

# EMBEDDED SYSTEMS

READY-TO-USE LECTURE MATERIALS  
FOR UNDERGRADUATES

INTRODUCTION

# 12 WEEK COURSE OUTLINE (1/2)

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- 1) Introduction
  - What are embedded systems
  - Characteristics
  - Sample Market Segments
  - The IoT Era
- 2) Computer Architecture
  - RISC vs. CISC
- 3) ARM Cortex-M Architecture
  - Block Diagram
  - Registers
  - Instruction set
  - Memory access
  - Exception handling
- 4) Memory
  - SRAM
  - DRAM (SDRAM, DDR)
  - ROM/EEPROM/Flash
- 5) Timer and GPIO
  - Timer
  - PWM
  - GPIO
  - Simple drivers (e.g LED, Relay)
  - Power drivers (motors)
- 6) Interrupt Controller

(Based on Cortex-M4 and the Renesas Synergy™ Platform)

# 12 WEEK COURSE OUTLINE (2/2)

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## 7) Analog Interfacing

- ADC / DAC

## 8) Serial Communication

- UART
- SPI
- I2C

## 9) CAN

- Physical interface
- Stack

## 10) USB

- Physical interface
- Stack

## 11) Ethernet

- Physical interface
- Stack

## 12) Software Development

- Software Process
- UML Class Diagram
- UML State Machine Diagram

## 13) Concurrent Programming

- Tasks / Context Switching, Scheduling
- Semaphores, Signals / Messages
- Common problems to avoid: deadlock, priority inversion

## 14) RTOS

- Thread Management
- Inter-thread communication and synchronization
- Timing Services
- Memory Management

(Based on Cortex-M4 and the Renesas Synergy™ Platform)



# LIST OF LABS – BASED ON SK-S7G2

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Lab1 – Synergy Installation – try demo program on the S7G2 board

Lab2 – Sample C program – means to access hardware peripherals; memory organization of a C program

Lab3 – Assembly Programming ATPCS – access from C a function written in assembly

Lab4 – Peripheral Sample device driver

Lab5 – Serial Communication

Lab6 – Display and Touch

Lab7 – RTOS

Lab8 – USB Device

Lab9 – IoT

# OVERVIEW AND PREREQUISITES

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This Embedded Systems course is organized into theory and practice parts. There are 12 theory sections and 9 labs. The labs solutions can be made available to instructors. All labs are conceived to be developed on the Renesas SK-S7G2 board, based on an ARM Cortex-M4F MCU.

The course assumes that the students have previous knowledge on:

- C programming for embedded systems
- Microcontrollers and assembly programming (on an architecture other than ARM)
- Digital Systems
- Digital communications and networks

# AUTHORS

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UTFPR is the Brazilian Federal University of Technology.

eSysTech – Embedded Systems Technologies is a company providing engineering and training services in the area of Embedded Systems. It is a spin-off of the Laboratory of Innovation and Technology in Embedded Systems of UTFPR.

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