What will we learn in Math 2552 Differential Equations?

- **1st order lin eq:** $y' + a(t)y = b(t)$
  solution method (integrating factor)

- **1st order separable eq:** $y' = g(t)f(y)$
  solution method (separating variables)

- **1st order autonomous eq:** $y' = f(y)$
  solution method (separating variables).
  stability & instability, behavior of $y(t)$ as t evolves.

- **1st order lin systems of const coeff's:**

  Homogeneous systems $\vec{\mathbf{x}}' = A\vec{\mathbf{x}}$
  $\begin{cases} \text{solution method (eigenvalues and eigenvectors).} \\ \text{stability/instability} \end{cases}$

  Non-Homogeneous systems $\vec{\mathbf{x}}' = A\vec{\mathbf{x}} + \vec{\mathbf{f}}(t)$
  solution method (variation of parameters)

- **2nd order lin eq of const coeff's:**

  Homogeneous eq $ay'' + by' + cy = 0$
  $\begin{cases} \text{solution method (characteristic roots).} \\ \text{stability/instability} \end{cases}$

  Non-Homogeneous eq $ay'' + by' + cy = f(t)$
  solution methods (undetermined coefficients, variation of parameters)

- **An Alternative Method:** Use the *Laplace transform* to solve
  $\begin{cases} n\text{-th order lin eq with const coeff.} \\ \text{1st order lin sys with const coeff.} \end{cases}$

- **1st order nonlin systems:**

  Stability problem.

  Construct lin approximation near equilibria.

- **Many applications, real world problems**

Heating/cooling,	Brine/salt in tanks,
Mechanical vibrations,	Electric circuits,
Population dynamics,	Ecological models (competitions, prey-predator),
.....,	even Romeo & Juliet will be modeled by diff eqs!

What about more general problems?

The following equations have no general solution methods.

$y' = f(t, y), \quad y'' = f(t, y, y')$
$\vec{\mathbf{x}}' = A(t)\vec{\mathbf{x}}, \quad \vec{\mathbf{x}}' = A(t)\vec{\mathbf{x}} + \vec{\mathbf{b}}(t)$
$\vec{\mathbf{x}}' = \vec{\mathbf{f}}(\vec{\mathbf{x}})$

We will have some discussions about them, but not that extensively.

For **More Advanced Theory**,

$\Longrightarrow$ Take Math
- 4347,4348 (PDEs)
- 4541,4542 (dynamical systems)
- 4581 (Fourier series and boundary value problems)
- 6307,6308 (advanced theory of ODEs)
- 6341,6342 (advanced theory of PDEs)
- 6705 (modeling & appl)
- 6646 (numerics)

See the following webpages for more info about these courses:

`http://www.math.gatech.edu/academics/undergraduate/projected-schedule`

`http://www.math.gatech.edu/academics/graduate/projected-schedule`