Program of the course “Real-Time Systems”
“Informatica e Sistemi in Tempo Reale”

A.A. 2023-24

Teacher	Prof. Giorgio Buttazzo
Semester	First
Credits	6
Objectives	The objective of this course is to teach the theoretical foundations and practical techniques for developing time-sensitive applications with high degree of concurrency and a set of performance requirements. The course focuses on special methodologies for increasing the predictability of computer controlled systems, including task and resource management algorithms. Students will learn how to design, analyze, and develop real-time software used in several application domains, as robotics, avionics, aerospace, automotive, multimedia, and biomedical systems.
Program	1. Basic concepts on real-time computing. Application domains. Typical system requirements. Limits of traditional approaches. Modeling real-time computational tasks. Extracting timing constraints from application requirements. Task Scheduling. Metrics for performance evaluation. 2. Real-time scheduling algorithms. Algorithm taxonomy. Scheduling with precedence constraints. Scheduling periodic tasks. Utilization-based analysis. Response-time analysis. Processor-demand analysis. 3. Protocols for accessing shared resources. The priority inversion phenomenon. Non-preemptive protocol, Highest Locker Priority, Priority Inheritance and Priority Ceiling Protocol. Stack Resource Policy. Estimating blocking times. Schedulability analysis under blocking times. 4. Aperiodic task handling. Fixed-priority servers (Polling, Deferrable and Sporadic Server). Dynamic priority servers (Total and Constant Bandwidth Server). Resource reservation for temporal isolation among multiple applications. 5. Overload management. Definition of computational load. Methods for overload handling. Admission Control. Robust Scheduling. Imprecise Computation. Job Skipping. Elastic scheduling. Handling overruns. Resource reservation mechanisms. 6. Practical guidelines to design and develop real-time software using the Pthread library under Linux.
Prior skills	Basic knowledge on mathematics, physics, computer architectures, programming languages, and operating systems.
Exam	The exam consists of a project development, a project report, and a written test. It is highly recommended to attend all the lectures to better understand both the theoretical part and properly address the project development.
Books	1. Giorgio Buttazzo, Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications", Third Edition, Springer, 2011. 2. Giorgio Buttazzo: "Sistemi in Tempo Reale", Terza Edizione, Pitagora Editrice, Bologna, 2006.
Web site	http://retis.sssup.it/~giorgio/courses/rts/rts.html