Course Name: Envirotech - do it yourself sensors for environmental research (001.2.5074)
Lecturers: Elad Levintal

Course description:
The objective of this course is to explore the integration of do-it-yourself (DIY) hardware, mainly open-source, low-cost microcontrollers and sensors, in environmental research. In this course, you will explore how the integrated use of this hardware type with concepts such as the Internet of Things (IoT) can be utilized to collect environmental data, automate processes, and improve environmental research. Throughout the course, you will gain practical knowledge on designing, developing, and implementing DIY-based solutions for different applications in environmental research, focusing on air, soil, water, and agricultural monitoring. For example, you will learn to use sensors to collect real-time temperature and CO_2 data from soils to calculate CO_2 emissions at the soil-atmosphere interface. This course is constructed for students interested in gaining hands-on experience in designing, coding, and implementing DIY-based sensor systems. By the end of this course, you will have a solid understanding of how to apply microcontrollers and sensors in environmental research, which will equip you with valuable skills for future research or professional opportunities. Although electronics and basic coding are the focus of this course, no previous engineering knowledge is needed – just motivation!

Credits:
Three points (three hours – lecture)

Course Language:
English

Prerequisites:
Second year and above

Evaluation (% of final grade):
- 10% - Presence
- 30% - Mid-semester project (individual)
- 60% - Final project (two people per project)
    - 30% - System setup and functionality
    - 20% - System documentation (GitHub)
    - 10% - Project presentation in class

Attendance regulation:
100% presence is required (10% of final grade)

Reading list:
Course website
Online, open-source resources

Detailed description of the course:
1. Introduction:
- Course overview
- Introduction to open-source, low-cost hardware concepts
- Introduction to microcontrollers
- Introduction to sensors
- Where to buy the hardware

- Introduction to Arduino IDE
- Introduction to online tools (ThingSpeak)
- DIY research labs and groups around the world
- Safety issues!

2. Basic electronics:
- Multimeter, Ohm's law, and circuitry
- Circuits on breadboard
- Soldering

3. Projects:
- What is a DIY sensor-based project
- Project flowchart
- Real-life projects examples
- Projects components: Data logging, power management (batteries, solar panels, sleep mode), online monitoring tools (dashboard), enclosures and weatherproofing/waterproofing
- Pitfalls and challenges
- Presenting the mid-semester project (individual) – build your own temperature, RH, and light logging device

4. Hardware:
- Microcontrollers
- Add-on boards (e.g., shields, wings)
- Sensors for air, soil, water, and agricultural monitoring
- Sensor communication protocols (I2C, UART, analog)
- Fritzing software

5. Sensor resolution, calibration, and validation
6. Software – Arduino IDE
- Arduino code structure
- Libraries
- Comments
- GitHub

7. Building your own data logger
- SD card
- Real-time clock
- Coding

8. ESP32
- ESP32 coding
- Using ThingSpeak with ESP32

9. Troubleshooting
10. Guest speaker – water content sensors
11. Projects development
12. Projects development
13. Projects development
14. Projects presentation in class