Syllabus for
ECE 499: Embedded Systems and Hardware Control
Section 001, Call Number 13763
(Spring 2016 Semester)

Instructors: Carl G. Schaefer, Jr. and Nathalia Peixoto.

Email: For Professor Schaefer: cschaef3@gmu.edu or cgschaefer@gmail.com
For Professor Peixoto: npeixoto@gmu.edu

Phone: Professor Schaefer: 703-331-5723. Professor Peixoto: 703-993-1567

Office Hours: Professor Schaefer: Monday, 6:15 – 7:15 PM or by appointment.
Professor Peixoto: by appointment (Thursdays are the preferred day)


Suggested Readings:

Course Prerequisites: CS112, Introduction to Computer Programming
ECE285, Electric Circuit Analysis I

Class Meets: Monday, 7:20 pm – 10 pm, Room 3208, Nguyen Engineering Building

Course Web Site: All lectures, class handouts, labs, and announcements will be posted on GMU Backboard.

Student Kit (required): Students will be required to purchase a lab kit to accompany the course. The kit cost is approximately $90 and contains a BeagleBone Black single board computer, sensors for all labs (including a photocell, switch, temperature sensor, soil moisture sensor, 3-axis accelerometer, and a weather sensor), a DC motor controller, an MCP3008 A/D converter, LED lamps, LED bar graph, and various other electronic components (diodes, resistors, capacitors, voltage regulator, op amp, BS270 FET, shift register, and resistor network).

Course Objectives: The specific objectives of the course:
• To introduce students to the fundamental engineering principles essential to the design and implementation of modern embedded systems. What are they, where are they, and how are they used?
• To learn the Linux operating system and to understand why it is the operating system of choice for many types of embedded systems;
• To introduce the fundamentals of integration, control, and communications between analog and digital electronics and sophisticated single board computers;
• To provide a hands-on design experience involving the interaction of hardware and software including sensors and actuators using C/C++ and Python;
• To introduce the concept of the Internet of Things (IoT) and machine-to-machine (M2M) communications through a semester project focused on the design and development of a distributed sensor application.

Grading:
40% Labs
20% Semester Project
20% Midterm Exam
20% Final Exam
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Week 1:  Introduction to embedded systems
Week 2:  The BeagleBone Black (BBB) hardware and the Cloud9 IDE
  Lab 1:  Setting up WiFi; “Hello World” application using the Cloud9 IDE
Week 3:  Embedded Linux; introduction to the operating system and the virtual file system
  Lab 2:  Power regulation and conditioning; the LDO power regulator
Week 4:  Linux sysfs, Bash shell, Device Tree, and the configuration and control of BBB GPIO
  Lab 3:  C/C++ compilers, Python BBIO libraries, and simple servo control
Week 5:  Introduction to sensors, sensor electronics, and GPIO interrupts
  Lab 4:  Digital I/O and switch debouncing; event triggers and simple data logging
Week 6:  Analog-to-Digital conversion and the BBB ADC
  Lab 5:  Light and temperature sensors, voltage dividers, and their interface to the BBB ADC
Week 7:  Semester Project Assignment: IoT Distributed Sensor Network
Week 8:  BBB bus communications; I2C, SPI, and UART
  Lab 6:  Integrating the MCP3008 ADC with the SPI communications bus
Week 9:  Interacting with the physical environment; motors and motor controllers
  Lab 7:  The SN754410 H-bridge and DC motor control; Stepper motor control
Week 10:  Interacting with the physical environment; advanced analog sensors
  Lab 8:  Development of a simple “bubble” level using an I2C accelerometer
Week 11:  The Internet of Things (IoT): network communications, web sensors, PaaS, and VNC
  Lab 9:  The BBB as a web server using Apache
Week 12:  Computer Vision using OpenCV and Linux
  Lab 10:  Tracking an object using OpenCV
Week 13:  Introduction to the BBB Realtime Processor Unit (PRU)
  No lab:  Semester Project Demonstration
Week 14:  Final Exam

Exam and Honor Code Policy:  Make-up exams will only be given to students with excused absences. Make-up exams must be arranged in advance of the exam date. All exams will be closed book, closed notes. The GMU Honor Code will be strictly enforced.

General:  The use of cellular phones or other personal communications devices while class is in progress, or during tests, will not be tolerated. If you must have them, please turn audible ringers off and take conversations outside of class. The class is asked to respect the rights of other students and the instructor and to avoid conversations during class.

ACADEMIC INTEGRITY
GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else’s work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

GMU EMAIL ACCOUNTS:  Students must use their Mason email account to receive important university information, including messages related to the class. See http://masonlive.gmu.edu for more information

OFFICE OF DISABILITY SERVICES:  If you are a student with a disability and you need academic accommodations, please see me during the first week of classes and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS. http://ods.gmu.edu
OTHER USEFUL CAMPUS RESOURCES:
WRITING CENTER: A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu
Online/virtual reference service page is: http://library.gmu.edu/ask.
ECE infoguide: http://infoguides.gmu.edu/electrical
Zotero expert: Chris Magee; email: cmagee@gmu.edu or 703-993-2247. Students can contact him to ask Zotero questions or to make an appointment.

UNIVERSITY POLICIES: The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/.

OFFICE OF STUDENT CONDUCT: http://studentconduct.gmu.edu/

WAVES: Wellness, Alcohol and Violence Education and Services
WAVES promotes wellness within the Mason community through health education, alcohol/drug assessment and education, and violence awareness, prevention and sexual assault response. We help students make healthy, safe choices and encourage lifelong, thoughtful healthy decision-making through individualized support, creative programming, and evidence-based education and outreach.

WAVES office 703-993-9999, SUB I, Suite 3200
24-Hour Sexual and Intimate Partner Violence Crisis Line 703-380-1434 waves.gmu.edu
• 703-360-7273 (Fairfax County Office for Women and Domestic and Sexual Violence Services 25 hotline)
• 703-228-4848 (Arlington County Domestic Violence Services Hotline)
• 703-368-4141 (Prince William County Sexual Assault Victims Advocacy Services (SAVAS) hotline)
• 1-800-838-8238 (Virginia Family Violence and Sexual Assault Hotline)
• 1-800-656-HOPE (Rape, Abuse and Incest National Network) https://ohl.rainn.org/online/

CAPS: Counseling and Psychological Services
Counseling and Psychological Services (CAPS) provides a wide range of free confidential services to students, faculty, and staff. Services are provided by a staff of professional clinical psychologists, social workers, counselors, learning specialists, and psychiatric providers. CAPS individual and group counseling, workshops, and outreach programs are designed to enhance students’ personal experience and academic performance. Visit us at caps.gmu.edu for additional resources.
• For consultation or emergency assistance during office hours call 703-993-2380.
• For assistance during non-office hours, call University Police at 703-993-4357.
• 703-527-4077 (CrisisLink)
• 1-800-273-8255 (National Suicide Prevention Lifeline)
• 1-877-838-2838 (Veterans’ Crisis Hotline)

Student Health Services (SHS) — Provides confidential health care to enrolled students in emergency and non-emergency circumstances on the Fairfax, Arlington and Prince William campuses. If there is a medical emergency and Student Health Services (SHS) is closed, please contact the free after-hours nurse ((703) 993-2831), a hospital emergency room, an urgent care facility, or call 911.

SUB 1, Suite 2300, 703-993-2831

University Police:
Emergency: 911 Non-Emergency: (703) 993-2810
Reporting a Crime (Crime Solvers Anonymous Tip Hot-Line): (703) 993-4111
Mason Police Website: http://police.gmu.edu/
Eric Heath, Chief of Police Phone: (703) 993-3840 E-mail: eheath2@gmu.edu