Subject	Embedded Control Systems	Course Code	CT324	Theoretical	3hrs / wk
Semester	6	Prerequisite	CT320	Practical	3hrs / wk

Course Description:

This course introduces students to the basics of models, analysis tools, and control for embedded systems operating in real time. Students learn how to combine physical processes with computation. The course has a strong laboratory component, with emphasis on a semester-long sequence of projects.

Topics to be covered include the following:

1. Models of computation: finite state machines, threads, ordinary differential equations, hybrid systems, actors, discrete-events, data flow
2. Basic analysis, control, and systems simulation: Bisimulations, reachability analysis, controller synthesis, approximating continuous-time systems.
3. Interfacing with the physical world: sensor/actuator modeling and calibration, concurrency in dealing with multiple real-time streams, handling numerical imprecision in software
4. Mapping to embedded platforms: real-time operating systems, execution time analysis, scheduling, concurrency
5. Distributed embedded systems: Protocol design, predictable networking, security

	Specific Learning Outcomes	Lab
Week 1	• Introduction. • Cyber-Physical Systems.	
Week 2	• Sensors and Actuator. • Memory Architectures.	Interfacing with the WiiMote
Week 3	• Interfacing to Sensors and Actuators. • Interrupts.	Embedded Development Tools
Week	**Specific Learning Outcomes**	**Lab**

4	• Model-Based Design. • Model Modal Behavior.	Generate Music and Program an ADC in MicroBlaze
Week 5	**Specific Learning Outcomes**	**Lab**
	• Extend and Timed Automata. • Composition of State Machines.	Cal Climber Navigation in C
Week 6	**Specific Learning Outcomes**	**Lab**
	• Hierarchical State Machines. • Multitasking.	Cal Climber Hill Climb in C
Week 7	**Specific Learning Outcomes**	**Lab**
	• Operating systems, Microkernels, and Scheduling. • Scheduling Anomalies.	Model-Based Cal Climber Navigation and Hill Climb
Week 8	**Specific Learning Outcomes**	**Lab**
	• Specification; Temporal Logic. • Comparing State Machines.	Project Management
Week 9	**Specific Learning Outcomes**	**Lab**
	Midterm I	
Week 10	**Specific Learning Outcomes**	**Lab**
	• Reachability Analysis. • Execution Time Analysis.	
Week 11	**Specific Learning Outcomes**	**Lab**
	Synchronous/ Reactive Models	
Week 12	**Specific Learning Outcomes**	**Lab**
	• Execution Time Analysis • Dataflow Models 1	
Week	**Specific Learning Outcomes**	**Lab**

13	Midterm II	
Week 14	**Specific Learning Outcomes**	**Lab**
	• Project Presentation	

Course Assessment:

Course Work	Mid-term Tests	Final Examination	Final Exam Practical
10	30	40	20

NOTE: Course Work may include Assignments, Lab reports, Projects and Practical Activities.

Textbooks:

1. Introduction to Embedded Systems, by E. A. Lee and S. A. Seshia, 2011-2012.

Note: This is the same course teaching at Berkeley University Of California.

Course Link: http://chess.eecs.berkeley.edu/eecs149/index.html