CMSE423 - Embedded System Design

Department: Software Engineering

Instructor Information

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Meeting times and places

Group 1
Thursday 14:30-16:20, CMPE 033
Friday 14:30-16:20, CMPE 033
Lab
Monday 16:30-18:20, CMPE 227

Group 2
Tuesday 14:30-16:20, CMPE 126
Wednesday 10:30-12:20, CMPE 127
Lab
Friday 14:30-16:20, CMPE 227

Program Name: Software Engineering	**Program Code:** 29

Course Code	**Credits**	**Year/Semester**
CMSE423	4	2022-2023 Fall

Catalog Description

Application areas, common characteristics, and challenges in embedded system design. Requirement specification, models of computation and modeling methods such as automata, and state charts, data flow modeling. High-end Embedded Systems (HES) hardware, ASICs, processors, memories, communication, conversion between analog and digital inputs and outputs, sampling, and actuators, secure hardware. Embedded operating systems, general requirements, RTOS, virtual machines, real-time databases. IoT projects and implementation. Evaluation and validation, performance evaluation, energy and power models, simulation, rapid prototyping, emulation. Test, test pattern generation, evaluation of test patterns, design for testability.

Prerequisites: CMPE223/CMSE222

Course Web Page

https://staff.emu.edu.tr/felixbabalola/en/teaching/cmse423

Textbook(s)

– E.A. Lee and S.A. Seshia, Introduction to Embedded Systems. A Cyber-Physical Systems Approach, 2nd Ed, MIT Press, 2017.

Topics Covered and Class Schedule

Week 1	Trends in Embedded Systems Industry, application areas [Embedded Industry Survey]. Common challenges in High-end Embedded Systems (HES) design and applications
Week 2	Importance of modeling the real world, and cyber world, for given requirement specifications
Week 3	Modeling the continuous physical world: physical laws and constraints, kinematics, and dynamics, Signal flow diagrams.
Week 4	Discrete Systems Modeling, Discrete and Hybrid systems, automata, and state charts
Week 5	Commons of HES Projects, Simulation, Emulation, and Rapid Prototyping, Sensors and Actuators, sampling
Week 6	HES hardware, communication, Input-Output Ports, analog, digital, and serial inputs and outputs
Week 7	Processors and Memory systems, RTOS, virtual machines, real-time databases

Week 8-9	MIDTERMS
Week 10	IoT projects and implementation: NodeRED on Raspberry and on PC. Team project discussions (project introduction).
Week 11	Incremental Design, test, test pattern generation, evaluation of test patterns, design for testability (project design).
Week 12	Evaluation and validation: performance evaluation, energy and power models (project implementation)
Week 13	Security of Embedded Systems, Cryptographic, Symmetric, and Public Key encryption, Kerckhoff's principle, Confidentiality, Integrity, Authenticity. Software Security, Attacker and Threat models, Security in Embedded Industry
Week 14-15	FINAL EXAMS

Course Learning Outcomes

Upon successful completion of the course, students are expected to have the following competencies

1. Perform kinematic and dynamics modelling of simple physical systems for High End Embedded Systems (HES) design
2. Know typical structure of a HES, and use simple digital I/O ports.
3. Know analog, digital and hybrid approaches, and use a typical AD converter of a HES.
4. Know typical control, and monitoring approaches for HES.
5. Know common cyber modelling tools and methods, and apply FSM techniques on HES.
6. Know common principles of IoT systems, and apply them on an IoT platform.
7. Analyse technical requirements and design a HES using indicators, displays, sensors and actors.
8. Analyse and comment on ethical social and environmental responsibilities of an embedded system design.
9. Practice an embedded system preliminary design starting from technical requirements.
10. Practice an embedded system design in teams including its tests.
11. Prepare a team design report to document hardware/software development of a HES, including its tests.

	Method	**No**	**Percentage**
Assessment	Midterm Exam(s)	1	25
	Final Examination	1	30
	Lab	7	10
	Term Projects	2	20
	Quiz/Assignment	2-4	10
	Attendance	~	5

Policy on missed labs: There will be no makeup for missed labs.

Policy on makeups: For eligibility to take a makeup exam, the student should bring a doctor's report within 3 working days of the missed exam.

Policy on the NG grade: If you miss two exams with no valid excuse, you will be given the NG grade.

Prepared by: Dr. Felix Babalola	**Date:** 30 September 2022