	-	-	✓
CO-4	✓	✓	-	✓
CO-5	✓	-	-	✓
CO-6	✓	-	-	-