Hybrid Course: Course Contract – MATH 4330/8336 – Fall 2009
Introduction to Partial Differential Equations (PDEs)
University of Nebraska at Omaha

Instructor Mahboub Baccouch

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Class Times Mondays 5:30-6:45 p.m. Location in DSC 109

Schedule Viewing Schedule: Approximately fifteen 2.5 hour lectures (15 weeks)

Office Hours TWR: 2:15 PM- 4:00 PM, and other time by appointment. You do not need to make an appointment to see me during my regular office hours.

Website You may download some class material (such as homework assignments, solutions, and supplemental readings) at the following course website:

http : *//myweb.unomaha.edu/ mbaccouch/*4330_F09.*html*

Description This course covers the basic methods of PDEs. The main goal is to provide a solid conceptual understanding of some of the basic topics in the field of PDEs. The students will be exposed to both theoretical and applied points of view. Standard topics such as characteristics, separation of variables, and Fourier series are included.

Textbook Required. By Walter A. Strauss, Partial Differential Equations, An Introduction, 2^{nd} Edition (2008); Publisher: John Wiley and Sons. New York; ISBN: 978-0-470-05456-7. The course will be also based on the professor's typed lecture notes, which are available on my homepage. I intend to cover chapters 1-6 and, if time permitting, 8 of the textbook, but not all sections of each chapter. The Solutions Manual (not required) contains detailed solutions to about half of the problems. The assignments will be from the other half of problems.

Supplementary Matthew P. Coleman, An Introduction to Partial Differential Equations with MATLAB, Chapman and Hall/CRC, 2005 (ISBN: 9781584883739) (Similar level).

Nakhle H Asmar: Partial Differential Equations and Boundary Value Problems with Fourier Series, Prentice Hall, Upper Saddle River, NJ, 2004. (Similar level)

Applied Partial Differential Equations, 4th Ed., Richard Haberman, Prentice Hall, 2003(Similar level).

Prerequisite Required prerequisite: MATH 1970 (calculus III) and MATH 2350 (Ordinary Differential Equations: ODEs). Other topics will be introduced as needed. Many of the techniques used to solve PDEs involve reductions to systems of ODEs, so an introductory course in ODEs is required. It is recommended, but not required, that students take MATH 2050 (Applied Linear Algebra) before taking this course.

For whom Graduates and undergraduates (third or fourth year majors in computer science or mathematics) needing a basic familiarity with techniques for solving PDEs.

Course Description and Objective

This course introduces the basics of PDEs, guided by applications in physics and engineering. Both analytical and numerical solution techniques will be discussed. PDEs play important roles in pure and applied mathematics. They are at the heart of applied mathematics and many other scientific disciplines. In fact, many PDEs are from Chemistry, Engineering, Finance, Physics and Mechanics etc. This course will give an introduction to the subject. Examples of various PDE types will be discussed, in particular, those PDEs arising from real problems in Engineering and Physics. Analytic and approximation methods will be covered. The purpose of this course is to introduce the student to certain problems arising in physics and engineering and provide the student with the standard mathematical techniques in Fourier series for solving such problems. The aim of this course is to teach you how to solve PDEs and interpret the resulting solutions. More emphasis will be placed on solution techniques than on theorems and proofs, which is appropriate for a course in an engineering school. We will discuss many techniques, such as the method of characteristics, separation of variables, Fourier transform, and many others. The material presented is applicable to any field of study that makes use of PDEs to model its phenomena, whether that field is physics, finance, biosciences, electrical engineering, or anything else. The main topics to be covered include, in rough order: Transport equations; Characteristics; Classification of PDEs; Boundary value problems; Heat conduction; Vibrating membranes; Helmholtz equations; Maximum principle; Separation of variables; Fourier series; Harmonic functions; Distributions; Green's functions; finite element method; Choice of supplementary topics and applications will depend on the interests of the class. The majority of the topics covered in this course are theoretical. By the end of this course, students should be able to:

1. identify different methods of solving PDEs and apply them to obtain solutions for various classes of differential equations.

2. apply their knowledge of PDEs to construct and analyze models arising in applications in mathematics, physics, engineering, business, and biology.

3. perform quantitative and qualitative analysis of problems described by PDEs.

Course Outline and Tentative Schedule

This is an introductory course on PDEs. In addition to first order PDEs (such as the transport equation) we will study in detail the main types of second order PDEs (as illustrated by the Laplace equation, the heat equation, and the wave equation), with an emphasis on understanding the different qualitative behavior of the solutions. We will cover the selected topics according to the following (tentative) schedule:

- Chapter 1: Where PDEs Come From (2-3 weeks): elliptic, parabolic and hyperbolic equations;
- Chapter 2: Waves and Diffusions (2-3 weeks): d'Alembert formula, maximum principle;
- Chapter 3: Refections and Sources (2 weeks): Heat equation, Reflection of waves;
- Chapter 4: Boundary Problems (2 weeks): Solution to heat and wave by separation of variables;
- Chapter 5: Fourier Series (2-3 weeks): Basic properties, convergence, differentiation;
- Chapter 6: Harmonic Functions (2 weeks): 2-D PDEs: separation of variables
- Chapter 8: Computation of solutions (1-2 weeks): Numerical methods for PDEs.

Teaching Methodology

This is a hybrid course, half classroom and half online. It will meet on Mondays for classroom instruction with additional course activities being satisfied online. This course is similar to an online course except that students are required to come to class on campus once each week. Every week you will have a lecture to read followed by some practice problems. You must read the materials before the classes. We will meet every Monday to summarize the key points and to discuss some practice problems and any question you might have. These meetings will be primarily to see the student progress, question/answer session, lectures and examinations. Students should be prepared to read the posted lectures outside of class time in order to learn most of the material. All course documents, course information, and individual grade reports will be available online throughout the semester on the Blackboard course site. Additional information on course content are posted on the course website, so please check there for details. Students will be expected to attend lectures, participate in discussions, and complete the written homework.

Homeworks

Homework problems and their due dates will be posted on the course webpage as we proceed (There are approximately 12 problem sets). A problem set is handed out every week, and due in class on the session of the following week. Homework outlined on the course syllabus will be set each Monday and due the following Monday unless otherwise notified. Read each section and do homework weekly as assigned. Late assignments will not be accepted. An assignment will be considered late if it is not handed in by the end of the class period on the day that it is due. All homework should be an individual effort. I will set reading one week before each class, and start each class with time for questions on the reading, current assignments and such. In order to fully understand the material covered in lecture, you are strongly encouraged to work on all the homework problems. If you have difficulties with any of the assigned problems or any other problems in your textbook please see me as soon as possible. It is suggested that you start to work on homework problems right after they are assigned. When computing the final grade for each individual at the end of the semester, the lowest 2 homework assignment grades will be dropped to allow for occasionally missing a class for whatever reason.

Mid-Term/ Final

There will be 2 mid-term exams and a comprehensive final exam. Make-up exams will only be given in exceptional circumstances, and then only when notice is given to me in advance with a suitable written excuse. Dates are listed on the course website Exams will be closed book and closed note, unless otherwise stated.

- First Midterm Exam: Monday, Sep 28
- Second Midterm Exam: Monday, Nov 2
- Final Exam: Wednesday, December 16, 5:30 - 7:30.

Grading and Evaluation Criteria

Students are expected to do reading and assignments as they are assigned. Graded work will include homework problems, 2 mid-term exams and a final exam. The final grade will be calculated using the following weights: mid-term 30% (15% *each*); final 20% and homeworks 50%. Also, special activity

points will be awarded to students for active participation in class, solving problems, finding typos in my notes, or pointing out my mistakes. You may get up to 5% activity points to be added to your total score. Percentages of at least 90, 80, 70, 60 guarantee grades of at least A-, B-, C-, D- respectively. The instructor will decide upon A-, B-, C-, and D- letter grades individually based upon points earned, attendance, class participation, evidence of a student's effort and improvement over the course of the semester.

Make-up Policy

If a student fails to take an exam or fails to hand in an assignment on time, his/her score is zero unless the reasons are beyond the student's control. Make-up exams will only be given under exceptional circumstances, such as in the incidence of a serious illnesses or dire family emergency. In the incidence of such an emergency, the student must make every effort to inform the instructor of his or her request to take a make-up exam before the start of the scheduled exam. For an excused absence from a test, the final exam will substitute for that test grade. Unexcused absences will result in a zero score.

Attendance

It is very important to attend lecture in this course, as lectures will involve demonstrations, classroom activities, and discussion of material not covered in the textbook. Students are expected to attend every class meeting and to arrive on time. If a student is absent from class, he/she is responsible for all material, announcements and assignments missed. I will not check attendance, but you are responsible for knowing what happens in each class including assignments, information about test topics, and due dates. Thus if you miss a class, check for news, either from a classmate or from me: checking the course web page should also help.

Honor

Students may study together but when doing their homework, take-home or in-class exams, they must do it completely alone. The honor code applies to all graded work in this course. Copying from others, either from fellow students or off the internet, or from any other source, except as expressly indicated by me in writing and fully documented, is strictly forbidden and may constitute grounds for failure.

Note

I will make every effort to make this course enjoyable and profitable to you. However, you must make the effort to learn. For example, you should study your notes, read your text, and use the library without being reminded. Note that you may need more than the minimum 6 hours per week. If you are not making sufficient progress at 6 hours per week, I will expect a higher weekly commitment (7,8 hours). Your overall time commitment to this course should be around 8 to 10 hours per week. Any student with special needs or circumstances should feel free to meet with me during office hours or to schedule an appointment. You are welcome to discuss with me any questions or concerns about the course during my office hours or by appointment.

Accommodations are provided for students with verified disabilities. For more information contact Services for Students with disabilities in EAB 117 or 554-2872, TTY 554-3799.