UNIVERSITY OF
WATERLOO

MTE202 - ORDINARY DIFFERENTIAL EQUATIONS
Mathematical Modelling (Lecture 10)

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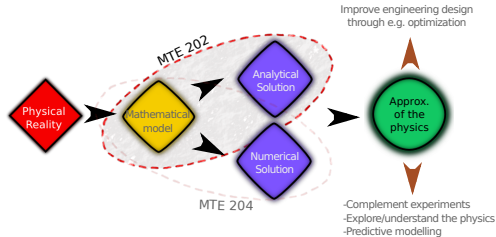Mechanical and Mechatronics Engineering

TODAY'S LECTURE

- ► We take a step outside of MTE202.
- ► Discuss mathematical modelling within a broader engineering context
- ► Links together engineering/design, mathematics, and physics

Lecture plan:

- ► Contextualize mathematical modelling
- ► Key Principles of mathematical modelling

MATHEMATICAL MODELLING

- ► The ability to develop mathematical models is (IMHO) **one of the most important skills for an engineering undergrad**
- ► The solution strategies to ODEs are tools, modelling is the assumption, **physical understanding is the objective**
- ► Modelling is used to study heat transfer, fluid dynamics, material science etc. (..and banking and finance, quants?)

BACKGROUND

- ► Generally, we need to create mathematical models from our physical understanding of a problem
- ► The problem is rarely defined in mathematical terms
- ► Often contains incomplete information, ambiguities, too much/too little information
- ► Need to use engineering intuition to focus on what is relevant and make judicious assumptions
- ► Skills are transferable/generalizable (to other classes and/or other fields). The general approach towards mathematical modelling remains the same!
- ► Problems seen in MTE202 will be academic/simple. The approach to a real problem is analogous.

KEY PRINCIPLES OF MATHEMATICAL MODELLING

- ▶ Dimensional Homogeneity and Consistency
  - The dimensions of a mathematical model must be consistent. If we model an equation for the mass balance of a system, all the terms must have dimensions of mass. Units must also be consistent.
- ▶ Abstraction and Scaling
  - The model should have the correct level of detail and abstraction for the desired output.
- ▶ Conservation and Balance Principles