Revised Embedded Systems Curricula

Background
Current Graduate Curriculum in embedded systems consists of 4 courses in the CSE 237 series. These courses were designed by Rajesh under the assumption of single instructor to teach all these courses, and could be offered in any order with some overlap concepts consisting of about one week of instruction. None of these were required courses in either the MS or PhD program.

The Embedded Systems group now consists of three faculty members who are able to offer these courses on a consistent schedule. Taken together, the faculty has the availability to offer six courses in the general area. In addition, the group has instructional needs for a much larger set of graduate students in the Embedded Systems and Computer Engineering area to make sure that important knowledge and skills are covered for all our students.

In this context, the group undertook a detailed review of the curriculum, requirements and our instructional needs. This document lists our suggestion for revised course syllabus that entirely fits within the existing course descriptions, along with suggested offerings of the individual courses.

CSE 237A: Introduction to Embedded Systems
Offered two times a year.

This is a required course for all Embedded Systems students, as well as one of the two options among the four required courses for Computer Engineering students. The course syllabus is outlined as follows:

- Embedded System Components (4 lectures)
- Models of Computation: Descriptions (4 lectures)
- Timing, Clocks (2 lectures)
- Task Scheduling (6 lectures)
- Real-time communications (3 lectures)

The lab component of this course will consist of 3-4 lab exercises using Intel DBPX272x stations and/or a DSP station, along with a course project.

CSE 237B: Software for Embedded Systems
Offered once a year.

Lecture Outline:
- Programming Embedded RT Systems (4 lectures)
- Exception Handling and Recovery Blocks (1 lecture)
- Programming time facilities (1 lecture)
- Low level programming: Device Drivers (4 lectures)
- Real-Time Operating Systems (4 lectures)
- Virtualization for Embedded systems (2 lectures)
- Software performance estimation and optimization (4 lectures)

The lab component of this course will consist of 3-4 lab exercises using Cypress microcontroller boards or equivalent, along with a course project.
CSE 237C: System Level Design Automation
Offered once a year.

The focus of this course is on algorithms and methods behind optimization and synthesis tools in embedded systems.

Lecture Outline:
- Models of Computation: Tagged Models, Theory (4 lectures)
- Architectural/Behavioral Synthesis (5 lectures)
- Methods for power/performance optimization (4 lectures)
- Simulation: basics and acceleration (2 lectures)
- Parallel Discrete Event Simulation (2 lectures)
- Emulation (1 lecture)
- Verification and verification languages (2 lectures)

The laboratory component consists of experiments with CAD tools as well as programming exercises using tools such as Ptolemy.

CSE 237D: Embedded Systems Design
Offered once a year.

The focus of this course is on providing design and prototyping experience in embedded systems.

Lecture Outline:
- Reprogrammable Components: FPGA architectures (4 lectures)
- Prototyping using FPGAs (2 lectures)
- DSP on FPGA based Systems (2 lectures)
- HCI in Embedded Systems (4 lectures)
- Embedded Systems Security (6 lectures)

The laboratory component consists of 3-4 exercises using Xilinx XUP boards as well as a project.
Proposed MEng/MS in CSE/CE

Core
- Three out of four courses for CE, first three for CSE:
  - CSE 202 algorithm design and analysis
  - CSE 221 OS
  - CSE 240A principles of comp arch
  - One of:
    - CSE 241A Introduction to Computing Circuitry
    - CSE 237a/b/c/d One class in Embedded Systems sequence
- Seminar course:
  - CSE 292 faculty research seminar

<table>
<thead>
<tr>
<th></th>
<th>Thesis</th>
<th>Meng –Std</th>
<th>Meng-Interdisc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>12 units</td>
<td>12 units</td>
<td>12 units in CSE</td>
</tr>
<tr>
<td>2nd Concentration</td>
<td>0</td>
<td>0</td>
<td>12 units outside CSE</td>
</tr>
<tr>
<td>Electives</td>
<td>12 units</td>
<td>20 units</td>
<td>8 units within CSE</td>
</tr>
<tr>
<td>Thesis/Project</td>
<td>CSE 298</td>
<td>CSE 297</td>
<td>4 units of 297</td>
</tr>
<tr>
<td>Final step</td>
<td>Thesis</td>
<td>Capstone Presentation</td>
<td></td>
</tr>
</tbody>
</table>

Concentrations:
- CSE:
  - AI, Bioinf, Comm Nets, Graph., Crypto, DB, Distrib Comp, Parallel Comp, SW, Storage
- CE: 12 units out of courses listed on the next page

Interdisciplinary concentrations:

MEng/MS in CE: students who complete 12 units of concentration in the CE courses listed on the next page; else students get MEng/MS in CSE.
CE Concentration (VLSI/CAD, Arch/Compilers, Embed. Sys)

- **CSE241A** - Introduction to Computing Circuitry
- **CSE242A** - Integrated Circuit Layout Automation
- **CSE243A** - Introduction to Synthesis Methodologies in VLSI CAD
- **CSE244A** - VLSI Test (*New Fall 2002*)
- **CSE244B** - Testable and Fault Tolerant Hardware Design
- **CSE245** - Computer Aided Circuit Simulation and Verification
- **CSE248** - Algorithmic and Optimization Foundations for VLSI CAD
- **CSE249B** - Topics/Seminar in VLSI
- **CSE249C** - Topics/Seminar in CAD

- **CSE240A** - Principles in Computer Architecture
- **CSE240B** - Advanced Computer Architecture
- **CSE246** - Computer Arithmetic Algorithms and Hardware Design
- **CSE247** - Application Specific and Reconfigurable Computer Architecture
- **CSE249A** - Topics/Seminar in Computer Architecture

- **CSE237A** - Introduction to Embedded Computing
- **CSE237B** - Software for Embedded Systems
- **CSE237C** - Validation and Testing of Embedded Systems
- **CSE237D** - Design Automation and Prototyping for Embedded Systems
- **CSE249D** - topics/seminar in embedded systems

- 291CE – Special Topics in Computer Engineering
**PhD Program**

**PhD core:**
- CSE 202  (Algorithms)
- CSE 221  (Operating Systems)
- CSE 240A  (Architecture)
- One of: CSE 241A  (Introduction to Computing Circuitry)
- CSE237a /b/c/d (One of Embedded Systems sequence)
  - CSE 200  (Complexity) for CSE or
- CSE 292  (Faculty Research Seminar)

**PhD Breath:**  *(12 units)*
Units must be from two other areas different from the major area

**PhD Elective:**  *(8 units)*

**PhD Depth:**  *(12 units)*
- Theoretical Computer Science (CSE 200, 201, 203-208)
- PL,SW  (CSE 210, 211, 218, 230, 231, 238, 270, 271, 275)
- Computer Systems (CSE 222-228, 260-262, 268A)
- Database Systems (CSE 133, CSE 232, CSE 232B, CSE 233)
- AI  (CSE 250A-251, 253-256, CSE 258A plus Cognitive Science 200, 260)
- Graphics and Vision (CSE 252, 252A, 252B, 252C, 272)
- Bioinformatics (CSE 280A, 280B, 282, 283, Math 283)
- **Computer Engineering**
  - CSE 231  Adv. Compilers
  - CSE 237A-D  ES
  - CSE 240B-248  CAD/VLSI/Testing/Arch
  - ECE 260A  VLSI Digital System Algs and Architectures (4)
  - B  VLSI Integrated Circuits and Systems Design (4)
  - C  VLSI Advanced Topics Seminar (4)
  - ECE 284  Special Topics in Computer Engineering (4)

Research Exam
TA requirements
Quals
Defense