8/23

**Section:** 1.1  
**Agenda:** Review of course policies. Introduction to ODEs. The order of an ordinary differential equation. Autonomous and nonautonomous equations. First-order linear and nonlinear equations. The \( n \)-parameter family of solutions to an ODE of order \( n \). The origins of ODEs in mathematical modeling. Radioactive decay and the motion of a mass on a spring.

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**Sections:** 1.1.2, 1.2, 1.3.2, 1.3.1  

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**Sections:** 1.3.1, 1.1.1, 2.1  
**Agenda:** Particle mechanics. The equations of motion in the forms

\[
m\ddot{x}_i = F_i(t, x, \dot{x}) \quad \text{and} \quad m\ddot{v}_i = F_i(t, v), \quad i = 1, 2, 3.
\]

The falling body in the viscous fluid. Conservation of energy. The Hamiltonian

\[
H(x, \dot{x}) = \frac{1}{2}m\|\dot{x}\|^2 + f(x).
\]

Derivation of the pendulum equation via conservation of energy. The initial value problem. Separable equations.  
**Assignment:** Section 1.1, problems 2-5, 7, 8. Section 1.2, problems 2, 3, 6-8. Show that

\[
\frac{d}{dt} H(x(t), \dot{x}(t)) = 0.
\]

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**Sections:** 2.2, 1.3.4  
**Agenda:** Writing guidelines. First-order, linear equations. The solution to the homogeneous linear equation. The variation-of-parameters method for the inhomogeneous equation. The structure theorem. Newton’s law of cooling: \( T' = -h(T - T_e) \) for a positive constant \( h \). Note that the equation is both linear and autonomous.  
**Assignment:** Section 2.2, problems 1, 2, 3, 5, 6, 10, 11. Section 1.3.4, problems 1-3.
9/6  Sections: 1.3.4, 1.3.5, 2.3.1
Assignment: Section 1.3.5, problems 1,2,5,6. Don’t nondimensionalize.
Due: Section 2.2, problems 6,10, and section 1.3.4, problems 1,2, are due on Thursday, 9/8.

9/8  Sections: 2.3.1
Assignment: Section 1.2, problem 9, section 2.1, problem 9, section 2.2, problem 21, section 2.3, problems 1 and 2.

9/13 Sections: 3.2, 3.4

9/15  Agenda: The Wronskian determinant. Linear dependence of solutions implies that the Wronskian is zero. Linear independence implies that the Wronskian is never zero. The general solution to LHE is

\[ u(t) = c_1 u_1(t) + c_2 u_2(t), \]

where \( u_1 \) and \( u_2 \) are independent solutions. Solving the initial value problem for LHE.
Assignment: 2.2, problem 21 and 2.3, problem 2, are due on Thursday, 9/22.

9/20  Agenda: How to find linearly independent solutions to the second-order, linear, homogeneous equation \( Lu = 0 \). The method of reduction of order for finding a second solution given a first. Finding two solutions using the characteristic equation when \( L \) has constant coefficients.

9/22  Sections: 3.4.1, 3.4.2
9/27  Sections: 3.4.4
   Agenda: The second-order, linear, inhomogeneous equation. The general solution. Finding a particular solution by the method of variation of parameters.
   Assignment: Section 3.4 (pages 115-117) do problems 1, 2, 8, 11, 12, 14, 16 and 17.
   Notes: Exam 1 will be on Thursday, 10/6. It will cover first and linear, second-order equations.

9/29  Section: 4.1
   Agenda: Introduction to the Laplace transform. Transforms of \( \exp(at) \) and \( t^n \). Piecewise continuous functions of exponential order.

10/4  Section: 4.2

10/6  Agenda: Exam 1.

10/11 Sections: 4.2, 4.3
   Agenda: Inverting Laplace transforms. Partial fractions and inverse Laplace transforms. Using the Laplace transform to solve initial value problems for linear, constant-coefficient equations with \( t_0 = 0 \). Convolutions.
   Assignment: In section 4.1, do problems 4, 6, 7, 8, 12, 13, 14. In section 4.2, do problems 1, 2, 3.

10/13 Section: 4.3

10/20 Sections: 4.4, 4.5
   Assignment: Section 4.4, problems 1-7. Hand in 5 and 6 on Tuesday, 10/25.

10/25 Sections: 4.5, 5.1
   Assignment: Section 4.5, problems 1-6. Hand in 3,5 and 6 on Tuesday, 11/1.
   Notes: Exam 2 will be on Tuesday, 11/15.
11/1  Section: 5.1  

11/3  Section: 5.2  
**Agenda:** Matrix theory, continued. The $n \times m$ matrix as a *linear* mapping from $\mathbb{R}^m$ to $\mathbb{R}^n$. The null space, or kernel of a matrix. Solvability of the $n \times n$ system $Ax = b$. Gaussian elimination.

**Assignment:** Section 5.2, problems 1-6.

11/8  Sections: 5.2, 5.3  
**Agenda:** Gaussian elimination. Linear independence and dependence. Vector-valued functions. $n$-dimensional linear systems. Existence and unicity for the initial value problem. The general solution. Superposition for homogeneous linear system.

**Assignment:** Read pages 174-5. In Section 5.2, do problems 11-14 and 16-18.

11/10  Sections: 5.2, 5.3  
**Agenda:** The $n$-dimensional linear system, continued. We proved three results:

1. $n$ vectors in $\mathbb{R}^n$ are linearly independent if and only if their determinant is zero.

2. $n$ solutions $\{U_1(t), \ldots, U_n(t)\}$ to the $n$-dimensional linear system $X' = A(t)X$ are independent for all $t$ if and only if they’re independent at a single point.

3. Let $\{U_1(t), \ldots, U_n(t)\}$ be $n$ linearly independent solutions to the $n$-dimensional linear system $X' = A(t)X$. Then the general solution is $c_1U_1(t) + \cdots + c_nU_n(t)$.

**Notes:** Tuesday’s exam will cover Laplace transforms material from 5.1 and 5.2.

11/15  **Agenda:** Exam 2.

11/17  Section: 5.3  
**Agenda:** The $n$-dimensional, homogeneous, constant-coefficient, system $x' = Ax$. Eigenvectors and eigenvalues.

11/22  Section: 5.3  
**Agenda:** The $n$-dimensional, homogeneous, constant-coefficient, system $x' = Ax$. Solutions of the form $e^{\lambda t}v$, where $(\lambda, v)$ is an eigenpair.

**Assignment:** Section 5.3, problem 1.
Section: 5.3

Agenda: Solving the two-dimensional system $x' = Ax$. Real, distinct eigenvalues. Complex eigenvalues. The single eigenvalue case. The phase plane.

Assignment: Section 5.3, problems 2 and 3.

Words: Congeries

12/1

Section: 5.3


Assignment: Section 5.3, problems 4-10.

Notes: The final exam will be given Wednesday, 12/14, 10:00-12:00.

12/6

Section: 5.3

Agenda: The nonhomogeneous system $x' = A(t)x + f(t)$. The fundamental matrix. The general solution. The variation-of-parameters formula. The initial value problem.

Assignment: Section 5.4, problems 1-6.

Notes: The final exam will be given Wednesday, 12/14, 10:00-12:00.

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Sections: 6.2, 6.3

Agenda: Euler’s method. Nonlinear systems. Linearization about an equilibrium point.

Words: Meretricious

Notes: The final exam will be given Wednesday, 12/14, 10:00-12:00.