Course Profile

Degree Program:

- ☐ ECE-Electrical & Computer Engineering
- ☐ ME-Mechanical Engineering
- ☑ General Courses for Both ECE & ME Degree Programs

Course Name: Partial Differential Equations and Boundary Value Problems
Course Code: Vv454
Course Credits: 4
Course Category: ☐ Required ☑ Elective

Terms Offered:

☐ Fall ________________ (YYYY-YYYY)
☑ Spring ______________ (2011-2012)
☐ Summer ________________ (YYYY-YYYY)

Course Pre/Co-requisites: Vv286 or Vv256

Textbook:

The textbook for the course is **Pinchover, Y., and Rubinstein, J.,** *An Introduction to Partial Differential Equations*, Cambridge 2005. Additional material may be uploaded to the SAKAI CLE.

Instructor:

Horst Hohberger
horst@sjtu.edu.cn
Office 218, Law School Building
Office Hours: Tuesdays and Thursdays, 1-2 pm and by appointment; at other times, just drop in and see if I have time for you. You are always welcome.

Teaching Assistants:

Pi Yibo
piyibo@sjtu.edu.cn

TA Office hours will be announced at the beginning of the term.

Grading Policy:

The median grade of the course will be a "B.''

The grade will be composed of the course work and the exams as follows:

- First midterm exam: 20%
- Second midterm exam: 25%
- Final exam: 30%
- Course work: 25%

Grade points (0-4) for each of these four components will be calculated and averaged according to the above percentages. From this a final grade is determined.

In addition, in order to gain a grade better than an F, a student must obtain an aggregate 3 grade points in the three exams and at least a D in the course work.

The grade may be curved to achieve a course median of B.

Academic Integrity: (Any types of honor code regulations like class rules, homework policy, exam rules or project collaboration policy could be defined here)

The rules for observing the Honor Code in this course are quite simple: you must **never** show any other student your **written work**. You are not allowed to write down formulas for another student, or to let them see your homework, or to demonstrate something to them on a blackboard or use any other type of written communication.

You **are allowed** to **talk** about the course work (the weekly assignments), but may not communicate in writing. For example, it is allowed to tell another student "I solved this differential equation by substituting as for a homogeneous equation." It is not allowed to actually show another student the written calculations of how you did this.

When faced with a particularly difficult problem, you may want to refer to other textbooks or online sources such as Wikipedia. If you do use any outside sources to help you solve a homework problem, **you are not allowed to just copy the solution**; this is a violation of the Honor Code! The correct way of using outside sources is to understand the contents of your source and then to write in your own words and without referring back to the source the solution of the problem. Your solution should differ in style significantly from the published solution. If you are not sure whether you are incorporating too much material from your source in your solutions, then **you must cite the source that you used.**

Of course, during exams, no communication of any kind (verbal or written) is allowed!

Course description and detailed teaching schedule:

The course begins with a first introduction to modeling, viz. the derivation of an equation to model fluid (or traffic) flow. This is taken as a starting point for the investigation of first-order partial differential equations and their solution using the method of characteristics and related techniques. We focus on linear and quasi-linear equations, but also treat the eikonal equation from optics as a basic example of how to solve fully nonlinear equations. Special attention will be paid to Burgers's equation, shock waves and traffic problems.

We next turn to quasilinear second-order equations and give the basic classification scheme into hyperbolic, parabolic and elliptic equations. This completes the first part of the course.

We then derive further important equations of physics and engineering, including the equations for vibrating strings and beams, the heat equation and the cable equation. These are all seen to be of second-order quasilinear type and for the remainder of the course, we will discuss various solution methods to such equations.

As a first example, we consider the wave equation for the infinite string, proving its well-posedness for finite time intervals and deriving d'Alembert's solution. The treatment includes weak solutions as natural results from d'Alembert's solution formula.

Motivated by the heat equation for the finite bar, we continue with an extensive treatment of the method of separation of variables for the classical evolution equations on finite one-dimensional spatial domains. As part of this discussion, an introduction to the theory of square-integrable functions, Fourier series and Sturm-Liouville theory is given. We conclude with a discussion of the potential equation on rectangular domains

The separation-of-variables approach for the heat equation on the infinite bar leads naturally to the introduction of the Fourier transform. We give a brief account of the classical theory, with emphasis on practical applications. We solve the telegraph equation and discuss the “wine cellar problem”.

Next, we treat a selection of problems in higher dimensions that can be treated using the separation-of-variables technique. This includes a brief introduction to Bessel functions and Legendre polynomials. Applications include electrostatic problems, vibrations in two dimensions and fluid flow.

Finally, we turn to elliptic equations, in particular, the Laplace equation. There are marked differences in the properties of the solutions compared with those of the evolution equations, and we discuss some of them (such as the maximum principle). We derive Poisson's integral formula for the unit disk and give a brief account of the use of Green's functions for the solution of the potential equation.

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The planned timetable for the syllabus is given below. There may be deviations from this as the term progresses.

Week	Lecture Subject	Textbook Sections	Date
1	Introduction Method of Characteristics The Cauchy Problem	1.1 - 1.3 2.1 - 2.3; 2.6 2.4 - 2.5	14-2-2012 15-2-2012 16-2-2012
2	Burgers's Equation The Eikonal Equation Nonlinear PDEs	2.7 2.8 2.9	21-2-2012 22-2-2012 23-2-2012
3	Classification of 2nd order PDEs Classical PDEs of Physics and Engineering	3 1.4 - 1.6, 5.6.1	28-2-2012 29-2-2012 1-3-2012
4	**First Midterm Exam** The Wave Equation for an Infinite String Separation of Variables	**1 - 3** 4	6-3-2012 7-3-2012 8-3-2012
5	Square Integrable Functions and Fourier Series Sturm-Liouville Problems Evolution Equations	5, 6	13-3-2012 14-3-2012 15-3-2012
6	Separation of Variable for the Laplace Equation The Fourier Transform	7.7 Evans et al.	20-3-2012 21-3-2012 22-3-2012
7	The Eigenvalue Problem for the Laplacian **Second Midterm Exam**	9.5 **4 - 6, 7.7**	27-3-2012 28-3-2012 29-3-2012
8	Separation of Variables in Higher Dimensions	9.6 - 9.8	3-4-2012 5-4-2012
9	Elliptic Equations	7.1 - 7.5, 7.8	10-4-2012 11-4-2012 12-4-2012
10	TBA	TBA	17-4-2012 18-4-2012 19-4-2012
11	**Final Exam**	**Evans et al.** **9.5-9.8,** **7.1-7.5, 7.8**	24-4-2012 25-4-2012 26-4-2012