UNIVERSITY OF NEBRASKA AT OMAHA

MATH 4330/8336: Introduction to Partial Differential Equations

MW 5:30 PM – 6:45 PM | Dr. Baccouch

Definition: A partial differential equation (PDE) is an equation which imposes relations between the various partial derivatives of a multivariable function.

Overview of Content and Purpose: This course introduces the basic methods of partial differential equations (PDEs) guided by applications in physics and engineering. The main topics to be covered include; The Linear First-order PDEs, Transport equations, Characteristics, Classification of PDEs, Separation of variables, Fourier series, Heat conduction, vibrating membranes, boundary value problems, Maximum principle, Sturm-Liouville problems, Fourier series, Fourier integrals, Harmonic functions, Legendre polynomials, Distributions; Green's functions. This corresponds to Chapters 1 to 7 of the textbook.
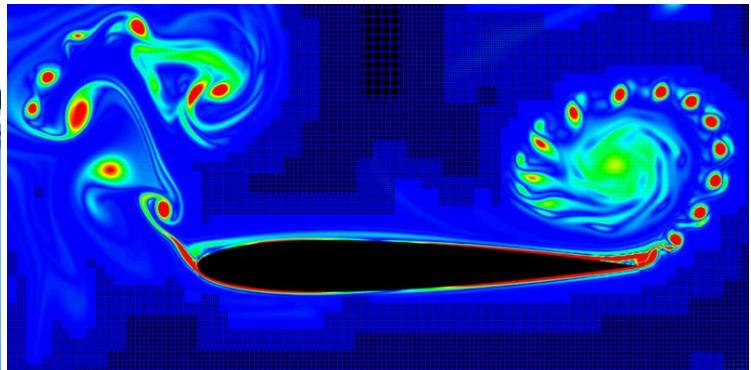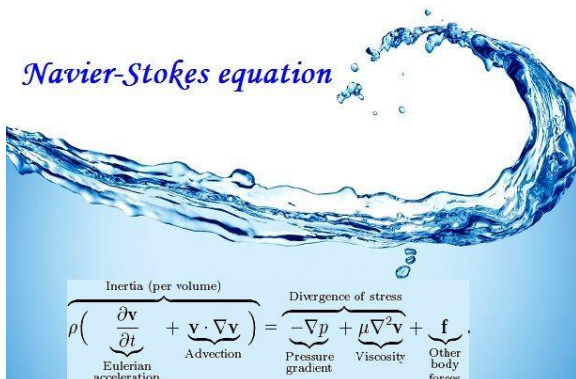
Course Description: This course introduces the basic methods of PDEs guided by applications in physics and engineering. PDEs play important roles in pure and applied mathematics. They are at the heart of applied mathematics and many other scientific disciplines. In fact, many PDEs come from Chemistry, 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.

Prereq: MATH 1970 and MATH 2350. Other topics will be introduced as needed.

Basis for Evaluating Student Performance: Grades will be based on homework and exams.

Teaching Methodology: This course will be presented by lecture, class discussion, and questions. Questions are encouraged in class and out.

Textbook: Walter A. Strauss. Partial Differential Equations, An Introduction, 2nd Edition (2008); Publisher: John Wiley and Sons. New York; ISBN: 978-0-470-05456-7

Navier-Stokes equation

$$\rho \left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla p + \mu \nabla^2 \mathbf{v} + \mathbf{f}$$

Inertia (per volume): $\rho \left(\underbrace{\frac{\partial \mathbf{v}}{\partial t}}_{\text{Eulerian acceleration}} + \underbrace{\mathbf{v} \cdot \nabla \mathbf{v}}_{\text{Advection}} \right)$ = Divergence of stress $\underbrace{-\nabla p}_{\text{Pressure gradient}} + \underbrace{\mu \nabla^2 \mathbf{v}}_{\text{Viscosity}} + \underbrace{\mathbf{f}}_{\text{Other body forces}}$

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