University of Tehran
School of Electrical and Computer Engineering

Course:	**8101945 – Real Time Embedded Systems**
Course type:	<table><tr><td></td><td colspan="6">EE*</td><td colspan="3">CE*</td><td rowspan="2">Credit: 3</td></tr><tr><td></td><td>Com</td><td>E</td><td>P</td><td>B</td><td>Con</td><td>D</td><td>SW</td><td>HW</td><td>IT</td></tr><tr><td>Required</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Elective</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☒</td><td>☐</td><td>☐</td></tr></table>
Level:	Undergraduate ■ Graduate ☐
Co-requisite(s):	None.
Prerequisite(s):	Operating Systems I (8101443) Computer Architecture (8101207)
Prerequisite by topic:	Concepts of scheduling in operating systems, low level programming, computer system architecture, compiler concepts
Textbook(s):	[1] E. A. Lee and S. A. Seshia, *Introduction to Embedded Systems – A Cyber-Physical Systems Approach*. UC Berkley, 2017.
Coordinator:	Kargahi , Professor, School of ECE
Goals:	Embedded systems have a significant role in transportation applications, intelligent traffic control, banking and information and defense systems. This lesson is devoted to the design, implementation, and analysis of real-time embedded systems' theory. The lesson involves expressing the hardware components of embedded systems, hybrid modeling in cyber-physical systems, designing cyber-physical systems, including scheduling and managing processes and resources in real-time systems, as well as programming techniques for these systems. This lesson is presented in theory-practical terms.
Outcome:	Upon successful completion of the course, students will be able to 1. Have a good insight on the specifications and components of the embedded systems 2. Have a good insight on the computational models used in the embedded systems 3. Decide on the use of software / hardware for system design 4. Manage resources in a real-time embedded system
Topics:	1) Introduction and basic concepts - Applications of cyber-physical systems - The process of changing computer systems towards embedded uses - Characteristics of an embedded system - Design problems of embedded systems 2) Synchronized computational models - Discrete computational model -Continuous computational models

	-Hybrid computing models - Real time computational models - Model based design 3) Hardware components of an embedded system - Embedded processors (single-core and multi-core) - Memory architecture in embedded systems - Input / Output devices and sensors – Real-time and embedded connections and embedded buses 4) Operating system and embedded software - Real-time scheduling methods - Analysis of the run time of the processes - Programming embedded systems - Low-level software optimizations 5) Separate hardware and software in an embedded system - Criteria for hardware / software partitioning - Typical methods for hardware / software partitioning 6) Verification of embedded systems - Simulation and testing of embedded systems - Official and model-based verification methods
Computer usage:	Embedded Linux or an appropriate RTOS, Windows CE, Java, C++
Assignments:	4 homework assignments
Projects:	1 group project which is delivered in several phases.
Grading:	Assignments: 10 % Quizzes: 10 % Midterm exams: 20% Final exam: 30% Project: 30%
Further readings:	[1] *Embedded System Design (Embedded System Foundation of Cyber-Physical Systems).* Springer, 2011. [2] Some standards including ARINC 664, POSIX 1003.1b, etc.
Prepared by:	
Date:	December 5,2017

*EE: Electrical Engineering		CE: Computer Engineering	
Com	Communications	SW	Software
E	Electronics	HW	Hardware
P	Power	IT	Information Technology
B	Bioelectronics		
Con	Control		
D	Digital System		