Syllabus: ESE481 Design of Secure IoT Embedded Systems

Fall 24, K. Short

Lecture: Tuesdays and Thursdays 12:30 to 1:50 pm, Light Engineering room 154.
Laboratory: Tuesday 8:00 to 10:50 am in Light Engineering room 228.
Office Hours: TBD

Course Objectives

This course focuses on the design, development, and implementation of secure IoT systems using microcontrollers, radio modules, sensors, and actuators. Topics include practical network concepts, security and access management. installation of security credentials on a microcontroller. Microcontrollers with radio modules. Pre-provisioned radio modules. AWS serverless IoT. ExpressLink and AT commands. Permissions, policies and rules. IoT payloads and JSON. Message brokers. Publish and subscribe principle. MQTT broker and verification tools. IoT centric cloud services and their use. Operating a microcontroller in low power modes. The laboratory portion of the course provides hands-on experience in designing and implementing secure IoT embedded systems.

Tentative List of Course Topics

The following is a tentative list of topics to be covered. Variations from this list and topic order are likely.

Introduction to IoT - Remote Monitoring and Control of the Physical Environment - Phases of Sensor Data: Collection, Transmission, and Storage
Basic Data Flow to and from Server and Client - Security Credentials and Messages - Physical Communications Channels. WireShark.
Major Cloud Providers - Cloud Services and Device Support - AWS IoT, Google Cloud, and Microsoft Azure - AWS Serverless IoT Design Flow
IoT Security and Encryption Basics - Private Key, Client Certificate, and X.509 Root Certificate
Identity and Access Management (IAM) - IAM Policies (as JSON documents). Use of Policies to Describe Permissions (What You Can Use) in AWS Cloud. Least Privilege Model
Microcontrollers with Radio Modules for IoT - ESP8266 and ESP32
Installing Security Credentials - Cloud side provisioning
Pre-provisioned WiFi Radio Modules - ExpressLink Modules - Expressif ESP32-C3-Mini AWS IoT ExpressLink - u-blox USB-NORA-W256AWS
Message Brokers - Messaging Protocols - Publish/Subscribe Model - MQTT - Verification Tools - Virtual IoT Device Apps - MQTTfx, MQTT Explorer

JSON IoT Data Payloads - JSON Parsing in C
Managed Cloud Services - Computation, Storage, Database, Analytics - Rules and Actions - IoT Centric Services - AWS IoT Simple Storage Service (S3), Grafana, Analytics, QuickSight, and CloudWatch
Device Shadows - Continued Device Operation Without Cloud Connectivity and Synchronized Data Once Connection Restores
Over-the-wire (OTW) and over-the-air (OTA) - Remote Security Updates, Bug Fixes, and Firmware Updates
Microcontroller Low Power Modes and Operation - Low Power Design

Prerequisites

The prerequisite for this course is ESE381 Embedded Microprocessor System Design II.

Course Structure

This course has a lecture, discussion, and laboratory format. Lectures and discussions assume that you have completed the prerequisite reading assignments.

Laboratory sessions start the week starting September 8th. Laboratory sessions are held in the Embedded Systems Design Laboratory, room 228 in the Light Engineering Building.

Source Material

The following textbooks and references are required for this course:

1. Bernstein, James. Networking Made Easy: Get Yourself Connected (Computers Made Easy Book 2). Kindle Edition.

2. Borsay, Stephen. AWS Serverless IoT: Inexpensive IoT Projects to take you from Zero to AWS IoT Hero. Kindle Edition, ISBN: 979-8-9867878-0-0, 2022.

3. Cope, Stephen. MQTT For Complete Beginners: Learn The Basics of the MQTT Protocol. Stephen Cope. Kindle Edition.

4. AWS IoT Core Developer Guide Amazon Web Services. A link will be provided.

5. AWS IoT ExpressLink programmer's guide v1.1. A link will be provided

Manufacturers' application notes, data sheets, and technical papers are also used in this course. These are made available on Brightspace either directly or via links.Grades

Course grade computation (exam dates are tentative):

Exams		**45%**
Exam 1	Thursday, Sept. 19th	15%
Exam 2	Tuesday, Oct. 22nd	15%
Exam 3	Tuesday, Nov. 19th	15%

Makeup Final Dec. 17 11:15 am to 1:45 pm

Laboratory	**45%**
Lecture Attendance	**10%**

There are three required exams, Exams 1, 2, and 3. If you miss any one of these exams, for any reason, you must take the comprehensive makeup final. Your grade on the Makeup Final will replace a single missing exam grade. If you miss two or more exams, your Makeup Final grade replaces only a single exam grade. Other missed exam grades will be 0s. The Makeup Final Exam will be comprehensive and more difficult than Exams 1, 2, and 3.

If you don't miss any exams, you cannot take the Makeup Final Exam.

NO LABORATORY WORK IS ACCEPTED LATE. ALL PRELAB SUBMISSIONS MUST BE RECEIVED BY 9:00 PM ON THE DAY BEFORE YOUR SCHEDULED LABORATORY SESSION OR THEY WILL BE CONSIDERED LATE AND WILL NOT BE ACCEPTED.

ANY QUESTIONS RELATED TO LABORATORY OR EXAM GRADES MUST BE RESOLVED WITHIN 7 CALENDAR DAYS FROM THE DAY THE GRADED MATERIAL IS MADE AVAILABLE FOR RETURN.

Academic Dishonesty

Academic dishonesty is taken very seriously in this course. If you are caught cheating on an exam you will get a grade of F for the course and your case will be submitted to the Committee on Academic Standing and Appeals (CASA) of the College of Engineering for further action.

Tentative Lecture Schedule

Lectures are presented based on the assumption that you have completed the reading assigned prior to the lecture. This same assumption applies to exams as well. A tentative schedule of the lecture topics is provided on Brightspace. Each lecture handout will be available on Brightspace at least one week prior to the lecture. It is recommended that you print each lecture handout and bring it to class.

Brightspace
You can access class information on-line at: https://mycourses.stonybrook.edu/d2l/login If

you used Brightspace during the Fall semester, your login information (Username and Password) has not changed. If you have never used Stony Brook's Brightspace system, your initial password is your SOLAR ID# and your username is the same as your Stony Brook username, which is generally your first initial and the first 7 letters of your last name.

For problems logging in, go to the helpdesk in the Main Library SINC Site or the Union SINC Site, you can also call: 631-632-9602 or e-mail: helpme@stonybrook.edu.

The University Senate Undergraduate and Graduate Councils have authorized that the following required statements appear in all teaching syllabi (graduate and undergraduate courses) on the Stony Brook Campus:

Student Accessibility Support Center Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Academic Integrity Statement

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.