University of Tehran
School of Electrical and Computer Engineering

Course	Cyber-Physical Systems		
Course type, level, credit	Optional	Graduate	3 units
Field, Major	Computer Engineering	Software	
Co-requisite(s)	-		
Prerequisite(s)	-		
Prerequisite by topic	Basic concepts related to data structures, algorithms, and operating systems		
Goals	Real-time embedded systems play a vital role in many application domains including drive-by-wire automotive systems, intelligent traffic control systems, telecommunication and banking systems, and autonomous robots. Therefore, these systems constitute the core knowledge required to deal with cyber-physical systems. In this course, we will discuss topics about the design, modeling, and theoretical analysis of centralized and distributed real-time systems. The goal of this course is to provide a deep understanding about processor scheduling and resource management in centralized and distributed real-time embedded systems composed of diverse activities with different degrees of criticality and with different forms of timing requirements. This course is structured to improve students' research skill and their ability of critical thinking.		
Outcome	Upon successful completion of the course, students will be familiar with: • Design, modeling, and analysis of cyber-physical systems • Real-time scheduling and resource management • Energy harvesting, energy management, and temperature management of embedded real-time systems • Dependability and optimization in safety-critical systems		
Topics	• Background: motivation for, and definition of, real-time and embedded computing systems. • Cyber-physical systems • Sensors and actuators • Characterization of real-time and embedded systems: application constraints and design methods. • Performance measures for real-time systems. • Modeling of real-time tasks and evaluation of		

	system's ability of meeting application constraints. • Formal methods for specifying and reasoning about timing constraints. • WCET estimation. • Problem definition and terminology of single- and multiprocessor real-time scheduling. • Task assignment and scheduling to meet application time constraints. • Resource management difficulties in real-time embedded systems and well-known solutions. • Performance evaluation of real-time systems. • Real-time communications. • Fault-tolerance techniques for real-time embedded systems: models, algorithms and architectures. • Power and energy issues in real-time embedded systems. • Green software.
Required software	Different simulation tools related to real-time systems.
Assignments	6 homework
Projects	
Grading	Project and paper review: 40% Midterm exam: 30 % Final exam: 30 %
Textbook(s)	[1] Edvard A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", Berkeley, 2016. [2] Jane W. S. Liu, ″Real-Time Systems″, Prentice Hall, 2000. [3] Articles from IEEE & ACM Transactions and Conferences, and Springer and Elsevier Journals.
Further readings	[1] G. Buttazzo, G. Lipari, L. Abeni, M. Caccamo, ″Soft Real-Time Systems: Predictability vs. Efficiency″, Springer, 2005.