

NET 451 Syllabus – Networking for IoT – Spring 2023

Instructor	Dr. Sharief Oteafy	Phone	312 362-8127
Office	CDM 846 (via Zoom)	E-mail	soteafy@depaul.edu
Office Hours	Thursdays 1 – 2:30 pm (or by appointment)	Website	d2l.depaul.edu
Class Location	CDM 222	Class time	Thursdays 5:45 pm – 9 pm

--- Any changes made to this syllabus will be announced in class -- This is Version 1: 28 March 2023 ---

Course Overview

This course will cover networking for low-power devices, focusing on the Internet of Things (IoT). Our emphasis will be on energy-efficient network design and implementation, and topics will cover design challenges in scalability, interoperability, and performance evaluation. This course will establish foundations for leveraging Cloud Computing variants (Fog, Cloudlets and Cloud) for improving network operation and IoT data management. Students will learn how to formally model and design protocols for IoT systems, and gain practical experience in developing IoT prototypes in a course-long team-based project. The course will also cover recent developments in Cellular IoT infrastructures, and will address security vulnerabilities and challenges in CPS systems. The broader scope of Cyber Physical Systems (CPS) will be addressed both in design and integration with IoT systems.

Pre-requisite: IT 263

Resources:

Optional text: Dynamic Wireless Sensor Networks, by S. Oteafy and H. Hassanein, Wiley, 2014

Weekly readings (papers) to be assigned by course instructor.

Grade distribution over required coursework

Task	% of final grade
2 Homework assignments	20 %
Midterm exam	20 %
Technical presentation	10 %
Project implementation and Report	25 %
Final Exam	20 %
Class participation	5 %

Attendance and required coursework

Students are expected to attend **all class sessions**. At the end of each class, reading material (if any) will be announced, in preparation for the following class. All students are expected to communicate with the instructor (beforehand) if they anticipate they won't be able to attend a given class session. If a class is missed, it is upon the student to schedule a meeting as soon as possible with Dr. Oteafy to recap on what was discussed, and plan their studies accordingly. The Class participation & discussion grade will be **earned** as follows: students gain **0.5 %** credit towards their final grade for each lecture **actively** attended (total of up to 10% of final grade for 10 class sessions). Active attendance means that you will respond if I call on you, **and** actively engage in class discussions. It is critical that you strive to attend all class sessions, and engage with the material in the live class discussions.

Course policies

General academic policies

All students are required to manage their class schedules each term in accordance with the deadlines for enrolling and withdrawing as indicated in the [University Academic Calendar](#). Information on enrollment, withdrawal, grading and incompletes can be found at: cdm.depaul.edu/enrollment. Note that **April 10th 2023** is the last date to drop the class with no penalty.

Plagiarism

There is a "zero-tolerance policy" regarding plagiarism. This stands for both the plagiarizer and the person(s) facilitating plagiarism (e.g., allowing someone to plagiarize their work). There's a great resource put together by DePaul University, which you can find here: <https://resources.depaul.edu/teaching-commons/teaching-guides/learning-activities/Pages/avoiding-plagiarism.aspx>

Academic Integrity

One of the core principles of education is establishing Academic Integrity. It is a viable component in the classroom, one by which learning objectives could be honestly and efficiently met. The principles of academic integrity should span all of your learning endeavours, within and beyond this course. For more information on Academic Integrity, especially definitions and norms, please visit: <https://offices.depaul.edu/academic-affairs/faculty-resources/teaching/academic-integrity/Pages/resources.aspx>. This will be the basis of all of our interactions in this course. If you have any questions or concerns, feel free to drop by and see me.

Deadlines and submission policies

Assignments are due on D2L by 11:59 pm on the deadline day posted on each assignment, unless otherwise announced. All of your work (exams, assignments, report, etc) must be your original work. Any evidence of departure from Academic Integrity will be reported, and ensuing sanctions will be pursued. You are expected to read, understand and comply with DePaul's policy on Academic Integrity, which you can reach from the aforementioned website. **Late submissions receive a 10% penalty for every day after the deadline.**

Missing exams and/or deadlines

Emergencies happen and that is quite understandable. If you miss an exam due to a certain emergency (e.g., accident, emergency hospitalization, etc) please communicate with me as soon as you can to resolve any outstanding issues. If a major illness hinders you from attending an exam or submitting a deliverable (assignment), you need to contact me beforehand via e-mail. Notices received after the deadline will not be accounted for (unless for an emergency as highlighted above). If the illness occurred after the deadline, even if accompanied with a doctor's note, you would receive a zero for that exam/deliverable.

Otherwise, missing an exam without prior approval will warrant an automatic zero. Generally, all extensions are considered on a case-by-case basis. Falling sick prior to a deadline does not automatically warrant an extension. If you have any questions or concerns, please don't hesitate in contacting me.

Disability Accommodation

Feel free to speak to me as soon as possible regarding any difficulties you feel you might be encountering in this course, ideally within our first week of classes. Kindly refer to DePaul's Center for Students with Disabilities website <https://offices.depaul.edu/student-affairs/support-services/for-specific-populations/Pages/students-with-disabilities.aspx>. If you feel that any given disability is hindering you, or you are not sure and wish for a consult, please reach out to CSD at csd@depaul.edu; they are trained to help out and point you to the appropriate resources. All of us at DePaul have the common goal of helping you learn, and achieve your potential.

Grade calculation

Final grades will be calculated as follows: points earned divided by possible points in each category will be multiplied by the contribution percentages shown to yield a total course percentage score between 0% and 100%. Letter grades will be assigned as:

A = 90% - 100%	A- = 88% - 90%	B+ = 86%-88%	B = 80% - 86%	B- = 78% - 80%
C+ = 76% - 78%	C = 70% - 76%	C- = 68% - 70%	D+ = 66% - 68%	D = 60% - 66%
		F = 0% - 60%		

Class schedule and topics

Week	Class date	Tentative Topics
1	March 30	An overview of IoT and Cyber Physical Systems: Operational mandates, Protocol stacks and design principles Evolution from MANets and WSNs
2	April 6	Low-power communication: RF/Acoustic communication, and design trade-offs IEEE 802.11ah (HaLow), IEEE 802.11ax (HEW), Sigfox®
3	April 13	Medium Access Control: Design trade-offs for power, overhead, interference and robustness
4	April 20	Designing ad hoc networks: Formal methods of design + FSM representations
5	April 27	ZigBee®, Bluetooth, BLE, Thread, and LoRaWAN Midterm exam
6	May 4	Data representation and Resource management in IoT IoT reference models
7	May 11	Impact of Cloud variants on IoT operation (Mist, Fog, Cloudlets and Cloud)
8	May 18	Cellular IoT and M2M communication (LTE-M, NB-IoT) Convergent-IoT design principals Technical presentations (10 minutes per student)
9	May 25	Interplay with CPS (M2M, Vehicular IoT, and role of Actuation) IoT Standards & Alliances: IEEE P2413, Allseen, Thread, LoRaWAN Technical presentations (10 minutes per student)
10	June 1	IoT security: Design challenges, vulnerabilities and light-weight solutions Final project demos and presentations
11	June 8	Final exam

Learning Outcomes

After completing this course, students will be able to:

- Synthesize foundational ad hoc networking concepts for CPS and IoT
- Analyze and design Ad hoc Networks
- Design protocols for IoT networks in a team-based setting
- Develop preliminary designs of IoT systems
- Understand and identify security challenges in IoT and CPS

Exams

All exams will be in person, in class, on paper.

Course evaluations

During the course, your feedback on how well the course is running (pace, difficulty, resources, etc) will be solicited. This is a vital component of improving and tailoring this course to your learning objectives. While all students are expected to achieve the learning outcomes highlighted above, each of us inevitably learn differently.

If you have any concerns about how the course is running, or would like to suggest an improvement, feel free to reach out to me. Also, on week 10, we will hold the official course evaluations in class.

Course Project

Students are expected to learn how to formally model and design protocols for IoT systems, and gain practical experience in developing IoT prototypes in a course-long team-based project. Students will get to work as teams on developing IoT systems on different kits (chosen from GrovePi+, mCookie 302, Raspberry Pi 3) of their choosing, to apply the fundamentals of IoT design covered in this course. We will discuss team-formation in class 1, and the expectations in collegial development, team-based learning, and the development of a final system with accompanying documentation and presentation. Most IoT/CPS systems today involve multi-disciplinary teams, and it is important that students acquire the skills needed to partake in such team-based development.