METHODS OF MATHEMATICAL PHYSICS SEMINAR

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1. Description of Mathematical Physics and the Seminar

Mathematical physics is an interdisciplinary science which, on the basis of the fundamental (mostly phenomenological) laws of physics, uses mathematical methods to study process evolving in material media. Its purpose is to formulate equations describing a process to within a reasonable degree of idealization (ie., disregarding details that are not essential for its qualitative and quantitative essences), to develop methods for solution of the resulting problem, and to analyze the qualitative and quantitative properties of the solutions. In this latter respect mathematical physics borders on numerical analysis and experimental natural science.

In this seminar we shall restrict our attention to phenomena of the "macro" world—more precisely, to processes evolving in continuous media.

This seminar would probably consist of 8 sessions, telling the story of some naive analytical methods of mathematical physics. The main textbook we use focuses on analytical tools (ie., series, integral transforms, eigenfunctions, special functions, etc.). But actually these methods are far away from modern mathematical physics. Here goes an typical example.

To be noticed, our attention in this semester will be simply restricted on partial differential equations with applied solutions and two special functions.

2. Syllabus

The main reference of this seminar is *Methods of Mathematical Physics* by Qiao Gu. Several adjustments will be taken depending on the evaluation of the seminar.

Table 1: Syllabus

Lec #	**Topics**	**Chapters**
1	ODE Review Vector Differential Operator Laplace Operator	Chap 1
	Fourier Integral	Chap 2

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Table 1 – Continued from previous page

Lec #	Topics	Chapters
	Convolution Fourier Transformation Dirac Delta Function	Chap 3
	Introduction to Laplace's Eq., Heat Eq., Wave Eq. Physical Interpretation Transport Eq. & its Solution	Chap 5
2	Laplace's Eq. & Poisson Eq. Homogeneous Eq. & Nonhomogeneous Eq. Initial & Boundary Value Problems Green Function & Its Integral Geometric Restriction for the Boundary	Chap 12
3 & 4	Heat Eq. & Wave Eq.	Chap 10
5 & 6	Separation of Variables	Chap 6 & 7
	Methods of Eigenfunction	Chap 8 & 9
	Laplace Transformation Integral Transformation	Chap 4 Chap 11
7 & 8	Bessel Function	Chap 13
	Legendre Function	Chap 14

3. Recommended Readings

Table 2: Recommended Readings

Level	Title	Author	Feature
Basic	Methods of Mathematical Physics	Qiao Gu	Analysis
	Partial Differential Equations	Lawrence Evans	Qualitative Theory
	Partial Differential Equations: an Introduction	Walter Strauss	Low Dimension, Specific Cases
Advanced	Methods of Mathematical Physics I & II	R. Courant & D. Hilbert	Classical, Complete, Hard

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Table 2 – Continued from previous page

Level	Title	Author	Feature
	Mathematical Physics: a Modern Introduction to its Foundations	Sadri Hassani	Algebra, Def-Prop-Thm-Proof
	Mathematical for Physics: a Guided Tour for Graduate Students	Micheal Stone & Paul Goldbart	Modern, Topology, Physics

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