Sensors & Actuators In Mechatronics

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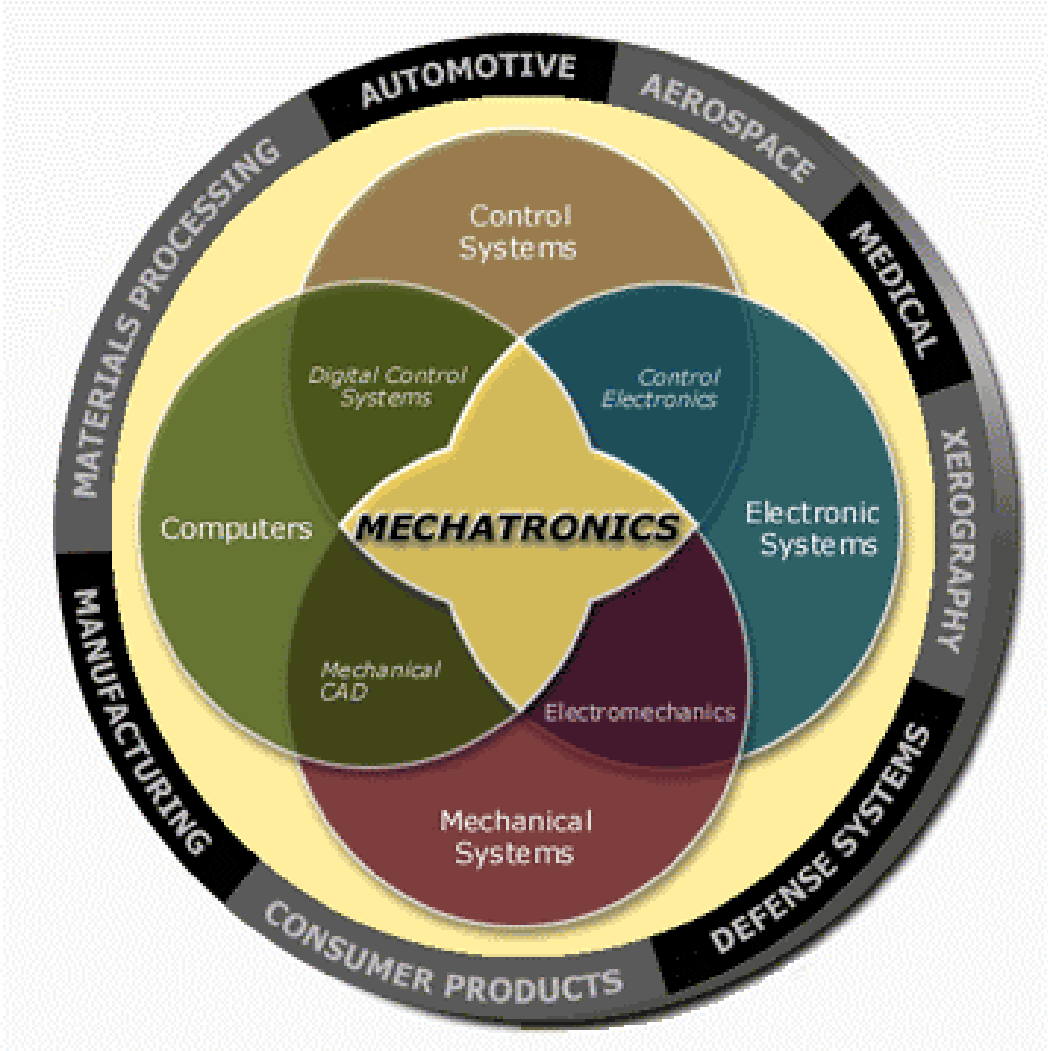
What is Mechatronics ?

Mechatronics is the ***synergistic*** combination of mechanical engineering, electronics, controls engineering, and computers, all ***integrated*** through the design process.



The Design Challenge

The cost-effective incorporation of electronics, computers, and control elements in mechanical systems requires a new approach to design.

The modern engineer must draw on the synergy of

Mechatronics

Difficulties in Mechatronic Design

- Requires System Perspective
- System Interactions Are Important
- Requires System Modeling
- Control Systems Go Unstable

Balance: The Key To Success

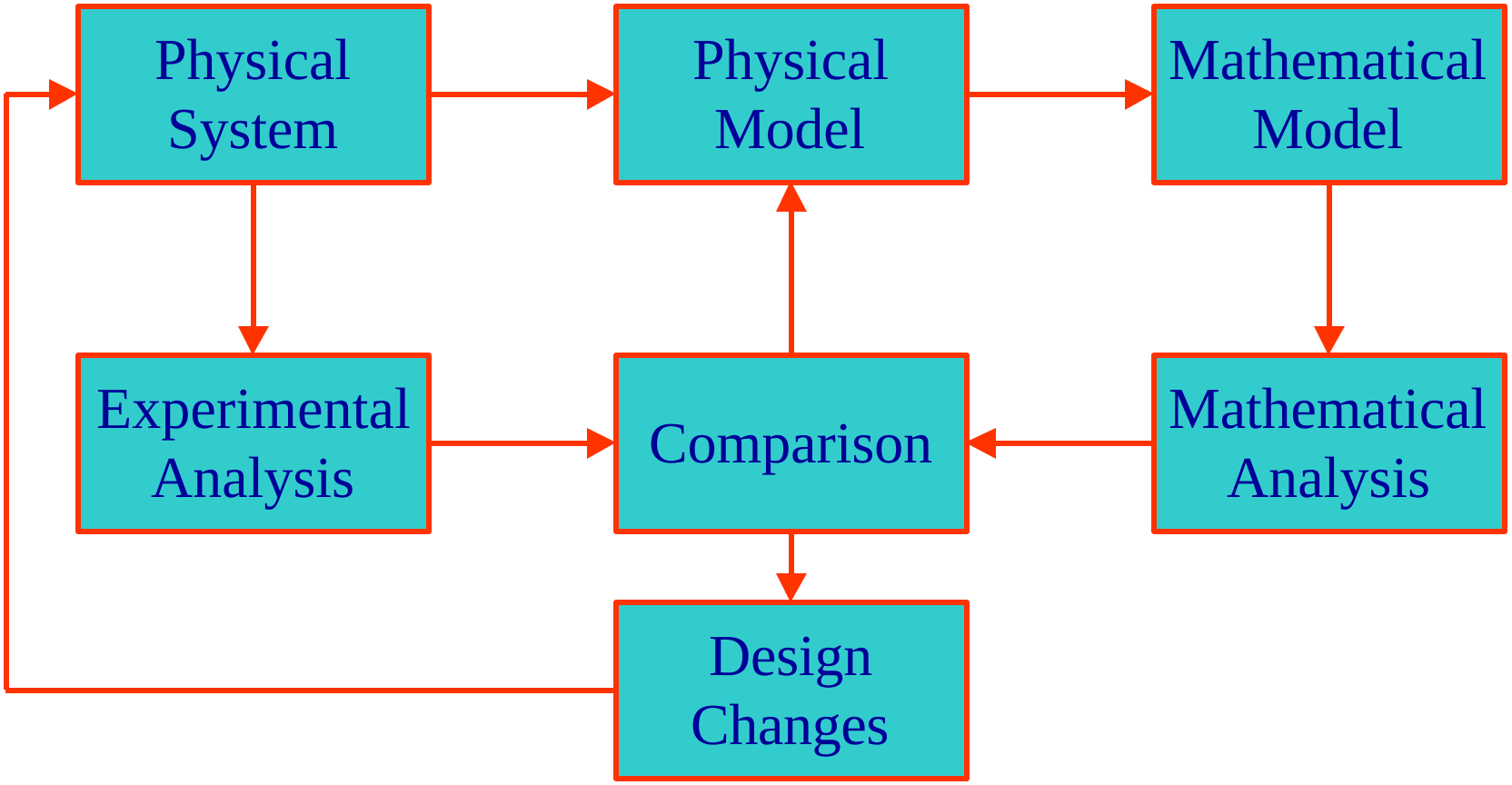
Modeling, Analysis, & Control Design

Experimental Validation & Hardware Implementation

The Mechatronic Design Process

Computer Simulation Without Experimental Verification Is At Best Questionable, And At Worst Useless!

Dynamic System Investigation



Realm of Mechatronics

- High Speed
- High Precision
- High Efficiency
- Highly Robust
- Micro-Miniature

Mechatronic Design Concepts

- Direct Drive Mechanisms
- Simple Mechanics
- System Complexity
- Accuracy and Speed from Controls
- Efficiency and Reliability from Electronics
- Functionality from Microcomputers

Think System !

Mechatronic Areas of Study

- Mechatronic system design principles
- Modeling, analysis, and control of dynamic physical systems
- Selection and interfacing of sensors, actuators, and microcontrollers
- Analog and digital control electronics
- Real-time programming for control
- Advanced topics, e.g.,
  - fuzzy logic control
  - smart materials as sensors and actuators
  - magnetic bearings

Challenge To Industry

- Control Design and Implementation is still the domain of the specialist.
- Controls and Electronics are still viewed as afterthought add-ons.
- Electronics and Computers are considered costly additions to mechanical designs.
- Few engineers perform any kind of modeling.
- Mathematics is a subject not viewed as enhancing one's engineering skills but as an obstacle to avoid.
- Few engineers can balance the modeling\analysis and hardware implementation essential for Mechatronics.

Course Topics

- Fundamentals of Electromechanical Motion Devices (2 periods)
- Direct-Current Motors (1 period)
- Stepper Motors (1 period)
- Brushless DC Motors (1 period)
- Fundamentals of Fluid Power: Modeling, Analysis, and Control (1 period)
- Hydraulic Actuators (1 period)
- Pneumatic Actuators (1 period)
- Sensors & Measurement Systems (1 period)
- Analog & Digital Motion Sensors (3 periods)
- Motion Control Systems (1 period)

Course Objectives

- Understand the fundamental concepts of electromechanics and fluid mechanics (hydraulics and pneumatics).
- Apply these fundamental concepts to the modeling, analysis, and control of brushed dc motors, stepper motors, brushless dc motors, solenoids, and hydraulic and pneumatic actuators.
- Understand the key elements of a measurement system.
- Understand the basic performance specifications of analog and digital sensors and actuators.
- Become familiar with the operating principles and physical/mathematical models of a variety of analog and digital motion sensors.

- Understand the key issues in hardware implementation of analog and digital actuators and sensors.
- Become proficient in the use of MatLab/Simulink to model and analyze actuators and sensors for use in mechatronic systems.
- Understand what comprises a mechatronic motion control system and the key elements in its design.

Assessment

- <u>Homework Assignments</u>
  - 10 assignments will be given during the course.
  - Students will have 2 weeks to complete each assignment.
  - They are to be **individually** and **professionally** done and handed in. Collaborative discussion (Not Copying!) on homework assignments is permitted and encouraged.
  - MatLab / Simulink (and some Toolboxes) will be used in the solution of some of these assignments.
  - The assignments will be graded and will count 75% (10 @ 7.5% each) of the final grade.

- Regarding late assignments, all reasonable excuses will be accepted provided they are discussed with the instructor **prior** to the due date for the assignment.

- Final Examination
  - There will be a closed-book, closed-note, final exam covering the entire course. It is worth 25% of the final grade. It will focus on the fundamental concepts studied in the course.

- Grade Summary
  - Homework Assignments (10 @ 7.5%) 75%
  - Final Exam 25%