Instructor

Kevin C. Craig, Ph.D., Professor of Mechanical Engineering, Rensselaer Polytechnic Institute
B.S., 1973, United States Military Academy, West Point, NY M.S., 1977, M.Phil., 1981, Ph.D., 1986, Columbia University, NY

Professor Craig teaches and performs research in the areas of mechatronic system design, control systems, modeling, dynamics, and the study of active materials and their application in design.
He has developed the Mechatronics Program at Rensselaer which includes an extensive teaching and research laboratory, two senior-elective/1st-year graduate courses, Mechatronics and Mechatronic System Design, and the graduate courses Sensors and Actuators in Mechatronics and Advanced Mechatronics.
Over the past dozen years, he has conducted hands-on, integrated, customized, mechatronics workshops for practicing engineers at Xerox, Pitney Bowes, Dana, Procter & Gamble, Plug Power Fuel Cells, NASA Kennedy Space Center, U.S. Army ARDEC, and for the ASME Professional Development Program. Since coming to Rensselaer in 1989, Craig has graduated 33 M.S. students and 19 Ph.D. students. He is the author of over 30 refereed journal articles and over 50 refereed conference papers. Emphasis in all his research is on a balance between modeling/analysis/simulation and hardware verification/implementation. He is a fellow of the ASME and a member of the IEEE and ASEE. He received the 2006 RPI School of Engineering Education Excellence Award and the 2006 RPI Trustees' Outstanding Teacher Award.

Location

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Information

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Enrollment procedures

Enrollment fee: **1600 Euro (+ VAT 20 %)**.

The fees include participation in the course, lunches, dinners, coffee breaks, in addition to the learning materials.

During the course, direct experience is developed using specific tools (both physical tests and those on computers and workstations, as suited to the number of participants).

The deadline for registration is:

Enrollment form

First and Last Names _____
Title _____
Institution _____
Activities _____
Tel _____
Fax _____
E-mail _____

Information for the invoice letterhead
Corporate name _____
Address _____
Community _____
ZIP Code _____
Prov. _____
VAT number _____
Signature and seal _____
Date _____

The TCN Consortium reserves the right to postpone or cancel the scheduled course, giving timely warning by fax or e-mail to the participants; in which case, it's only obligation is to provide a reimbursement of the received payment, without penalties. Further details about enrollment procedures and the lodging arrangements can be directly requested from the organizing secretary, to whom specific personal requests may also be addressed.

To be faxed to Secretary of the TCN Consortium
Via Galimberti, I-24124 Bergamo
Tel. +39 035 368711 Fax +39 035 362970
Sig.ra Mirella Prestini
Attach a photocopy of a bank statement
Bank transfer to: Cassa Rurale di Trento
Swift Code: CCRTIT2T76A For credit: TCN scarl
IBAN: IT35 S 08304 01804 000003304330 BBAN: S 08304 01804 000003304330

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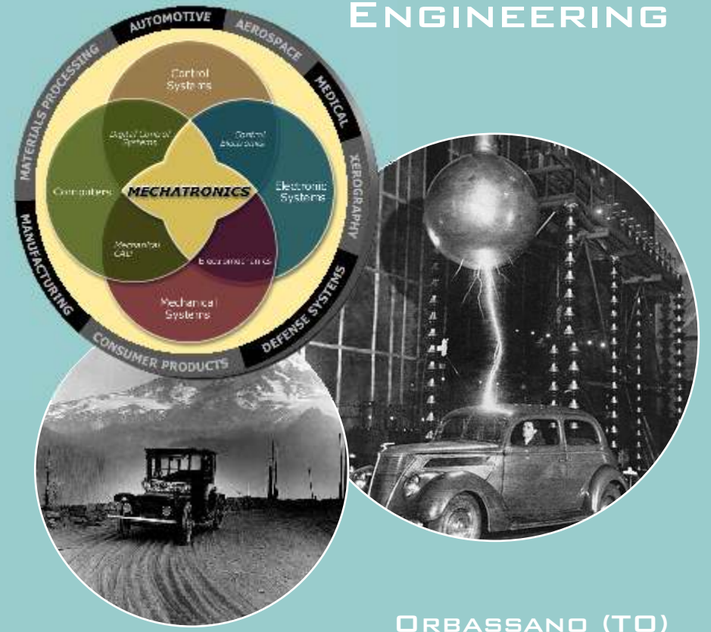
MECHATRONICS

The Practice of Multidisciplinary System Engineering



ORBASSANO (TO)
2007

DR. KEVIN CRAIG
PROFESSOR OF MECHANICAL ENGINEERING
RENSSELAER POLYTECHNIC INSTITUTE

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Course Description

Mechatronics, as an engineering discipline, is the synergistic combination of mechanical engineering, electronics, control engineering, and computers, all integrated through the design process. It involves the application of complex decision making to the operation of physical systems. Mechatronic systems depend on computer software for their unique functionality. This course studies mechatronics at a theoretical and practical level; balance between theory/analysis and hardware implementation is emphasized; emphasis is placed on physical understanding rather than on mathematical formalities. A case-study, problem-solving approach, with hardware demonstrations, either on video or in class, and hardware lab exercises, is used throughout the course. This course covers the fundamental areas of technology on which successful mechatronic system designs are based: physical modeling, from design model to truth model, and mathematical modeling of dynamic multidisciplinary physical systems; analysis of mathematical models through analysis and computer simulation; measurement systems (analog and digital sensor modeling, analysis, and implementation) for model validation and control; control actuator (electromechanical and fluid) modeling, analysis, and implementation; continuous controller design and real-time analog and digital implementation; analog and digital control and power electronics. Throughout the coverage the focus is kept on the role of each of these areas in the overall design process and how these key areas are integrated, from the very beginning of the design process, into a successful mechatronic system design. Starting at design and continuing through manufacture, mechatronic designs optimize the available mix of technologies to produce quality precision products and systems in a timely manner with features the customer wants. The real benefits to industry of a mechatronic approach to design are shorter development cycles, lower costs, and increased quality, reliability, and performance.

Key Features

- Balance between Theory and Practice
- Integration of Mathematical & Scientific Fundamentals with Industrial Applications
- Customized to the Needs of the Participants from Industry
- Use of Videos & Daily Hands-On Hardware & Software Exercises
- Proven Techniques Developed and Tested in Numerous Workshops for Xerox, Pitney Bowes, Procter & Gamble, Dana, Plug Power Fuel Cells, and NASA
- Testimonial from the Proctor & Gamble Corporate Engineering Technology Laboratory: "The value of mechatronics to P&G is in evaluating concepts, writing performance-based specifications and evaluating designs, evaluating existing systems, and creating the seemingly impossible. It has allowed us to develop machines faster, cheaper, and right the first time. We have developed in-house mechatronics courses based on Professor Craig's workshops for us and he keeps us up to date by teaching an advanced mechatronics course periodically at P&G. We have saved millions of dollars as a result of Professor Craig's numerous workshops for us and the mechatronic approach to design he most effectively teaches and demonstrates."

Course Learning Objective

- Understand the importance of the integration of modeling and controls in the design of mechatronic systems.
- Understand the dynamic system investigation process and be able to apply it to a variety of dynamic physical systems.
- Understand the importance of physical and mathematical modeling (both from first principles and using system identification experimental techniques) in mechatronic system design and be able to model and analyze mechanical, electrical, magnetic, fluid, thermal, and multidisciplinary systems and identify the analogies among the various physical systems.
- Understand and be able to model various nonlinear and parasitic effects in real dynamic systems: backlash, time delay, saturation, Coulomb friction, unmodeled resonances.
- Be able to develop a hierarchy of physical models for a dynamic system, from a truth model to a design model, and understand the appropriate use of this hierarchy of models.
- Become proficient in the use of MatLab/Simulink and LabVIEW to model and analyze nonlinear and linear mechatronic systems.
- Understand the key elements of a measurement system and the basic performance specifications and models of a variety of analog and digital mechatronic sensors.
- Understand the characteristics and models of various electromechanical actuators (brushed dc motor, brushless dc motor, and stepper motor) and hydraulic and pneumatic actuators.
- Understand analog and digital circuits and components and semiconductor electronics as they apply to mechatronic systems.
- Understand the fundamentals of power electronics as it applies to mechatronic system actuators.
- Understand stability (absolute and relative) and performance (command following, disturbance rejection, robustness) as it applies to feedback control systems.
- Understand and be able to apply, with the use of the MatLab and LabVIEW, various control system design techniques: open-loop feedforward control, classical feedback control (rootlocus and frequency response), and state-space control.
- Understand industrial motion control: types of controllers (PID-type control modes and variations), tuning of controllers, and position/velocity control loops with encoders/ resolvers.
- Understand the digital implementation of control and basic digital control design techniques.
- Become proficient in the use of MatLab and LabVIEW to design and analyze analog controllers and verify their digital implementation.
- Have an awareness of more advanced control design techniques, e.g., model predictive control, adaptive control, fuzzy logic control, and multivariable control.
- Be able to implement a real-time controller through the use of National Instruments control hardware and LabVIEW programming.
- Be able to apply all these skills to the design of a mechatronic system.

The true mechatronics engineer is that rare individual who has a genuine interest and ability across a wide range of technologies, and who takes delight in working across disciplinary boundaries to identify and use the particular blend of technologies which will provide the most economic, elegant, and appropriate solution to the problem in hand. Furthermore, he/she is a high communicator who has the knack of being able to enthuse others about technologies outside their own, and hence to break down built-in resistance to the use of alternative approaches. To evaluate concepts generated during the design process, without building and testing each one, the mechatronics engineer must be skilled in the modeling, analysis, and control of dynamic systems and understand the key issues in hardware implementation. This course strives to develop in each student a balance between these. This course studies in depth the key areas of technology on which successful mechatronic designs are based and thus lays the foundation for the students to become true mechatronic engineers.

Course Schedulers

4 Weeks Individual Study with e-mail Assistance by the Instructor

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Modelling and Analysis of Dynamic Systems	Feedback Control of Dynamic Systems	Physical and Mathematical Modelling	Electro-mechanical Mechatronic Actuators	Electronics	Individual Meetings
Electronics and Instrumentation	MatLab and LabVIEW basics	Dynamic Systems Response	Measurement Systems	Control Systems	Individual Meetings
support to study of Fundamentals of Mechatronics	***support to study of Fundamentals of Mechatronics***	Mechatronic Systems Case Studies	Mechatronic Systems Case Studies	Mechatronic Systems Case Studies	

Course Prerequisites

Basic Knowledge of:
- Modeling and Analysis of Dynamic Systems
- Electronics and Instrumentation
- Feedback Control of Dynamic Systems

Intended Recipients

This workshop is intended for professionals with 1-3 years experience in industry who wish to learn how mechatronics and a mechatronic approach to design can enhance their engineering analysis and design skills.

Participants should have a B.S. degree in an engineering discipline, with some previous course work in modeling and analysis of dynamic systems, electronics and instrumentation, and feedback control of dynamic systems.