PHY 3601 Methods in Theoretical Physics I

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Course Description

This course provides a survey of various analytical techniques commonly used to solve problems in theoretical physics. The following physical problems are used as examples: the vibrating string, waves, electrostatics, heat conduction and coupled oscillators. Students are advised to take PHY 2001, 2002, and 2003 or their equivalents before taking this course. Prerequisite: permission of the instructor.

Course Content

	Topics	**Highlights of Fundamental Concepts**
1.	Vibrating string and one-dimensional wave equation	Equation of motion of a homogeneous vibrating string with fixed ends; solution by separation of variables and eigenfunction expansion (Fourier series). Equation of motion of an inhomogeneous vibrating string, Sturm-Liouville problem in general, orthogonality of eigenfunctions. Initial-value problem of the one-dimensional wave equation on the whole real line and its general solution.
2.	Electrostatics	Poisson's equation and Laplace's equation in electrostatics. Solution of two-dimensional and three-dimensional Laplace's equation in rectangular coordinates with various boundary conditions. Laplace's equation in spherical coordinates: the general solution with azimuthal symmetry, series solution of Legendre's differential equation, introduction to spherical harmonics. Laplace's equation in cylindrical coordinates: solution by separation of variables, Bessel's differential equation, and series solution (optional).
3.	Heat conduction problem	Derivation of diffusion equation. Solution of diffusion equation by the Laplace transform method and the Fourier transform method.
4.	Coupled oscillators	Equation of motion and the normal mode problem. Systems of linear equations, inverse of a matrix, multiplication and transformation of matrices, eigenvalues and eigenvectors, properties of Hermitian matrices. Concept of abstract vector space, linear dependence and independence, completeness, basis, scalar product.

Learning Outcomes

1.	Through the study of this course, students will not only have learned the mathematical tools necessary for future studies in physics, but also have mastered the art of analyzing and expressing a physical problem in a mathematical way, and then solving it.

Learning Activities

Lecture		Tutorial		Exercise Class and Assignment		Laboratory		Project / Report		Presentation		Case study		Web teaching		Other 1 (specify)		Other 2 (specify)	
(hr / week)		(hr / week)		(hr / week)		(hr / week)		(hr in total)		(hr in total)		(hr in total)		(hr / week)		(hr in total)		(hr in total)	
in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class	in class	out class
2.25	2	0.75	1	0.75	3														
M	M	M	M	M	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

M: Mandatory activity in the course O: Optional activity NA: Not applicable

Assessment Scheme

	Component	Description	Weight
1.	Homework	The homework will be graded by the TAs and the graded homework will be returned to you. If you have enquiries concerning the grading, please feel free to contact me or the TAs.	15%
2.	Midterm Examination	The schedule of midterm examination will be announced later.	35%
3.	Final Examination	The final examination will be centrally arranged by the university.	50%

Learning Resources

	Resource	Web link or ref no. in library
1.	M L Boas, "Mathematical Methods in the Physical Sciences", 2nd ed, Wiley, 1983	QA37.2.B698 1983
2.	G Arfken, "Mathematical Methods for Physicists", 3rd ed, Academic Press, 1985	QA37.A68 1985
3.	R V Churchill and J W Brown, "Fourier Series & Boundary Value Problems", 4th ed, McGraw-Hill, 1987	QA404.C6 1987
4.	P R Wallace, "Mathematical Analysis of Physical Problems", Dover, 1984	
5.	G Stephenson, "Mathematical Methods for Science Students", 2nd ed, ELBS/Longman, 1973	QA37.S815 1973

Feedback for Evaluation

1.	Send email to the teacher, give him a call, or come to his office, especially for issues that require immediate action;
2.	express your views in the mid-term and term-end course evaluation;
3.	express your views (or ask a student representative to help you convey the messages) in the staff-student consultation meeting held every year;
4.	post a message on the forum of the course website.

Course Schedule

	Topics	Week No.	Activities / Readings / References
1.	Vibrating string and one-dimensional wave equation	1-4	
2.	Electrostatics	4-7	
3.	Heat conduction problem	7-10	
4.	Coupled oscillators	10-13	

Teachers' or TAs' Contact Details

Teacher's Name	Contact	Additional Information
Lo Chi Fai	Office : SC 207 Tel. no. : 2609 6362 Email : cflo@phy.cuhk.edu.h	• • •
TA's Name	**Contact**	**Additional Information**
• To be arranged		

Academic Honesty and Plagiarism

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details can be found at http://www.cuhk.edu.hk/policy/academichonesty/.

1.	After the course registration, you are required to submit "Declaration of Honesty in Academic Work" declaring that you are aware of these policies, regulations and procedures. The form can be found at http://www.phy.cuhk.edu.hk/.

Facilities for Posting Announcements and Materials

1.	The course website (http://www.phy.cuhk.edu.hk/course/2009-2010/1/phy3601) contains the following useful information and resources: (a) All course materials, including lecture notes, homework and solution. The password for download will be given to you in the first lecture. (b) A notice board for announcements of assignments, latest download, and important events (e.g. examination schedule). (c) A web forum for you to ask questions, discuss problems with teachers and classmates. You are also welcome to express your comments on the course in the forum.