MP: Project Management, Master's Project and Master's Thesis

Program:	**Master's Program in Electrical Engineering and Information Technology**
Module / Course Title:	**Real-Time Systems**
No:	**MA01**
Semester:	EIT M1-3 (summer term)
Coordinator / Responsibility:	Prof. Dr. B. Mysliwetz (I), Prof. Dr. W. Schittenhelm (II)
Teacher:	Prof. Dr. B. Mysliwetz (I), Prof. Dr. W. Schittenhelm (II)
Language:	English
Position in Curriculum:	Mandatory course in EE/IT Master's program. Technical elective course for EIT-Diplom program in 8th semester.
Course Type / Weekly Hours:	50% lectures, 50% lab class, 4 hours per week
Workload:	Duration 1 semester Lecture/class presence: 4 hours x 15 weeks = 60 hours Lecture follow-up: 20 hours Lab class preparation/follow-up: 50 hours Examination preparation: 20 hours Total workload: 150 hours
Credits:	5
Prerequisites:	Working principles of microprocessors (IO, interrupts, stack). Programming experience in a blockstructured high level language, preferably ANSI C or C++. Basic knowledge of structure and working principles of a 'general purpose' operating system. Fundamental knowledge of the functional units of a personal computer. Fundamentals of control theory.
Goals / Learning Objectives:	**Goals** To enable students to design and implement software for real-time applications **Learning Objectives** at the end of this course, students will be able to: • Understand the mechanisms and problems associated with real-time applications • Apply real-time software design rules • Know the working principles and utilize the services of real-time operating systems • Realize the advantages of using real-time operating systems
Topics:	**Partl I – Real-Time Software Design and Real-Time Operating Systems (Mysliwetz)** Technical terms and definitions; examples of embedded real-time systems; real-time operating system concepts; processes, threads, tasks; scheduling principles; real-time software design; rate-monotonic scheduling approach; reentrant code; semaphores, mutual exclusion, shared resources; synchronization mechanisms; deadlocks; priority inversion; interprocess communication, overview of commercial real-time operating systems; practical laboratory exercises. **Lab (Part I)** Processes and Threads under Windows; Analysis of Fundamental Real-Time Properties of Windows on a PC; implementing a step motor control application with the real-time kernel µC/OS on an ARM Cortex-M based mi-

	crocomputer; application of semaphores as a mutual exclusion mechanism while accessing shared resources, effect of priority inversion. **Part II – PC-based Real-Time Control Systems (Schittenhelm)** Real-time applications based on personal computers: requirements, hardware and software design, overview and comparison of commercial PC-based systems. **Lab (Part II)** PC-based real-time systems via OPC-servers; Windows-CE development environment; real-time programming under VxWorks.
Grading / Examination:	Lab class preparation tests (3 x 15 minutes, 15%) in part I plus written test (60 minutes, 85%) at end of lecture period
Material:	Lecture notes, worksheets and lab-class problem descriptions available as PDF download files
Literature:	Labrosse, J. J.: *MicroC/OS-II - The Real-Time Kernel*, CMP Books, 1999; ISBN 0-87930-543-6 Tanenbaum, A. S.: *Modern Operating Systems*, Prentice Hall, 1992 Brause, R.: *Betriebssysteme - Grundlagen und Konzepte*, Springer, 2001; ISBN 3-540-67598-1 Iwanitz, F., Lange, J.: *OPC Fundamentals, Implementation and Application*; Hüthig-Verlag, 2002; ISBN 3-77-852883-1 Stallings, W.: *Operating Systems: Internals and Design Principles*, Prentice Hall, 2001; ISBN 0-13-031999-6