Preliminary Course information:

- Course Website and Course Calendar:
  http://caam.rice.edu/~caam336

- Piazza forum for questions + answers

- Grading policy for the course is strict. The answer is not enough! You must communicate that you understand the problem and reasonably justify your conclusion. This is an important skill for science and engineering in the real world.

- The TA sessions are vital to your success in the course. These sessions should focus on concrete problem solving. Concepts + techniques will be the focus of lecture.

- Lecture notes, references, and resources will be posted on the course website. See: CAAM 336 website → click on "references" link

- Matlab will be an important part of the course. There is a link to a matlab tutorial / primer under the reference material for lecture #1 on the website

- Another section of CAAM 336: M1OF: Instructor is Dr. Jesse Chan. Instructor: Dr. Chan

- My office Hours: T/Th 2-3pm Duncan 2038
  Dr. Chan's office Hours: M/W 2-3 Duncan 3023
  The course TA will also have an office Hour.
  * You are welcome to go to anyone's office hour. However if you need to make an individual appt please do so with your instructor.

- Homework: posted at 5pm every Wednesday on the course website
  - the due date will be noted
  - turn in during lecture or to your instructors mailbox (bottom floor of CAAM Dept - what Room?)
  - Rigorous, well explained solutions are expected. You may collaborate on homeworks and programming assignments but you must write up your own solutions in your own words. Transcribed solutions or code will not be allowed.
  - Please write the name of your residential college on your homework.
  - Exam dates and details, along with practice Exams, will be posted on the website. Exams will be common to both sections.

Chapter #1: Classification of Differential Equations.

Q: What is a differential Equation?

A: An expression specifying a relationship between an unknown function, its derivatives, and coefficients. A solution is any function satisfying the expression.

Example: $2_t u(x,t) + 3\, 2_x u(x,t) = 0$

Just like in algebra solutions need not be unique.

Example: $\frac{4x}{3}$ = an even number has infinitely many solutions: $\frac{4x}{3} = 2n \Rightarrow x = \frac{3n}{2}$ $n = 1, 2, 5, \ldots$

but: $\frac{4x}{3}$ = "an even number between 0 and 2" has only one solution corresponding to $n=1$.

- Types of Differential Equations:
  The taxonomy of differential equations has several broad, important categories:

  - Ordinary diff eqn: a diff eqn for an unknown function of a single variable: ex: $\frac{d}{dt} y(t) = a y(t)$

  - Partial diff eqn: a diff eqn for an unknown function of several variables: ex: $\partial_t u(x,t) + a\, \partial_x u(x,t) = 0$

  - Order of a diff eqn: The order of the highest derivative appearing in the equation.

  - Linear diff equation:
    Ex: $a(t) \frac{d^2 u(x,t)}{dt^2} + c(x) \frac{d}{dx} u(x,t) + u(x,t) = f(x,t)$
    is a second order linear PDE:
    $i7\, d^3/dt^3\, u(t) + \frac{d}{dt} u(t) = 0$
    is a third order linear ODE

  - Nonlinear diff equation: $\frac{d^2 x}{dx^2} u + u \frac{d}{dx} u = 0$ is a nonlinear second order ODE.

  - Homogeneous / Inhomogeneous: A diff eqn for which the zero function $u=0$ is a solution is called homogeneous otherwise it is called inhomogeneous.
    Ex: $a \frac{d}{dx} u + b \frac{d}{dt} u = 0$ is homogeneous but
    $a \frac{d}{dx} u + b \frac{d}{dt} u = f$ is inhomogeneous.

  - Constant and non-constant coefficients: The terms in front of the derivatives are called the coefficients of the equation. If these coefficients are numbers then the equation has constant coefficients. Otherwise these are called non-constant coefficients.
    Ex: $\partial_t u + 7 \partial_x u = 0$ v.s. $\partial_t u + (3xt)\, \partial_x u(x,t) = 0$
    Q: $\partial_t u + u \partial_x u = 0$ what type of coefficient?

- **Systems of differential Equations:**

Sometimes several differential equations appear together and involve the simultaneous solution of numerous unknown functions:

Ex: $x_1(t)$, $x_2(t)$, $x_3(t)$ unknown functions of t.

$$\begin{cases} \frac{d}{dt} x_1(t) = 3x_1 + 7x_3 \\ \frac{d}{dt} x_2(t) = -x_2 - 4x_1 \\ \frac{d}{dt} x_3(t) = x_1 + x_2 + x_3 \end{cases}$$

is a system of first order linear equations. Expressed in matrix form this is:

$$\frac{d}{dt}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 3 & 0 & 7 \\ 0 & -1 & -4 \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \rightarrow \vec{x}'(t) = \mathbf{A}\vec{x}(t)$$