

EMBEDDED SYSTEMS

READY-TO-USE LECTURE MATERIALS
FOR UNDERGRADUATES

INTRODUCTION

12 WEEK COURSE OUTLINE (1/2)

- 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)

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

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

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

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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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