ELC 4438 - Embedded Systems Design

Midterm Exam Study Guide

February 19, 2016

Embedded System Introduction

1. Embedded system definition (embedded system versus general purpose computer)
2. Characteristics of embedded systems
   1. Special functionality, special task
   2. Dependability
   3. Efficiency
   4. Real-time requirement
3. Design flow – System design methodology
   1. Y-chart representation of levels of abstraction
   2. Meet-in-the-middle methodology
4. Structure of embedded systems
   1. Star topology

Printed Circuit Board (PCB) Design

1. PCB design process
   1. Schematic capture
   2. Place components
   3. Route traces
   4. Generate Gerbers
   5. Fabrication
2. PCB design iteration
3. PCB design software
   1. Symbol + footprint + device = component
4. Design rule check (DRC) and electrical rule check (ERC)
5. Part list – the bill of material (BOM)
6. Pin list – the netlist

Model of Computation and Real-Time Scheduling

1. Definition of design models
2. Design models provide the basis of analysis, synthesis and verification
3. Features of a model
4. Model of computation
   1. Components
   2. Communication protocols
5. Reference model of embedded systems
   1. Temporal parameters
   2. Periodic and aperiodic/sporadic tasks
   3. Periodic task model
   4. Functional parameters
6. Real-time scheduling
   1. Scheduler and schedule
   2. Approaches to real-time scheduling
   3. Priority-driven scheduling: EDF, LST, RM, DM

Embedded Processor

1. Processor architecture
   1. Von Neumann architecture
   2. Harvard architecture
2. CISC vs. RISC
   1. Features
   2. Pros and cons
3. ARM instruction set
4. Category of embedded processors
   1. Micro Controller Unit (MCU)
   2. Micro Processor Unit (MPU)
   3. Digital Signal Processor (DSP)
   4. System on Chip (SoC)

ARM Embedded Processor

1. ARM processor feature – typical RISC feature
   1. Small volume, low power, low cost, high performance
   2. Use many registers, fast execution time on instructions
   3. Easy addressing methods
   4. 32-bit wordlength
   5. Embedded online simulator
2. ARM processor series
3. ARM Cortex-A, Cortex-R and Cortex-M
4. ARM Cortex-M3 and Cortex-M4 architecture (component diagram)

Embedded System Design and Synthesis

1. Partitioned sequential machine
2. Finite state machine
3. Example of a RISC stored program machine
   1. Data path – registers, ALU, multiplexer, memory, etc.
   2. Control unit – finite state machine

ARM Cortex-M Architecture

1. Programmer’s model
   1. Thumb state and debug state
   2. Thread mode and handler mode
2. Registers
   1. Register bank (13 general purpose registers and SP, LR, PC)
   2. Special registers
3. Memory system
   1. Memory system features
   2. Memory map
   3. Stack memory
   4. Memory protection unit (MPU)
4. Exception and interrupts
   1. Nested vectored interrupt controller (NVIC)
   2. Vector table
5. GPIO, TWIM and SPI
   1. General-purpose IO
   2. Two-wire master interface – I2C
   3. Serial peripheral interface bus