Courses for Semester #2

Ident. No. (Code)	Course Name	Status	Note
MM21	Distributed and Embedded Real time Systems.	Done	
MM22	Advanced Control Theory	Done	
MM23	Advanced Measurement Systems and Sensors	Done	
Elect.#2*			
MM25	Research Methodology	Done	

*see electives summary

MM: Master in Mechatronics
2: 2nd Semester
1 to 5: Serial No. of Course in the Semester

Distributed and Embedded Real time Systems, FINAL					
Identification number **MM21**	**Workload** 180 h	**Credits** 6 ECTS 3 CH	**Semester** 2	**Frequency of offer** Spring Semester	**Duration** 1 Semester

1	**Courses**	**Contact time**	**Self-study**	**Planed group size**
	Course instruction: 2 HPW Exercise: 2 HPW	4 HPW / 60 h	120 h	20 students

2 Course Description

Mechatronics is the merger of mechanics, electronics and computer concepts (interfacing and programming). This course involves computer interfacing and programming to control mechanical objects. In this course we will use a microcontroller or a field programmable chip (computer-on-a-chip) to interface with Mechatronics components such as switches, LED's, DC motors, stepper motors, relays, remote controls, and others. It will also present Personal Computers Interface (PCI) through Data Acquisition Cards (DAQ).

3 Learning outcomes) / competencies

On completing the course, students will e able to have to following skills:

- Knowledge and understanding

  A1-Tell the principles of microcontroller-based systems design

  A2-. Mention the design requirements of embedded systems

- Intellectual skills

  B1. Show improved comprehensive quality and innovative ability

  B2. Design and implement a real system based on a single chip microcontroller

- Professional and practical skills

  C1. Implement small mechatronics system considering both H/W and S/W requirements for a single-chip design.

  C2. Work with system design development tools such as MATLAB, LABVIEW, PROTEUS or any other available software.

- General and transferrable skills

  D1. Use programmable chip to manage operation of a Mechatronic system

  D2. Choose suitable hardware and software components for a reliable system

4 Contents

Designing and developing computer-based system: analysis phase, design phase, and implementation phase, **Design phase:** choosing a processor, choosing OS, choosing programming language, choosing developing tools, **Implementation phase:** Buses, I/O devices, timer/counter, interrupts, data acquisition systems, data distribution systems, **Microcontroller programming:** C program elements; header & source files, preprocessor directives, macros & functions, data type & data structures, loop & pointers, queues & stacks, **Embedded programming in C++, Motor control examples** (closed and open-loops), **PID example of mechatronic system, Serial and USB Communication:** connecting to PC, internet, wireless sensor networks for mechatronics systems, **Software engineering concepts in the system development process:** algorithm complexity, s/w process life cycle, **s/w analysis & design,**

	s/w implementation, testing, validating & debugging, Realization of real-time algorithms, Hardware and Software co-design, Real-time programming: soft & hard tasks, RTOS**,** RTOS Task scheduling, Interrupt routines in RTOS, Case studies of programming with RTOS, **Computer Interface through DAQ:** Specifications and Interface, **PC Control Programming through DAQ** (LABVIEW or MATLAB)
5	**Teaching Method** Lectures, discussions, tutorials, problem solving, modeling, project, self study.
6	**Requirements** Bachelor degree (BSc, BEng) in Electrical Engineering, Mechanical Engineering, or Computer Science
7	**Examination** written examination
8	**Requirements for awarding credit points** Module examination
9	**Significance of the mark for the final score** ***70 %***
10	**Representative module and full-time teachers:** Name of module coordinator at the offering institution
11	**Other Information** ▫ **Books** ▫ P. Laplante, *Real-Time Systems Design and Analysis*, IEEE Press, 2004 ▫ Q. Li, *Real-Time Concepts for Embedded Systems*, CMP Books, 2003 ▫ T. Noergaard, *Embedded Systems Architecture*, Newess Press, 2005 ▫ J. Peatman, "Embedded Systems Design with the PIC18F452 microcontroller", Prentice-Hall, USA 2003. ▫ M. Zurawski, *Embedded Systems Handbook*, CRC Press, 2005**.** ▫ Steven Heath, "Embedded Systems Design", 2nd edition, Newton, Mass. USA, 2002. **Websites** ▫ http://www.labcenter.com/download/prodemo_download.cfm#professional ▫ http://www.mathworks.com/products/matlab/ ▫ http://www.ni.com/labview/

Advanced Control Theory, FINAL

Identification number	Workload	Credits	Semester	Frequency of offer	Duration
MM22	180 h	6 ECTS 3 CH	2	Spring Semester	1 Semester

1	Courses	Contact time	Self-study	Planed group size
	Course instruction: 2 HPW Exercise: 2 HPW	4 HPW / 60 h	120 h	20 students

2 Course Description

The course introduces advanced concepts in the theory, analysis and design of control systems.

3 Learning outcomes) / competencies

On completing the course, students will be able to have to following skills:

- Knowledge and understanding
  - A1. Model and analyse control systems
  - A2. Evaluate the performance of control systems
- Intellectual skills
  - B1 Apply control engineering know-how to other scientific disciplines.
  - B2. Conduct research in advance control field to generate novel techniques.
- Professional and practical skills
  - C1. Design and simulate industrial and practical systems
  - C2. Improve performances of control systems
- General and transferrable skills
  - D1. Understand the requirements and operations of control systems
  - D2. Design and tuning techniques for performance improvement

4 Contents

Review of control engineering fundamentals: Dynamic response**,** Stability in the time-domain and frequency domain, Root locus analysis and design, PID controllers, **State space application and analysis:** State space technique for stability analysis, controllability, observability, design of state space controllers, **Robust control, optimum criteria, symmetric optimum**, **advanced control structures,** feed forward control, cascade control, pilot control, **Multi variable control systems, Non linear control systems**

5 Teaching Method

Lectures, discussions, tutorials, projects, modeling, computer simulations, self study.

6 Requirements

Under graduate Control course and Informatics, Advanced Engineering Mathematics.

7 Examination

Written examination

8 Requirements for awarding credit points

	Module examination + Simulation Project
9	**Significance of the mark for the final score** 70%
10	**Representative module and full-time teachers** Name of module coordinator at the offering institution
11	**Other Information** Literature: ▫ Control System Engineering, Norman S. Nise, 6th edition. John Wiley & Sons 2011 ▫ Modern Control Systems, Richard C. Doft and Robert Bishop 2004 ▫ Modern Control Engineering, 5th edition by Katsuhiko Ogata, 2009 ▫ Analysis and Control of Nonlinear Process Systems, Katalin M. Hangos, Jozef Bokor and Gabor Szederkenyi, Springer 2010 ▫ Control Systems Theory and Engineering Applications by Sergey Lyshevski ▫ Automatic Control Systems by Benjamin C. Kuo and Farid Golnaraghi

Advanced Measurement Systems and Sensors, FINAL					
Identification number **MM23**	**Workload** 180 h	**Credits** 6 ECTS 3 CH	**Semester** 2	**Frequency of offer** Spring Semester	**Duration** 1 Semester

1	**Courses**	**Contact time**	**Self-study**	**Planed group size**
	Course instruction: 2 HPW Exercise: 2 HPW	4 HPW / 60 h	120 h	20 students

2 Course Description:

The course is based on mechatronic philosophy, regarding mechanic, electronic and informatics as a whole. After finishing the course the student should be able to:-

- Analyze measurement- and control problems,
- Design and/or select the best suited sensors for a specified problem, regarding range, accuracy, dynamic behavior, environment requirements etc.
- Perform all necessary calculations regarding the sensor implementation and the analog and digital signal processing required.

3 Learning outcomes / competencies

On completing the course, students will be able to have to following skills:

- **Knowledge and understanding**

  A1- Describe the concepts of different measurement & Mechatronics systems used in industry.

  A2 - Describe the function, suitability of different sensors and Transducers.

  A3- Know and understand in depth the concepts of Input/ Output Signal conditioning

- **Intellectual skills**

  B1-Analyze, Design and/or select the suitable sensors for a given system.

  B2-Analyze & design the signal conditioning circuits.

  B3 – Conduct research in measurement system and sensor field to generate novel techniques

- **Professional and practical skills:**

  C1- Carry out calibration and error estimation of measuring devices .

  C2- Design and assessment of the sensors used in industrial systems.

  C3 – Improve system performance

- **General and transferrable skills**

  D1- Critical thinking.

  D2- Team work

  D3- Self learning..

4 Contents: Introduction- Mechatronics systems – Measurement systems- Performance terminology of sensors - Passive Sensors (Resistors-Capacity-Inductive); Active sensors: Piezoelectric sensors for force, pressure and vibration, electrodynamic sensors for speed and rotation, Photodiodes and Thermocouples. –Signal conditioning (Analog data processing- Digital data processing – Protection – Filtering)- Elements of optical sensors: LED, laser diode, photodiode, CCD sensor, optical waveguides, opto coupler:

Optical sensor systems: Light barriers, triangulation, fiber-optic sensors, spectrometer;

Lasers: Gauß beam, coherence, optical resonators, interaction of laser light with matter

Smart sensors and smart sensor systems (Definition – Different types- new trends)- Sensors

	selection- Small course project (groups of 3-4 students).
5	**Teaching Method:** Lectures, discussions, projects, tutorials and self-study.
6	**Requirements** Bachelor degree (BSc, BEng) in Engineering
7	**Examination** Written in-class exams; Take-home exams
8	**Requirements for awarding credit points** Module examination
9	**Significance of the mark for the final score** **70%**
10	**Representative module and full-time teachers** *Name of module coordinator at offering institution*
11	**Other Information** • Göpel, Hesse, Zemel: Sensors. Volumes 1, 4, 5, 7, VCH Verlag, Weinheim • Löffler-Mang: Optical Sensors. Vieweg and Teubner, Wiesbaden • Hecht, Zajac: Optics. Addision-Wesley Publishing Company

Research Methodology, FINAL

Identification number	Workload	Credits	Semester	Frequency of offer	Duration
MM25	180 h	6 ECTS 3 CH	2	Spring Semester	1 Semester

1	Courses	Contact time	Self-study	Planed group size
	Course instruction: 2 HPW Exercise: 2 HPW	4 HPW / 60 h	120 h	20 students

2 Course Description

The main aim of this course is to teach the students how to write thesis/research proposals. Therefore, the course provides the students with an opportunity to engage in research activities such as literature reviews, research planning, data analysis and reporting (written and oral) using a chosen mechatronics engineering research topic.

3 Learning outcomes) / competencies

On completing the course, students will be able to have the following skills:

- Knowledge and understanding

  A1.Recognize the ethical principles of conducting applied research.

  A2. Identify various sources of information.

  A3. Identifying and formulating research problem.

- Intellectual skills

  B1. Carry out literature searches and some ability to critically evaluate literature.

  B2. Design and conduct experiments, devise appropriate measurements, analyse and interpret data and form reliable conclusions.

- Professional and practical skills

  C1. Undertake and manage a research project of significant size and scope.

  C2. Demonstrate awareness of the importance of documenting all aspects of the development of an engineering project.

- General and transferrable skills

  D1. Apply project management skills to research activities

  D2. Communicate effectively in written and oral ways.

4 Contents

The course introduces students to some fundamentals of research methodology. This includes: Research ethics, engineering research methods, problem specifications, gathering and organizing relevant information, reading conference and journal papers, assessing retrieved information, analyzing and writing critical reviews, proposing and comparing different solutions, design of experiments, and technical writing.
At the end of the course, students should write his/her research proposal that will be carried out in the semester to follow

5 Teaching Method

Lectures, discussions, tutorials, and self study.

6 Requirements

	Undergraduate degree in engineering
7	**Examination** Research proposal: Report and presentation
8	**Requirements for awarding credit points** Module examination
9	**Significance of the mark for the final score** 70%
10	**Representative module and full-time teachers** *Name of module coordinator at offering institution*
11	**Other Information:**