UNIVERSITY OF WATERLOO

MTE202 - ORDINARY DIFFERENTIAL EQUATIONS

Mathematical Modelling (Lecture 8)

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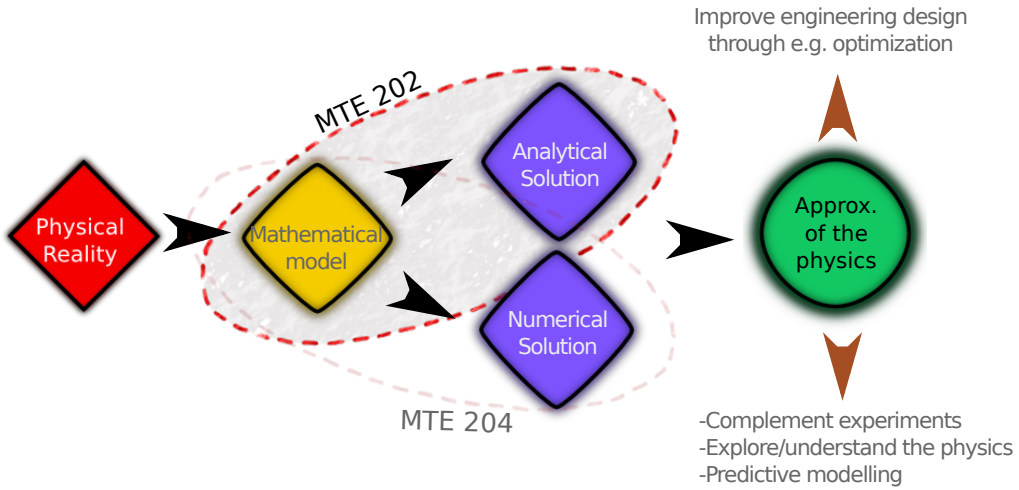
TODAY'S LECTURE

- 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 identical.

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