

## DELIVERABLE 5.3

### Setup E-Learning Modules

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## LIST OF CHANGES

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## 1. INTRODUCTION

This document reports on the e-learning training modules developed in the scope of the Erasmus+ Capacity Building Project 609971-EPP-1-2019-1-JO-EPPKA2-CBHE-JP "Introducing Recent Electrical Engineering Developments into Undergraduate Curriculum" (IREEDER).

In detail, the purpose of this document is to provide a detailed description of the three produced learning modules on:

- Cybersecurity
- Internet of Things
- Renewable Energy

This document is developed in the scope of the WP 5 - Exploitation of results and sustainability plan (Dissemination & Exploitation) of the Project in compliance with the Project description and all applicable rules & guidelines.

## 2. PLATFORM SELECTION

In what concerns the platform to host the e-learning modules, a thorough selection process was conducted in order to select a platform that should be as:

- **open** (with easy access to a wider audience, that should be able to register to the courses in a simple manner)
- and as **sustainable** (not dependent on an institutional platform – as many get reset every academic year, but longer lasting).

as possible.

The consortium opted for Google Classroom as a platform for hosting the three courses due to the following characteristics:

- the platform permits access to information anytime, anywhere;
- it allows for the management of multiple activities within the same course;
- it can host extensive material on each of the topic, making it adequate to host the 13 sessions of each course;
- it allows interaction with the Google suite of apps (Google Drive, Docs, Sheets etc.) for producing and storing work and for sharing learning materials;
- it permits discussions among participants (student/student interaction) and between participants and tutors (student/teacher interaction);
- it allows for an easy enrollment and organization of students/participants.

### 3. COURSE STRUCTURE

Each course duly identifies the course and the IREEDER project in the cover page (Figure 1).



*Figure 1: Course Header*

The entry page provides the introductory words on the course, detailing the learning outcomes of each course (Figure 2).



*Figure 2: Introductory Page*

The Classwork page gives access to:

- the structure of the course
- the calendar which contains information on the completion dates of the tasks
- the google drive folder associated with the course

The screenshot displays a course landing page for "Introduction to Internet of Things". The page features a navigation bar with tabs for "Stream", "Trabalhos da turma", "Pessoas", and "Notas". On the left, a sidebar lists the course structure, including "Todos os tópicos" and chapters 1 through 13. On the right, there are two yellow boxes: one for "Calendário Google" and another for "Pasta do Drive da turma". Below these, the course content is organized into chapters. Chapter 1, "Introduction to IoT", includes "IoT - Full Set of Slides" (published 8/06), "IoT Full Set of Lecture Notes" (published 8/06), "Chapter 1 Slides - Introduction to IoT" (edited 8/06), "Chapter 1 Lecture Notes" (edited 8/06), and "Introduction to IoT" (edited 17/06). Chapter 2, "Revision of Basic Programming an...", includes "Chapter 2 Slides - Revision of Basic Progra..." (edited 8/06), "Chapter 2 - Lecture Notes" (published 8/06), and "Quiz 2 : Revision of Basic Programming and ..." (edited 9/06).

*Figure 3: Landing Page: course structure, calendar and course folder access*

The full structure of the course is accessible at all times via the classwork page, and allows for a revision of previously introduced topics.



Stream	Trabalhos da turma	Pessoas	Notas
<p>+ Criar <span style="float: right;">Calendário Google Pasta do Drive da turma</span></p>			
<p>IoT - Full Set of Slides <span style="float: right;">Publicado em 8/06</span></p>			
<p>IoT Full Set of Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p><b>Chapter 1: Introduction to IoT</b></p>			
<p>Chapter 1 Slides - Introduction to IoT <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 1 Lecture Notes <span style="float: right;">Editado às 8/06</span></p>			
<p>Introduction to IoT <span style="float: right;">Editado às 17/06</span></p>			
<p><b>Chapter 2 : Revision of Basic Programming an...</b></p>			
<p>Chapter 2 Slides - Revision of Basic Progra... <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 2 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 2 : Revision of Basic Programming and ... <span style="float: right;">Editado às 9/06</span></p>			
<p><b>Chapter 3 : Software Development for IoT Em...</b></p>			
<p>Chapter 3 Slides - Software Development fo... <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 3 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 3: Software Development for IoT Embe... <span style="float: right;">Publicado em 9/06</span></p>			
<p><b>Chapter 4 : IoT architecture and components (...)</b></p>			
<p>Chapter 4 Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 4 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 4 - IoT architecture and components (L... <span style="float: right;">Publicado em 10/06</span></p>			
<p><b>Chapter 5 : IoT architecture and components (...)</b></p>			
<p>Chapter 5 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 5 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 5 - IoT architecture and components (... <span style="float: right;">Editado às 10/06</span></p>			
<p><b>Chapter 6 : IoT Microcontrollers, Sensors for D...</b></p>			
<p>Chapter 6 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 6 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 6 - IoT Microcontrollers, Sensors for D... <span style="float: right;">Publicado em 17/06</span></p>			
<p><b>Chapter 7 : IoT Connectivity Technologies</b></p>			
<p>Chapter 7 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 7 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 7: IoT Connectivity Technologies <span style="float: right;">Publicado em 16/06</span></p>			
<p><b>Chapter 8 : IoT Connectivity Protocols</b></p>			
<p>Chapter 8 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 8 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 8 - IoT Connectivity Protocols <span style="float: right;">Publicado em 17/06</span></p>			
<p><b>Chapter 9 : Data Storage and Cloud Systems</b></p>			
<p>Chapter 9 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 9 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 9 - Data Storage and Cloud Systems <span style="float: right;">Publicado em 17/06</span></p>			
<p><b>Chapter 10 : Data Analytics and Applications</b></p>			
<p>Chapter 10 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 10 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 10 - Data Analytics and Applications <span style="float: right;">Publicado em 17/06</span></p>			
<p><b>Chapter 11: IoT Security and security standards</b></p>			
<p>Chapter 11 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 11 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 11: IoT Security and security standards <span style="float: right;">Publicado em 21/06</span></p>			
<p><b>Chapter 12 : Ethics in IoT Networks and Applic...</b></p>			
<p>Chapter 12 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 12 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 12: Ethics in IoT Networks and Applicat... <span style="float: right;">Publicado em 15/06</span></p>			
<p><b>Chapter 13 : Key-Enabling Technologies and A...</b></p>			
<p>Chapter 13 - Slides <span style="float: right;">Editado às 8/06</span></p>			
<p>Chapter 13 - Lecture Notes <span style="float: right;">Publicado em 8/06</span></p>			
<p>Quiz 13: Key-Enabling Technologies and Ap... <span style="float: right;">Publicado em 16/06</span></p>			

Figure 4: Course structure

## 4. COURSE ON INTERNET OF THINGS

The course on Internet of Things (<https://classroom.google.com/w/NTEzOTQ1MjIwMjAw/t/all>) is composed of thirteen modules:

- **Chapter 1: Introduction to IoT**  
Abstract: Chapter 1 constitutes an introductory overview of the IoT. It defines the term IoT and, reviews the history and overviews the key-enabling technologies. It summarizes the main applications of IoT and identifies the key research directions and connections.
- **Chapter 2 : Revision of Basic Programming and IoT IDE**  
Abstract: Chapter 2 presents a revision of Basic Programming covering topics like variables, conditional statements, looping functions, I/O and presents the IoT IDE.
- **Chapter 3 : Software Development for IoT Embedded Systems**  
Abstract: Chapter 3 covers embedded programming in C including flow control, function decomposition, data representation and structures
- **Chapters 4 and 5 : IoT architecture and components (1/2 and 2/ 2)**  
Abstract: Chapters 4 and 5 present IoT architectures and the main IoT components, alongside references to Cyber-Physical systems, smart devices, and basicon storage and CPU, data movement, fetch-execute, accelerators, input/output inc. SPI/I2C, peripherals and Embedded device memory architecture; SRAM, DRAM,.
- **Chapter 6 : IoT Microcontrollers, Sensors for Data Acquisition and Actuators**  
Abstract: Chapter 6 introduces IoT Microcontrollers, Sensors for Data Acquisition and Actuators.
- **Chapter 7 : IoT Connectivity Technologies**  
Abstract: Chapter 7 discusses IoT Connectivity Technologies presenting the main Wireless technologies for the IoT (WiFi, Bluetooth, Zigbee, 6LowPAN, LoraWAN, etc.), Wireless sensor networks (Z-wave etc.) and mobile Technologies (4G, 5G).
- **Chapter 8 : IoT Connectivity Protocols**  
Abstract: Chapter 8 presents the main IoT Connectivity Protocols. These include edge connectivity and protocols, Network and Data Protocols and data transmission using IoT protocols (e.g. MQTT).
- **Chapter 9 : Data Storage and Cloud Systems**  
Abstract: Chapter 9 introduces the basics of Cloud Computing, processing in Internet of Things Services and Data Storage
- **Chapter 10 : Data Analytics and Applications**  
**Abstract:** Chapter 10 presents Data analysis and applications used in IoT. It deals with the Interpretation of IoT Data, Visualization of Data and gives an example through a case study
- **Chapter 11: IoT Security and security standards**  
Abstract: Chapter 11 overviews the principles of IoT Security and various security measures and standards proposed

- **Chapter 12 : Ethics in IoT Networks and Applications**

Abstract: Chapter 12 covers the ethical aspects in IoT overviewing topics related to data ownership, data protection, trust, transparency etc.

- **Chapter 13 : Key-Enabling Technologies and Applications in IoT**

Abstract: Chapter 13 overviews some key-enabling technologies and Applications in IoT such as Identification, Mobility, Positioning/Localization and also topics on how power up the IoT like Energy Harvesting, Battery Life Optimisation etc.

Each of the chapters contains detailed lecture notes, and a quiz (Figure 5) focusing on the corresponding chapter content.

### Quiz 1: Introduction to IoT

---

**Bluetooth Low Energy is an IoT technology for... \*** 10 pontos

Short range connectivity.

Long range connectivity.

Smartphones.

None.

**A common challenge in several IoT systems is... \*** 10 pontos

Energy consumption.

Addressing.

Throughput.

None.

**A typical consumer application of IoT is: \*** 10 pontos

Smart Home.

Smart City.

Smart Grid.

None.

**The Internet of Things architecture typically consists of the following layers: \*** 10 pontos

Devices, Edge Gateway, the Cloud.

Application, Transport, Network, Link and Physical layer.

Devices and the Cloud.

None.

**Which is a suitable IETF standard for IoT? \*** 10 pontos

6LoWPAN.

MQTT.

Bluetooth.

None.

**Currently, most "Things" are located... \*** 10 pontos

At home or at work.

In smart cities.

In datacenters.

None.

**What is the Internet of Things?** 10 pontos

A network of interconnected "things" using Internet technology.

A network of interconnected "things" using proprietary technology.

A network of people using "things".

None.

**Power Line Communication uses electrical wires to... \*** 10 pontos

Transfer digital data.

Transfer electrical power.

Connect to the Internet.

None.

*Figure 5: IoT Quiz, example*

## 5. COURSE ON RENEWABLE ENERGY

The course on Renewable Energy (<https://classroom.google.com/w/NTEzMzcwOTcyMTEz/t/all>) is composed of thirteen modules:

- **Chapters 1 and 2 : Introduction and Overview of Renewable Energy Resources (1/2 and 2/2)**  
Abstract: Chapters 1 and 2 introduce the topic of Renewable Energy Resources
- **Chapter 3 : Physics of sunlight and photovoltaics**  
Abstract: Chapter 3 covers the topic of Physics of Sunlight and Photovoltaics
- **Chapter 4 : Photovoltaic system components**  
Abstract: Chapter 4 introduces the topic of Photovoltaic system component: the photovoltaic circuit is described and the power electronics of the system are visited. The types of photovoltaic systems and their design are given.
- **Chapter 5 : Photovoltaic system calculation and aspects**  
Abstract: Chapter 5 covers the topic of photovoltaic system calculation and aspects, providing examples of photovoltaic applications, the economics of PV systems and their environmental aspects.
- **Chapter 6 : Solar Thermal Systems**  
Abstract: Chapter 6 discusses solar thermal systems, describing the technologies of concentrated solar power and thermal energy storage. Solar water heating systems are presented and various issues of a CSP system are described.
- **Chapter 7 : Wind Energy Fundamentals**  
Abstract: Chapter 7 introduces the topic of wind energy, addressing Wind Power, Wind Power Origin, Classification of Wind Turbines, Wind Turbine Subsystems, Types of Wind Generation Systems.
- **Chapters 8 and 9 : Wind Turbines Operation and Control (1/2 and 2/2)**  
Abstract: Chapters 8 and 9 discuss wind turbine electrical components, detailing the types of wind turbine generators, types of wind turbine generator systems and power electronic in wind turbines.
- **Chapters 10 and 11 : Energy storage (1/2 and 2/2)**  
**Abstract:** Chapters 10 and 11 provide an introduction to the main challenges of the electric power industry and to the various energy storage systems and their technical characteristics.
- **Chapter 12 : Off-grid / stand-alone systems**  
Abstract: Chapter 12 introduces the general definitions of off-grid, stand-alone and mini-grid systems of electrification
- **Chapter 13 : Integrating of Renewable Energy into electrical grid (Challenges, Solutions and Grid Code)**  
Abstract: Chapter 13 discusses challenges for utilities and system operators of renewable energy integration, as well as possible solutions.

Each of the listed chapters contains detailed lecture notes, and a quiz (Figure 6) focusing on the corresponding chapter content.

## Quiz 2

---

1. The majority of Earth's geothermal resources are 1 points

In the center of the tectonic plates

around the boundaries between tectonic plates

In the oceans

In the swallows of the Earth's crust

6. Marine energy 1 points

comes from waves

comes from tides

comes from salinity

all the above

2. The highest direct use of geothermal energy is in 1 points

space heating

bathing and swimming

geothermal heat pumps

greenhouse heating

7. The countries responsible for over 90% of total installed capacity of marine energy are 1 points

Republic of Korea and France

United Kingdom and Canada

Spain and China

Netherlands and Australia

3. Geothermal energy 1 points

contributes to global warming

is not considered a renewable resource

has no effect on land stability

does not pose any risk of triggering earthquakes

8. Wave energy converters 1 points

can be situated only on the shoreline

raise environmental concerns

include a tidal stream generator

do not produce underwater noise

4. The largest source of worldwide renewable electricity generation is 1 points

wind

solar

hydropower

biomass

9. Storage of energy: 1 points

Pumped storage systems store energy in the form of potential energy of water and are the less cost-effective type for storing energy

Compressed air energy storage uses compressed air to store generated energy

The storage capacity of the batteries does not depend on their age

Superconducting magnetic energy storage systems store energy in the electric field of a superconducting coil

5. Hydropower plants 1 points

store power with very high cost

have a very short life

have high emissions of greenhouse gases

can easily increase or decrease production

10. The power technology that shows decrease in average levelized cost of energy (LCOE) is 1 points

geothermal

hydropower

solar

bioenergy

Figure 6: RE Quiz example

## 6. COURSE ON CYBERSECURITY

The course on Renewable Energy (<https://classroom.google.com/c/MzYxOTg2MzA5MjU2>) is composed of thirteen modules:

- **Chapter 1: Security and Risk Management**  
Chapter 1 serves as an introductory overview of the CS field. It defines Security and Risk Management, basic concepts (confidentiality, integrity, availability and privacy), legal and regulatory issues, documented security policy, standards, procedures, and guidelines, risk management concepts and threat modelling.
- **Chapter 2 : Security Engineering: Introduction**  
Chapter 2 serves as an introduction to security engineering and how to implement and manage an engineering lifecycle using security design principles. It defines security models and architectures, countermeasures based upon information systems security standards.
- **Chapters 3 and 4 : Security Engineering: Cryptography & Key Management (1/2 and 2/2)**  
Abstract: Chapters 3 and 4 are about Cryptography & Key Management & Cryptography Services. They cover Cryptographic Lifecycle, Cryptographic Types, Public Key Infrastructure (PKI) and Key Management practices, Digital Signatures, Digital Rights Management (DRM), Non-repudiation, Integrity (hashing and salting), Methods of Cryptanalytic Attacks.
- **Chapter 5 : Chapter 5: Communications & Network Security: Introduction**  
Abstract: Chapter 5 is about secure design principles and cryptography used to maintain communications security.
- **Chapter 6 : Communications & Network Security: Securing network components**  
Abstract: Chapter 6 presents the securing network components, data, operation of hardware, transmission media, network access control devices and endpoint security.
- **Chapter 7 : Communications & Network Security: Securing communication channels**  
Abstract: Chapter 7 is about securing communication channels, remote access, data communications and virtualized networks.
- **Chapters 8: Security Operations: Logging, Monitoring & Access Control**  
Abstract: Chapter 8 describes login, monitoring, and access control.
- **Chapters 9: Security Operations: Intrusion detection & Prevention**  
Abstract: Chapter 9 is about intrusion detection and prevention.
- **Chapter 10 : Security Operations: Recovery & Incident Response**  
**Abstract:** Chapter 10 describes recovery and incident response.
- **Chapter 11 : Security Assessment and Testing**  
Abstract: Chapter 11 is about security assessment and testing, assessment and test strategies and penetration testing.
- **Chapter 12 : Software Development Security**



Abstract: Chapter 12 presents security in the software development life cycle and software protection mechanisms.

• **Chapter 13 : Impact of new technologies on cybersecurity**

Abstract: Chapter 13 overviews the impact of new technologies on Cybersecurity, Advanced Persistent Threats (APTs), BYOD and Technology Customization

As with the other two courses, each of the listed chapters contains detailed lecture notes, and a quiz focusing on the corresponding chapter content.

### Quiz 13

This quiz is intended to evaluate the gained knowledge from Chapter 13

1. These threats are listed in order of least to greatest capability.

a. Unsophisticated Threat (UT), Unsophisticated Persistent Threat (UPT), Smart Threat (ST), Smart Persistent Threat (SPT), Advanced Threats (AT), Advanced Persistent Threat (APT)

b. Unsophisticated Persistent Threat (UPT), Advanced Threats (AT), Unsophisticated Threat (UT), Smart Threat (ST), Smart Persistent Threat (SPT), Advanced Persistent Threat (APT)

c. Advanced Threats (AT), Advanced Persistent Threat (APT), Unsophisticated Threat (UT), Unsophisticated Persistent Threat (UPT), Smart Threat (ST), Smart Persistent Threat (SPT).

2. Possible targets of an APT are:

a. Theft of Intellectual property (corporate espionage)

b. Theft of private data (Insider trading, blackmail, espionage)

c. Theft of money (electronic funds transfer, theft of ATM credentials, etc.)

d. Leaking of classified government information (espionage, spying, etc.)

e. Political or activist motives

f. All of the above

3. APT Hacker Methodology (AHM) entails the following procedures:

a. Reconnaissance, Exploitation, Maintaining access, Progression, Exfiltration

b. Reconnaissance, Enumeration, Exploitation, Maintaining access, Clean up, Progression

c. Enumeration, Exploitation, Maintaining access, Clean up, Progression, Exfiltration

d. Reconnaissance, Enumeration, Exploitation, Maintaining access, Clean up, Progression, Exfiltration

4. It is financially costly for businesses to allow their employees to use their own devices for work.

a. True

b. False

5. One downfall of BYOD is that there is less control over use of devices outside of work.

a. True

b. False

5. One downfall of BYOD is that there is less control over use of devices outside of work.

a. True

b. False

6. Teleworkers can be vulnerable to social engineering attacks, in which attackers trick people into disclosing sensitive information or performing specific acts, such as downloading and running malicious files that appear to be benign.

a. True

b. False

7. Service Level Agreements (SLAs) specify the minimum standards for uptime, availability, procedures, customer service and support, security controls and requirements, auditing, reporting, and possibly other areas that define the business relationship and its performance.

a. True

b. False

8. What is the motivation for attacking a smart city?

a. Financial benefits

b. Privacy infiltration

c. Impeding operations

d. All of the above

9. In smart cities, wireless sensor systems (WSNs) do not need to have the three key security requirements similar to other communication networks (confidentiality, integrity and availability).

a. True

b. False

10. Which of the following is a possible cybersecurity solution for smart cities?

a. Cryptography

b. Intrusion Detection System

c. Watchdog System

d. Game Theoretic Deployment

e. All of the above

Figure 7: CS Quiz example

## 7. CONCLUSION

As mentioned in section 2, the option for the Google Classroom platform was primarily motivated by concerns of sustainability and easy access to interested participants. In line with these concerns, and in order to facilitate a “as-wide-as-possible” access to the developed modules, there are permanent links to each of the courses on the IREEDER website, which are also publicized in the project’s social media channels.

The screenshot shows the IREEDER website's 'DELIVERABLES' page. The navigation bar includes links for HOME, ABOUT, PARTNERS, WORKPACKAGES, DELIVERABLES, NEWS&ACTIVITIES, GALLERY, CONTACT, and REPOSITORY. The main content area lists several deliverables, with 'IREEDER D5-3 E-Learning Modules' highlighted in a yellow box. This section includes links to 'Internet of Things E-Learning Module', 'Cyber Security E-Learning Module', and 'Renewable Energy E-Learning Module'. Other deliverables listed include training workshops, quality assurance reports, dissemination plans, and a quality plan.

**IREEDER**

- IREEDER-D3-4 Training Workshops in Jordan
- IREEDER-D4-1 The first annual quality-assurance report
- IREEDER-D4-2 The second annual quality-assurance report
- IREEDER D5-1 Sustainability Plan
- **IREEDER D5-3 E-Learning Modules**
  - Internet of Things E-Learning Module
  - Cyber Security E-Learning Module
  - Renewable Energy E-Learning Module
- IREEDER-D6-1 Dissemination Plan
  - IREEDER-WP6 Dissemination Workshop at IU 13 Jan 2022
  - IREEDER-D6-3 Dissemination Workshop at PU 1 June 2022
  - IREEDER-D6-4 Dissemination Workshop at MU 5 Oct 2022
- IREEDER Quality Plan

**IREEDER**  
Introducing Recent Electrical Engineering  
Developments into undergraduate curriculum

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Figure 8: Links to the e-learning modules on the IREEDER website