

NET 451 Syllabus – Networking for IoT – Spring 2024

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Office Hours	Thursdays 10 – 11:30 am (or by appointment)	Website	d2l.depaul.edu
Class Location	Lewis 1510	Class time	Thursdays 5:45 pm – 9 pm

--- Any changes made to this syllabus will be announced in class -- This is Version 1: 1 April 2024 ---

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	25 %
Technical presentation	5 %
Project implementation and Report	20 %
Final Exam	25 %
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 14th 2024** is the last date to drop the class with no penalty.

Mental Health and Academic Assistance

DePaul has great resources just a phone call or email away. Sometimes people feel like their situation isn't the worst possible, so they assume they do not need help, but don't let that prevent you from reaching out! **DePaul University Counseling Services** – mental health is as important as physical health, and DePaul professionals are just a call away: offices.depaul.edu/student-affairs/about/departments/Pages/ucs.aspx (call (773) 325-7779 or 911 for emergency). **Office of the Dean of Students** can help you with a wide range of topics, including figuring out if you should withdraw or apply for an incomplete: offices.depaul.edu/student-affairs/about/departments/Pages/dos.aspx. There are lots of additional, more specific resources listed here with the **Office of Student Affairs**, including crisis hotlines: offices.depaul.edu/student-affairs/support-services/counseling/Pages/Crisis-Hotlines.aspx.

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. These principles should span all of your learning endeavours. For more information on Academic Integrity, especially definitions and norms, please visit: <https://resources.depaul.edu/teaching-commons/teaching/academic-integrity/Pages/default.aspx>. This will be the basis of all of our interactions in this course. All students are expected to abide by the University's Academic Integrity Policy which prohibits cheating and other misconduct in student coursework. Publicly sharing or posting online any prior or current materials from this course (including exam questions or answers), is considered to be providing unauthorized assistance prohibited by the policy. Both students who share/post and students who access or use such materials are considered to be cheating under the Policy and will be subject to sanctions for violations of Academic Integrity.

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. **Late submissions receive a 10% penalty for every 24 hour delay.**

Missing exams and/or deadlines

Emergencies happen and that is quite understandable. If you miss an exam due to an 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, you need to contact me beforehand via e-mail. Notices received after the deadline will not be accounted for (unless for an emergency). 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. 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.

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 = 93% - 100%	A- = 90% - 92%	B+ = 87%-89%	B = 83% - 86%	B- = 80% - 82%	
C+ = 77% - 79%	C = 73% - 76%	C- = 70% - 72%	D+ = 66% - 69%	D = 60% - 66%	F = 0% - 60%

Class schedule and topics

Week	Class date	Tentative Topics
1	April 2	An overview of IoT and Cyber Physical Systems: Operational mandates, Protocol stacks and design principles Evolution from MANets and WSNs
2	April 9	Low-power communication: RF/Acoustic communication, and design trade-offs IEEE 802.11ah (HaLow), IEEE 802.11ax (HEW), Sigfox®
3	April 16	Medium Access Control: Design trade-offs for power, overhead, interference and robustness
4	April 23	Designing ad hoc networks: Formal methods of design + FSM representations
5	April 30	ZigBee®, Bluetooth, BLE, Thread, and LoRaWAN Midterm exam
6	May 7	Data representation and Resource management in IoT IoT reference models
7	May 14	Impact of Cloud variants on IoT operation (Mist, Fog, Cloudlets and Cloud)
8	May 21	Cellular IoT and M2M communication (LTE-M, NB-IoT) Convergent-IoT design principals Technical presentations (10 minutes per student)
9	May 28	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 4	IoT security: Design challenges, vulnerabilities and light-weight solutions Final project demos and presentations
11	June 11	Final exam 17:45 – 20:00

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 (e.g. Makeblock mbot, GrovePi+, Raspberry Pi 4) 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.