Lecture 0: Course Overview

Seyed-Hosein Attarzadeh-Niaki

Teacher

- Seyed-Hosein Attarzadeh-Niaki
  - PhD in Electronic and Computer Systems (KTH, 2014)
- Research interests
  - System-Level Modeling and Design of Intelligent Embedded and Cyber-Physical Systems
  - Design-Space Exploration Problems
- Contact
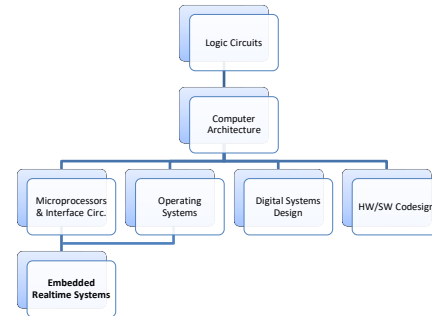 - Course-related: Courseware
  - Other stuff: h_attarzadeh@sbu.ac.ir

Positioning

- Programming Languages
  - C
- Operating Systems
  - Processes and threads
  - Scheduling
- Computer Architecture
  - Computer Organization
  - Instruction set
  - Memory hierarchy
- Microprocessors
  - Memory and IO peripherals
  - System programming and Assembly

```
                    Logic Circuits

                    Computer
                    Architecture

Microprocessors    Operating    Digital Systems    HW/SW Codesign
& Interface Circ.   Systems       Design

Embedded
Realtime Systems
```

Embedded Real-Time Systems   3

Course Requirements

- Pass the exams
- Complete the exercises in time
  - Analytical
  - Computer-based
  - Usually one week after they are announced
- Perform and present the course project
- **Active** participation in lectures and tutorials
  - Quizzes and online questions
 - Tutorial attendance

Embedded Real-Time Systems   4

Exams and Grading

- The mid-term exam
  - Exact time will be announced
  - Topics: modeling, design
  - ≈ 5 points
- The final exam
  - Topics: all the topics
  - ≈ 7 points
- Exercises
  - ≈ 6 points (0 or 1 for each exercise × lateness factor)
- Course Project
  - 2 points (with possible bonus points)
- Active participation
  - ±2 points

Embedded Real-Time Systems   5

Group Work

- Many activities in this course are performed in a group
  - Two students
  - Exercises and the course project
- You also present your work as a team;
  - but may be evaluated individually
- Pick a friend with whom you are comfortable to collaborate
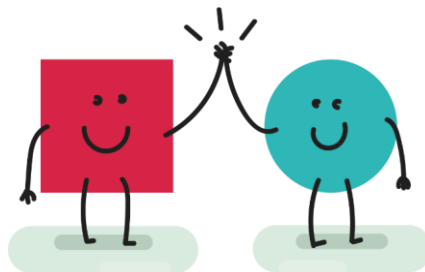
However, you should still be able to do everything individually.

Embedded Real-Time Systems   6

Course Material

No single book covers all the material in this topic
- Lee, Edward Ashford, and Sanjit Arunkumar Seshia. *Introduction to embedded systems: A cyber-physical systems approach*. Second Edition, MIT Press, 2017. (V2.2) Main book
- Marwedel, Peter. *Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things*. Vol. 4. Springer, 2021.
- Wolf, Marilyn. Computers as Components: Principles of Embedded Computing System Design. Vol 4. Elsevier, 2016.

Practical sources
- Pan, Tianhong, and Yi Zhu. Designing Embedded Systems with Arduino. Springer, 2018.
- Mathworks documentations

Embedded Real-Time Systems

7

Covered Topics

Introduction to embedded real-time systems
- Properties of embedded realtime systems
- Embedded software design

Model-based design
- Sequential models of computation (MoCs) and FSMs
- Concurrent MoCs: synchronous and asynchronous composition
- Modeling physical dynamics

Embedded platforms and system design
- Embedded processors and memories
- IO ports and devices
- Sensors and actuators
- A/D and D/A converters

Real-time OS and software
- Realtime scheduling

Implementation and mapping to target platform
- Code generation
- Optimization

Complimentary topics
- Quality
- Safety
- Security

Embedded Real-Time Systems

8

How Do We Conduct The Course?

- It is a senior undergraduate-level course
- Main concepts are discussed in the lectures
  - Not the boring details
- Students read the specified material to understand the remaining details
- Exercises and project will (hopefully) help to deepen your understanding of the subject

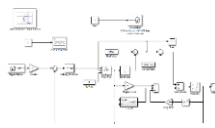Read the material, do not record/listen to lecturer's voice!

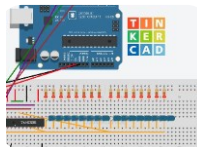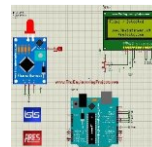Embedded Real-Time Systems 9

Tools Used in the Course
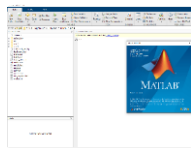
MATLAB Simulink Platform IO

TINKERCAD Proteus

Embedded Real-Time Systems 10