**Catalog Description**

Development of embedded software (firmware) using a real-time operating system (RTOS). Development of an application as a set of independent threads that communicate with each other via message queues and semaphores.

**Prerequisites**

COMP-GENG 421

**Credit and Contact Hours**

3 Units. 3-hours lecture-lab weekly.

**Typical Textbooks:**

Supplied lecture notes.

**Class Topics (Weeks)**

Development environment 1  
RTOS fundamentals 1  
Threads 1  
Semaphores 1  
Mutexes 1  
Queues 1  
Timers 1  
Peripherals 2  
Hazards and debugging 1  
Networking essentials 1  
Application design and structure 2  
Exams 1

**Typical Assessment**

Class participation 5%  
Quizzes 15%  
Assignments 15%  
Final Project 15%  
Mid-term Exam 20%  
Final Exam 30%

**Course Outcomes**

By the end of this course, students will be able to:

1. Describe in detail the fundamental inner workings of a small, real-time operating system (RTOS) suitable for microcontroller firmware development.
2. Develop application code that runs on top of an RTOS.
3. Debug RTOS-based application code using a combination of software and hardware techniques.
4. Avoid common hazards in multi-threaded application code.
5. Apply the tradeoffs between bare-metal and RTOS-based embedded software development when planning a project for a given microcontroller.
6. Develop, as part of a team, substantial embedded applications in C that are well designed, structured, and documented.

**Student Outcomes**

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| **Student Outcome** | **Addressed by Course Outcome(s)** |
| a) an ability to apply knowledge of mathematics, science, and engineering | 1-5 |
| b) an ability to design and conduct experiments, as well as to analyze and interpret data | 2-5 |
| c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | 1-6 |
| d) an ability to function on multi-disciplinary teams | 6 |
| e) an ability to identify, formulate, and solve engineering problems | 1-5 |
| f) an understanding of professional and ethical responsibility | 6 |
| g) an ability to communicate effectively | 5-6 |
| h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | 6 |
| i) a recognition of the need for, and an ability to engage in life-long learning | 5-6 |
| j) a knowledge of contemporary issues [in the profession] | 5 |
| k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | 1-6 |