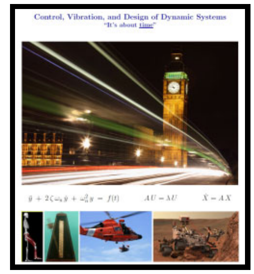
Control, Vibration, & Design of Dynamic Systems

"It's about time" – Paul Mitiguy



This textbook assists instructors who teach dynamic systems to upper-level undergraduate and graduate students majoring in mechanical, aerospace, robotics, or biomechanical engineering. Engineers equipped with the tools in this textbook are prepared for advanced studies in controls and have basic professional skills to build and control electromechanical systems.

Instructors who adopt this textbook tend to agree with the following.

- Review of previous knowledge makes new material easier to learn.
- Mathematics plays an important role in designing and analyzing real systems.
- Real problems and applications make textbooks interesting.
- Physical intuition is developed by exposure to non-intuitive phenomena.
- Learning primarily occurs by **doing**, e.g., doing homework and laboratory exercises.
- Interactive engaging teaching (classroom demonstrations, voting on multiple-choice questions, and encouraging students' questions and feedback) is more effective than grinding through theory and proofs.
- Open dialogue means answering questions such as "what's the point" and "who cares".
- Students have a much greater conceptual and physical understanding of how to design and control electromechanical systems when their design tools are first introduced in the **time**-domain. In short, students have a much clearer understanding of time t than of the complex variable s.

Advantages of this textbook

This textbook uses instructional techniques that are effective and compelling. Although many techniques are familiar, this textbook provides innovative enjoyable advantages to current textbooks.

1. **Homework problems**

   This textbook focuses on **what students do**, namely homework. This textbook's most innovative feature is its **120$^+$** pages of homework where meaningful problems are synthesized via small intelligible steps. Many instructors are keenly aware that a student's interaction with a technical textbook is dominated by homework.

   Students are motivated to learn when they solve interesting problems that make the topic relevant. Instead of short questions and quick "trick" answers, many problems lead students **step-by-step** through a complicated procedure so they **synthesize** the problem-solving **process** and ultimately arrive at a physically significant and satisfying result.

   Students are also motivated when they acquire skills that are relevant to their professional lives. This textbook's problems are from a wide range of engineering applications including robotics, biomechanics, mechatronics, computer graphics, aerospace, automotive, machine design, controls, etc.

2. **Interactive approach**

   Teaching techniques adapt and evolve with each generation of students. With ***interactive*** lectures, labs, and homework, students have sustained concentration and develop insights through interaction. To overcome weaknesses in focused concentration for abstract concepts, this textbook involves the student during homework and labs - requiring their constant attention and feedback.

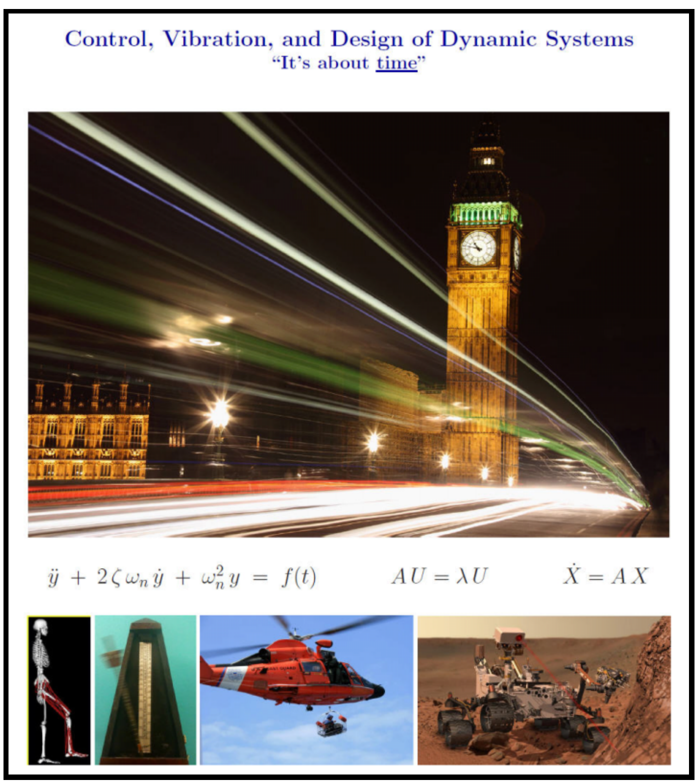
   In the past, students attended class, furiously scribbled copious notes into a notebook, and only reviewed their lecture notes or textbook to complete their assignments. The new techniques in this textbook motivate students to:

   - Attend class to see classroom demonstrations and complete their textbook/lecture notes.
   - Interact with instructors and classmates, e.g., voting on multiple choice questions.

- Actively ***think*** rather than simply read, copy, and organize diffuse information.
- Digest important concepts rather than passively listen to abstract mathematical proofs.
- Do system identification, systems analysis, and control-system design.
- Develop intuition about the time-dependent nature of dynamic systems.
- Gain physical insights into basic principles with simple experiments.
- Develop a hands-on, minds-on, can-do attitude.

3. **Instructor and student resources:** **www.MotionGenesis.com** ⇒ **Textbooks** ⇒ **Resources**
   - Laboratory and Working Model simulation files.
   - In-class student worksheets that directly correlate to student and instructor textbooks.
   - Fill-in-the-blank homework problem for in-class or at-home use.
   - Videos to help motivate topics.

4. **Optional: Interactive professional visualization and analysis software**
   To enhance the students' understanding, interest, and skill in dynamic systems, the textbook provides additional resources including laboratory experiments and professional simulation software (Working Model, **M**otion**G**enesis, MATLAB®, WolframAlpha, ...). In addition to acquiring valuable professional skills, students are exposed to basic numerical methods. For example, the time-dependent behavior of dynamic systems is demonstrated by solving linear and nonlinear differential equations and computing eigenvalues and eigenvectors. No prior knowledge of numerical methods is required.[1]



[1] ***Working Model*** is an easy-to-use computer simulation program that allows students to rapidly explore "what if" scenarios. ***MotionGenesis*** and other symbolic manipulators such as Maple and Mathematica allow an engineer to focus on their relevant concerns of analysis, design, and optimization, by dramatically reducing the amount of tedious algebra and simplification associated with solving linear and nonlinear *algebraic* and *differential* equations and computing eigenvalues and eigenvectors.