PHY6503: MATHEMATICAL METHODS FOR SCIENTISTS AND ENGINEERS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Mathematical Methods for Scientists and Engineers

Subject Code
PHY - Physics
Course Number
6503

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
MA2158 Linear Algebra and Calculus or equivalent

Equivalent Courses
Nil

Exclusive Courses
PHY8503 Mathematical Methods for Scientists and Engineers

Part II Course Details

Abstract

This is a graduate course on mathematical methods for physicists and engineers. Topics that will be covered include: linear algebra, fourier series, integral transforms, infinite series, complex analysis, ordinary and partial differential equations, integral equations, group theory, tensor methods, probability.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe and apply common mathematical analysis methods employed by physicists.	40		x	
2	Execute mathematical analysis using both analytical and computational methods.	40	x	x	x
3	Demonstrate the capacity for self-directed learning on topics related to mathematical analysis methods.	20	x		x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Explain key concepts of topics of the course	1, 2	2
2	Small Class Activities	Explain some details of how some techniques are applied	1, 2, 3	1
3	Assignments	Homework	1, 2, 3	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Coursework	1, 2, 3	50	Weekly assignments	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Capacity for using knowledge of mathematical methods to solve physics problems
2. Demonstrate correct understanding of key concepts

Excellent

(A+, A, A-) Student completes all assignments, and demonstrates excellent understanding of the mathematical methods employed by physicists. Student can thoroughly identify which methods are applicable for a given analysis. Student is able to utilize computing algorithms necessary to perform analysis digitally. Student is able to present analysis results effectively via text and graphs.

Good

(B+, B, B-) Student completes at least 80% of assignments, and demonstrates understanding of the mathematical methods employed by physicists. Student can identify which methods are applicable for a given analysis. Student is able to utilize algorithms necessary to perform analysis digitally. Student is able to present analysis results via text and graphs

Fair

(C+, C, C-) Student completes at least 70% of assignments, and shows some understanding of the mathematical methods employed by physicists. Student can usually identify which methods are applicable for a given analysis. Student is able to utilize simple algorithms to perform analysis digitally. Student can present results via text and graphs, but in a manner that may require some effort to interpret.

Marginal

(D) Student completes at least 60% of assignments, but can only demonstrate brief understanding of the mathematical methods employed by physicists. Student with guidance is able to identify which methods are applicable for a given analysis. Student is able to utilize simple algorithms to perform analysis digitally. Student presents results in a way that requires significant effort or further analysis to interpret.

Failure

(F) Student completes less than 50% of assignments. Or, fails to accurately describe the mathematical methods employed by physicists. Student is not able to identify which methods are applicable for a given analysis. Student fails to utilize simple algorithms to perform analysis digitally. Student can’ t present results in a meaningful way.

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Capacity for using knowledge of mathematical methods to solve physics problems
2. Demonstrate correct understanding of key concepts

Excellent

(A+, A, A-) Demonstrates excellent understanding of the mathematical methods employed by physicists. Student can thoroughly identify which methods are applicable for a given analysis.

Good

(B+, B, B-) Demonstrates understanding of the mathematical methods employed by physicists. Student can identify which methods are applicable for a given analysis.

Fair

(C+, C, C-) Shows some understanding of the mathematical methods employed by physicists. Student can usually identify which methods are applicable for a given analysis.

Marginal

(D) Only demonstrate brief understanding of the mathematical methods employed by physicists. Student with guidance is able to identify which methods are applicable for a given analysis.

Failure

(F) Fails to accurately describe the mathematical methods employed by physicists. Student is not able to identify which methods are applicable for a given analysis.

Assessment Task

Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1. Capacity for using knowledge of mathematical methods to solve physics problems
2. Demonstrate correct understanding of key concepts

Excellent

(A+, A, A-) Student completes all assignments, and demonstrates excellent understanding of the mathematical methods employed by physicists. Student can thoroughly identify which methods are applicable for a given analysis. Student is able to utilize computing algorithms necessary to perform analysis digitally. Student is able to present analysis results effectively via text and graphs.

Good

(B+, B) Student completes at least 80% of assignments, and demonstrates understanding of the mathematical methods employed by physicists. Student can identify which methods are applicable for a given analysis. Student is able to utilize algorithms necessary to perform analysis digitally. Student is able to present analysis results via text and graphs

Marginal

(B-, C+, C) Student completes at least 60% of assignments, but can only demonstrate brief understanding of the mathematical methods employed by physicists. Student with guidance is able to identify which methods are applicable for a given analysis. Student is able to utilize simple algorithms to perform analysis digitally. Student presents results in a way that requires significant effort or further analysis to interpret.

Failure

(F) Student completes less than 50% of assignments. Or, fails to accurately describe the mathematical methods employed by physicists. Student is not able to identify which methods are applicable for a given analysis. Student fails to utilize simple algorithms to perform analysis digitally. Student can’ t present results in a meaningful way.

Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

1. Capacity for using knowledge of mathematical methods to solve physics problems
2. Demonstrate correct understanding of key concepts

Excellent

(A+, A, A-) Demonstrates excellent understanding of the mathematical methods employed by physicists. Student can thoroughly identify which methods are applicable for a given analysis.

Good

(B+, B) Demonstrates understanding of the mathematical methods employed by physicists. Student can identify which methods are applicable for a given analysis.

Marginal

(B-, C+, C) Only demonstrate brief understanding of the mathematical methods employed by physicists. Student with guidance is able to identify which methods are applicable for a given analysis.

Failure

(F) Fails to accurately describe the mathematical methods employed by physicists. Student is not able to identify which methods are applicable for a given analysis.

Part III Other Information

Keyword Syllabus

- Probability and statistical analysis: distributions, generating functions, central limit theorems, stochastic processes
- Complex Variables: analytic functions, complex integrals, contour integration
- Fourier analysis: Fourier transforms, delta functions, power spectrum density
- Ordinary Differential Equations: exact and series solutions, special functions
- Partial Differential Equations: separation of variables, change of coordinates
- Computational methods: numerical methods, qualitative methods.

Reading List

Compulsory Readings

	Title
1	D.A. McQuarrie Mathematical Methods for Scientists and Engineers