Michigan Technological University
Electrical and Computer Engineering

Course Specification for
EE 3171 Microcontroller Applications

Curricular Designation: EE: required CpE: N/A RE: required

Catalog Description:

EE 3171 – Microcontroller Applications

Microcontroller Applications Introduces the concept of microcontroller-based systems. Describes some basic characteristics of microcontrollers and then goes into significant depth in the applications of a single microcontroller. Topics include C and assembly language programming, polled, interrupt and DMA input/output, assembly language, instruction set architecture interface and ASICs.

Credits: 4.0 *Lec-Rec-Lab:* (3-0-2) *Semesters Offered:* Fall, Spring, Summer
Restrictions: Must be enrolled in one of the following Major(s): Electrical Engineering
Pre-requisites: (EE 2241 or CS 1121 or CS 1111) and (EE 2174 or EE 2173)

Textbooks(s) and/or Other Required Materials:

ARM Microprocessor Systems: Cortex-M Architecture, Programming and Interfacing, Muhammad Tahir and Kashif Javed, 2017

Prerequisites by Topic:

- Mastery of number representation in binary, octal and hexadecimal, two's complement addition, binary multiplication
- Familiarity with synchronous sequential logic design with D flip-flops, including finite state machines
- Exposure to multiplexers, decoders, encoders and code converters
- Familiarity with programming in C or a similar high-level language

Course Objectives:

- Mastery of the topics associated with using a microcontroller in an embedded system environment
- Familiarity with differences between instruction sets, characteristics of instruction sets, RISC vs. CISC distinction and attributes
- Familiarity with ARM THUMB assembly language and C language programming, including but not limited to addressing modes, polled, interrupt and DMA I/O, interrupt service routines, and using on-board I/O systems

Topics Covered:

1. Assembly Language
   a) Theory of Microprocessors (Fetch-decode-execute cycle, pipelining)
   b) ARM THUMB Instruction Set, Addressing Modes
2. C Language: Basic Programming Review and Embedded Programming Concepts
3. Embedded System Design Concepts

a) System hierarchy; memory and interconnect, functional blocks, differences among microprocessors, microcontrollers, ASICs and System-on-a-chips
b) Clocks, Timers, Real-time Interrupts and Real-time operating systems
c) Interrupt, Polled and DMA I/O
d) Interrupt Service Handlers
e) Parallel vs. Serial I/O
f) Analog-to-Digital and Digital-to-Analog conversion
g) Pulse Width Modulation

Relationship of the Course Content to Program Outcomes:

Outcome	Topic and level of coverage
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Important
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Minimally important
3. an ability to communicate effectively with a range of audiences	Minimally important
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Minimally important
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Minimally important
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Minimally important
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Important

Contribution of Course to Meeting Degree Requirements:

4 Credit Hours – Engineering Topics

Class/Laboratory Schedule:

Lecture: 42 hours = 3 hours/week for 14 weeks
Lab: 28 hours = 2 hours/week for 14 weeks (note: 1 hour = 50 minutes)

Prepared by: Christopher (Kit) Cischke, Senior Lecturer Date: October 2020