Study Programme and Structure

Structure of the joint study programme

See section 3 (Joint Programme) and Figures 6 and 7.

Description of the Modules

Name	Green
ECTS workload	9
Semester	S1, S2; S3
Compulsory/elective	Compulsory
Objectives	Like a spine, the green module vertebrates the contents dealing with an environmentally friendly mindset, the 2030 agenda and SDGs, including environmental awareness, decarbonized systems and energy policies and regulation at the EU level, among other contents.
PLOs	See annex 4
Brief description of contents	Environmental awareness, Decarbonization, Energy Policy and regulation • Sustainable Development Goals • Environmental awareness • Decarbonization of Industry • Energy Policy in Europe vs rest of the world • Regulation, Standards and Grid codes • Electric Market regulations • Hydrogen technologies • Materials in Green Technologies
Offered by	USE, UCA, MCI, TUKE, UniGe, HH
Teaching Team	All partner universities, associated partners, external experts and volunteer students.
Language	English
Teaching format	Hybrid (onsite & online)
Teaching and Learning methodology	Seminars and Project/challenge-based learning

Assessment	Reports related to with topics, included or not, in the seminars. Students will have to do a research work about other related topics. Groups will present written reports and make oral presentation of them, in a seminar format.

Name	**Smart Grid and Renewable Energy Production and Integration**
ECTS workload	27
Semester	S1
Compulsory/elective	Compulsory
Objectives	It covers the most relevant aspects of electrical systems supporting cities, focusing on the "Smart grid" concept, along with different structural elements. The core contents of the programme are developed around renewable energy, generated, and integrated into the system by means of power electronics.
PLOs	See annex 4
Brief description of contents	Electric Power Systems (Smart Grid); Renewable Energy production and Integration and storage technologies • Electric power systems knowledge • Energy Systems • management of energy resources • Distributed Energy Resources • Energy Management Systems • Optimization in Power Systems • Ageing of Power Conversion Systems • Electric Power Systems • Energy storage • Smart Grids • Power Quality • Fault Tolerant Capability Systems • Analysis of Electric Power systems • Efficiency in Power Conversion Systems • The role of power electronics in Renewable Energy Systems • Monitoring and control of Electric Power systems • Energy Technology • Renewable Energy Integration into the systems • Power sector - Solar panels • Regulation, Standards and Grid codes • Renewable Energy production Technologies • Hydrogen technologies
Offered by	USE

Teaching Team	Mainly USE and TUKE, with participation of UCA, MCI, Associated partners and external experts Volunteer students
Language	English
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning methodology	• Lectures • Seminars and tutorials • Project/challenge-based learning • Visits to companies, facilities, and public administration • Laboratory and practical learning of experimental methods and techniques
Assessment	Some technical aspect will be assessed by written examination. To bring real world to students, they will face practical and real situations using software simulation and simulation in labs. To foment interdisciplinarity, students in groups will face interdisciplinary projects covering the whole module. Groups will present written reports and make oral presentation of them, in a seminar format. The evaluation process will consider design thinking, leadership, role in groups, etc. These projects will be an important percentage of the assessment. Roleplay situation, were each student or group face one aspect related to a real project about Smart grid and renewable energy

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**MODERN ELECTRICAL DISTRIBUTION NETWORKS**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*
Required Knowledge / Input profile	
- Basic knowledge of electric circuits: DC, single-phase AC, three-phase AC, DC/AC, DC/DC, AC/DC - Basic knowledge of electrical machines	
Description of content	

Theoretical classes:

1. **Urban and rural AC distribution networks (0,8 ECTS)**
   - 1.1. Medium voltage (MV) grids: : layout, primary substations, secondary substations, overhead and underground lines, grounding systems, etc
   - 1.2. Low voltage (LV) grids: layouts, overhead and underground lines, grounding systems, etc
   - 1.3. Protection system for MV and LV smart grids
   - 1.4. Conventional control devices: on load tap changers transformers, voltage regulators, capacitors
   - 1.5. Regulatory issues
2. **The electric mobility as the key role for efficient transportation (0,8 ECTS)**
   - 2.1. Technology of electric vehicle (EV)
   - 2.2. Technology of electric train and tram
   - 2.3. Charging stations for electric vehicles
   - 2.4. Traction substations
   - 2.5. Regulatory issues
3. **Energy production and storage technologies (0,6 ECTS)**
   - 3.1. PV generation
   - 3.2. Wind generation
   - 3.3. Cogeneration
   - 3.4. Storage technologies
4. **Active and passive consumers (0,6 ECTS)**
   - 4.1. Residential, commercial, and industrial passive consumers
   - 4.2. Prosumers: management of EV charging, renewable generation, and flexible demand
   - 4.3. Local energy communities
   - 4.4. Regulatory issues
5. **Impact of distributed resources on the smart grid (0,5 ECTS)**
   - 5.1. Effect of renewable generation
   - 5.2. Effect of electric vehicle charging
   - 5.3. Energy storage, prosumers and energy communities as flexibility providers

Practical classes:

1. Visit to primary and secondary substations, EV charging station, PV plant, batteries. **(0,55 ECTS)**
2. Simulation activity: Solar PV system integration **(0,2 ECTS)**
3. Simulation activity: Illustrating LV and MV distribution network with passive consumers **(0,15 ECTS)**
4. Simulation activity: Illustrating Effect of generation in distribution networks **(0,15 ECTS)**
5. Simulation activity: Illustrating Flexibility providers for decarbonized smart grids **(0,15 ECTS)**

Output profile /Competences adquired

- Layout and main features of MV and LV urban and rural networks
- Knowledge of the main hardware components within the smart grid: distributed renewable generation, electric vehicles and flexibility assets
- Impact of distributed renewable generation, electric vehicle, and prosumers on the smart grid

Teaching and Learning Methodology

- Classroom lectures
- Technical visits to associate partner facilities: primary and secondary substations, electric mobility infrastructures, renewable power plants, etc.
- Simulation activities in computer labs

Assessment

- Technological aspects will be assessed by written examination (75%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (25%). Compulsory attendance to practical classes

Bibliography

1. Power Distribution Planning Reference book. Second edition, Revised and Expanded. H. Lee Willis. Marcel Dekker. ISBN: 0-8247-4875-1
2. Electric Power Distribution System Engineering. Turan Gonen. CRC Press. ISBN: 978-1-4200-6200-7
3. Electric Power Distribution Handbook. T.A. Short. CRC Press ISBN: 0-8493-1791-6

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**ENERGY CONVERSION SYSTEMS IN SMART CITIES**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Knowledge of circuit analysis
- Basic knowledge of single-phase and three-phase electrical grids
- Knowledge of Fourier Analysis of periodic waveforms

Description of content

Theoretical classes:

1. **Smart cities and Power Electronic Conversion Systems (0,2 ECTS)**
   - 1.1. Smart city concept
   - 1.2. Smart city requirements from the energy scenario point of view
   - 1.3. Future needs of smart cities

2. **Power Electronic Conversion Systems for Renewable Energy Sources (0.8 ECTS)**
   - 2.1. Power converters for wind power systems
   - 2.2. Power converters for solar photovoltaic power systems
   - 2.3. Power converters for transportation applications
   - 2.4. Power converters for power quality applications in weak grids

3. **Power Electronic Conversion Systems for Energy Storage Systems (0,4 ECTS)**
   - 3.1. Power converters for battery-based energy storage systems
   - 3.2. Power converters for supercapacitor-based energy storage systems
   - 3.3. Power converters for other energy storage systems (pumping storage, and others)
   - 3.4. Power converters for hybrid energy storage systems

4. **Power Electronic Conversion Systems for Electric Vehicles (0,2 ECTS)**
   - 4.1. Basic concepts of Electric vehicles (EV)
   - 4.2. Power converters for on-board EV charging
   - 4.3. Infrastructures of fast EV charging

5. **Modulation of Power Electronic Conversion Systems (0,4 ECTS)**
   - 5.1. Concept of modulation
   - 5.2. PWM-based modulation methods for power converters
   - 5.3. Other mainstream modulation strategies

6. **Hydrogen as an energy vector**
   - 6.1. Hydrogen in smart cities
   - 6.2. Hydrogen production
   - 6.3. Hydrogen storage and distribution
   - 6.4. Hydrogen and fuel cells. Hydrogen vehicles.

7. **Requirements and features of Power Electronic Conversion Systems (0,4 ECTS)**
   - 7.1. Efficiency in power conversion systems
   - 7.2. Reliability in power conversion systems
   - 7.3. Fault diagnosis in power conversion systems
   - 7.4. Fault-tolerant capability
   - 7.5. Power quality
   - 7.6. Power density

Practical classes:

1. Simulation activity: power converters for domestic solar PV applications. **(0,3 ECTS)**
2. Simulation activity: power converters for industrial solar PV applications. **(0,3 ECTS)**
3. Simulation activity: power converters for the integration of battery-based energy storage systems. **(0,2 ECTS)**
4. Simulation activity: power converters for electric vehicles **(0,3 ECTS)**
5. Simulation activity: visit to hydrogen lab **(0,1 ECTS)**

Output profile /Competences adquired

- Knowledge of the mainstream solutions of power converter topologies for the integration of renewable energy sources
- Knowledge of the mainstream solutions of power converter topologies for the integration of energy storage systems
- Knowledge of the mainstream solutions of power converter topologies for electric vehicles
- Modulation methods of power converters
- Knowledge of requirements and features of power converters
  Knowledge of modelling power converters using Matlab/Simulink

Teaching and Learning Methodology

The training activities will be organized on two main activities:

- Theoretical concepts (3.3 ECTS). Lectures and seminars on the theoretical concepts and technology behind the energy conversion systems.
- Practical labs activities (1.2 ECTSs). Practical activities (with real standardized devices and/or simulation software) to introduce the practical aspects of energy conversion systems.

Assessment

- Technological aspects will be assessed by written examination (75%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (25%). Compulsory attendance to practical classes

Bibliography

- Wu, B., Lang, Y., Zargari, N. and Kouro, S. (2011) Power Conversion and Control of Wind Energy Systems 77. John Wiley & Sons Ltd., Hoboken, 3-6.
- Fu-Bao Wu, Bo Yang, Ji-Lei Ye, Grid-Scale Energy Storage Systems and Applications, Academic Press, 1st Edition - June 11, 2019
- Ashok L. Kumar, S.Albert Alexander, Madhuvanthani Rajendran , Power Electronic Converters for Solar Photovoltaic Systems, Academic Press, 1st Edition - November 1, 2020
- Holmes, D.G. and Lipo, T.A. (2003) Pulse Width Modulation for Power Converters: Principles and Practice. IEEE Press, Piscataway.

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**ANALYSIS OF ACTIVE DISTRIBUTION NETWORKS**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic knowledge of circuit theory: DC circuits, single-phase and three-phase AC circuits
- Knowledge of operation of power converters
- Basic knowledge of control theory
- Programming skills

Description of content

Theoretical classes:

1. **Static electrical model of distribution networks (0,6 ECTS)**
   - 1.1. Single-phase model for MV lines
   - 1.2. Three-phase model for LV lines
   - 1.3. Single-phase model for three-phase transformer
   - 1.4. Electrical model of demand and generation

2. **Flexibility on grid by new power conversion-based solutions**
   - 2.1. Flexible PV and wind generation
   - 2.2. Distribution statcoms
   - 2.3. Energy storage systems
   - 2.4. Vehicle to grid and vehicle to home
   - 2.5. DC link

3. **Power flow tools for distribution networks (0,6 ECTS)**
   - 3.1. Fundamentals of systematic solutions of electrical circuits
   - 3.2. Balanced admittance-based power flow
   - 3.3. Unbalanced admittance-based power flow
   - 3.4. Overview of power flow tools

4. **Continuity of supply and power quality in smart grids (0,6 ECTS)**
   - 4.1. Continuity of supply and network layouts
   - 4.2. Key performance indexes for individual and zonal assessment of continuity of supply
   - 4.3. Power quality disturbances
   - 4.4. Continuity of supply and power quality standards

5. **DC versus AC distribution networks (0,2 ECTS)**
   - 5.1. Why hybrid AC/DC networks?
   - 5.2. Hybrid AC/DC network architectures
   - 5.3. Comparative evaluation of hybrid configurations
   - 5.4. AC/DC hybrid network layout
   - 5.5. Active control of AC/DC hybrid LV networks

Practical classes:

1. Simulation activity: flexibility provided by converters+PV. **(0,2 ECTS)**
2. Simulation activity: flexibility provided by converters+V2G and V2H **(0,2 ECTS)**
3. Working group in computer lab: study case of a microgrid **(0,4 ECTS)**
4. Simulation activity: Modelling and Analysis of distribution networks with passive consumers and different models of loads **(0,15 ECTS)**
5. Simulation activity:Modelling and analysis of distribution network with generation and EV **(0,15 ECTS)**
6. Working group in computer lab: Modelling and Analysis of distribution network with flexibility providers **(0,45 ECTS)**
7. Experimental testing in scaled-down distribution networks **(0,15 ECTS)**

Output profile /Competences adquired

- Knowledge of distribution systems modelling and analysis involving smart grid technologies for both balanced MV grids and unbalanced LV grids.
- Key performance indexes to quantify continuity supply and quality signal in distribution networks
- Knowledge of the operation of power conversion systems in order to meet the requirements in smart cities application.
- Knowledge of V2G and V2H applications
- Basic knowledge about the integration of renewable energy systems in the grid
- AC versus DC networks and hybrid AC/DC solutions in smart distribution grids

Teaching and Learning Methodology

- Classroom lectures
- Simulation of power systems to check the standards fulfillment.
- Practical activities in the smart grid laboratory:
  - Signal quality analysis
  - Electrical analysis of the behavior of the smart grid according to its balanced or unbalanced nature.
- Working groups on modeling, analysis and solution proposals for secure network operation
- Role-play using commercial and/or open source software for distribution network analysis

Assessment

- Technological aspects will be assessed by written examination (60%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (20%). Compulsory attendance to the practical classes
- Report and presentation of the activities developed in the group work sessions. (20%)

Bibliography

1. Distribution System modelling and Analysis. William H. Kersting. CRC Press. ISBN: 0-8493- 5806-X

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**ANALYSIS OF POWER CONVERSION SYSTEMS**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Knowledge of the mainstream solutions of power converter topologies for the integration of renewable energy sources
- Knowledge of the mainstream solutions of power converter topologies for the integration of energy storage systems
- Knowledge of the mainstream solutions of power converter topologies for electric vehicles
- Modulation methods of power converters
- Knowledge of requirements and features of power converters
- Knowledge of modelling power converters using Matlab/Simulink

Description of content

Theoretical classes:

1. **Smart cities and Network codes (0,5 ECTS)**
   - 1.1. Requirements of smart cities
   - 1.2. Grid codes and standards for smart cities

2. **Control of Power Electronic Conversion Systems (0.8 ECTS)**
   - 2.1. Voltage-oriented control
   - 2.2. Direct Power Control
   - 2.3. Field-oriented control
   - 2.4. Direct torque control
   - 2.5. Model Predictive control
   - 2.6. Other control methods
   - 2.7. Vehicle-to-grid and vehicle-to-home examples

3. **Advanced Modulation of Power Electronic Conversion Systems (0.4 ECTS)**
   - 3.1. Advanced PWM-based modulation methods
   - 3.2. Space-vector modulation strategies
   - 3.3. Pre-programmed PWM techniques
   - 3.4. Other advanced modulation methods

4. **Smart grid electrical analysis (0.4 ECTS)**
   - 4.1. Interconnection of power systems in a microgrid
   - 4.2. Operation of power systems in the microgrid
   - 4.3. Stability of the smart grid: virtual inertia, grid forming, grid following, converter-dominated grids
   - 4.4. Awareness of the key role of DC for future smart grids
   - 4.5. Challenges in smart grids to meet the smart cities requirements

Practical classes:

1. Simulation activity: Voltage oriented control for VSI. **(0,3 ECTS)**
2. Simulation activity: Field oriented control of VSI. **(0,3 ECTS)**
3. Simulation activity: Model predictive control of grid-connected VSI. **(0,2 ECTS)**
4. Simulation activity: PWM-based modulation methods of power converters **(0,2 ECTS)**
5. Simulation activity: Vehicle-to-grid power conversion systems **(0,2 ECTS)**
6. Simulation activity: Integration of a utility-scale solar PV conversion system **(0,2 ECTS)**
7. Working group: Interconnection of several power converters to build a microgrid **(1 ECTS)**

Output profile /Competences adquired

- Knowledge of grid codes and power-based solutions for their compliance
- Knowledge of the mainstream solutions of control of power converters
- Knowledge of advanced solutions of modulation methods of power converters Knowledge of the analysis of smart grids and microgrids

Teaching and Learning Methodology

The training activities will be organized on two main activities:

- Theoretical concepts: Lectures and seminars on the theoretical concepts and technology behind the analysis of power conversion systems.
- Practical labs activities: Practical activities (with real standardized devices and/or simulation software) to introduce the practical aspects of power conversion systems.
- Working groups on modeling, analysis and solution proposals for different power conversion systems

Assessment

- Technological aspects will be assessed by written examination (60%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (20%). Compulsory attendance to the practical classes
- Report and presentation of the activities developed in the group work sessions. (20%)

Bibliography

- Wu, B., Lang, Y., Zargari, N. and Kouro, S. (2011) Power Conversion and Control of Wind Energy Systems 77. John Wiley & Sons Ltd., Hoboken, 3-6.
- Fu-Bao Wu, Bo Yang, Ji-Lei Ye, Grid-Scale Energy Storage Systems and Applications, Academic Press, 1st Edition - June 11, 2019
- Ashok L. Kumar, S.Albert Alexander, Madhuvanthani Rajendran , Power Electronic Converters for Solar Photovoltaic Systems, Academic Press, 1st Edition - November 1, 2020
- Holmes, D.G. and Lipo, T.A. (2003) Pulse Width Modulation for Power Converters: Principles and Practice. IEEE Press, Piscataway.

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**REAL-TIME MONITORING OF SMART GRIDS**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Modelling and analysis of balanced and unbalanced power distribution networks
- Basic knowledge about statistical mathematics

Description of content

.

Theoretical classes:

1. **Operation of smart distribution grids (0,2 ECTS)**
   - 1.1. Advanced distribution management systems (ADMS)
   - 1.2. Scheme and time scale for smart grid operation
   - 1.3. Definition of distribution grid operation states
   - 1.4. Approaches to network visibility

2. **Monitoring distribution grids** (Tecnología electrónica 0,8 ECTS)
   - 2.1. Communication protocols in substations.
   - 2.2. Advanced Metering Infrastructure (AMI) at low-voltage
     - 2.2.1. Low-Voltage Supervisory (LVS)
     - 2.2.2. Smart metering solutions
   - 2.3. Demand response (DR) protocols

3. **State estimation application (0,8 ECTS)**
   - 3.1. State estimation tool: objectives and components
   - 3.2. Prefiltering of measurements
   - 3.3. Observability analysis and pseudo-measurements generation
   - 3.4. State estimation algorithm
   - 3.5. Detection and identification of errors in measurements
   - 3.6. Real experiences of distribution state estimation

Practical classes:

1. Communication protocols in substations; IEC61850 (0,4 ECTS)
2. Simulation activity: LVS data integration (0,2 ECTS)
3. Smart Metering solution: data retrieve and analysis from PRIME network (0,2 ECTS)
4. DR protocols: OpenADR scheduling (0,2 ECTS)
5. Demand profiles forecasting based on meter data (0,2 ECTS)
6. Simulation activity: state estimation in MV smart networks. **(0,15 ECTS)**
7. Simulation activity: state estimation in LV smart networks. **(0,15 ECTS)**

8. Simulation activity: state estimation in secondary substations of smart cities **(0,1 ECTS)**
9. Working group session: case of use solving the problem of observability and state estimation of a distribution network comprising different level of voltages (0.75 ECTS)
10. Experimental testing of state estimators in scaled-down distribution networks **(0,15 ECTS)**
11. Visit to a company implementing ADMS **(0,2 ECTS)**

Outpul profile /Competences adquired

- Knowledge of the issues involved in the management and operation of a smart grid with a high presence of flexible resources: time scale and available control resources
- Awareness of the importance of system monitoring: monitoring systems and devices for different levels of a smart grid.
- Knowledge about the most common communication standards
- Knowledge about techniques for demand prediction
- Digitalization as an enabler of the smart grid technologies: network observability and real-time network estimation as key points for smart cities.

Teaching and Learning Methodology

- Classroom lectures
- Use of commercial and/or open source software for: Demand/Generation forecasting (??) and for state estimation
- Practical activities in smart grid labs and computational lab
- Practical development based on projects: several activities in where the students (under the teacher supervision) analyze the different system involved in the observability of a power network, defining a possible solution architecture for a specific proposed case.

Assessment

- Technological aspects will be assessed by written examination (40%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (30%). Compulsory attendance to the practical classes
- Report and presentation of the activities developed in the group work sessions. (30%)

Bibliography

- Liu, C.; McArthur, S.; & Lee, S.; *Smart Grid Handbook (vol. 1, 2 & 3)*; WILEY; 2016.
- Bishop, P.; & Nair, N.K.; *IEC 61850 Principles and Applications to Electric Power Systems*; Springer; 2022.
- Gomez Exposito, Antonio, Conejo, A., Cañizares, Claudio. Electric Energy Systems: Analysis and Operation. EEUU. Crc Press. 2008. ISBN 0-8493-7365-4
- Gomez Exposito, Antonio, Abur, Ali. Power System State Estimation: Theory and Implementation. New York. Marcel Dekker Inc. 2004. ISBN 0-8247-5570-7
- Yuan, Y; & Yang, Y.; *IEC 61850-Based Smart Substations. Principles, Testing, Operation and Maintenance*; Elsevier, 2019.
- PRIME Standard; *Narrowband Orthogonal Frequency Division Multiplexing Power Line Communication Transceivers for PRIME Networks*; Standard ITU-T G.9904.
- DLMS/COSEM protocol. *Device Language Message Specification (DLMS), Companion Specification for Energy Metering (COSEM)*; IEC 62056 series of standards.
- OpenADR Alliance; OpenADR 2.0 Demand Response Program Implementation Guide; 2014

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**OPTIMAL OPERATION OF SMART GRIDS**
Module:	*Smart grid and Renewable Energy Production and Integration*
ECTS Workload:	*4.5*
Semester:	1st semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic knowledge of circuit theory: DC circuits, single-phase and three-phase AC circuits
- Basic knowledge of control theory
- Programming skills

Description of content

Theoretical classes:

1. **Optimization of smart distribution grids (0,2 ECTS)**
   - 1.1. Networks optimization objectives
   - 1.2. Utility controls at different voltage levels
   - 1.3. Third-party controls
   - 1.4. Centralized versus decentralized optimization approaches.
2. **Optimization techniques (0,4 ECTS)**
   - 2.1. Lineal programming techniques
   - 2.2. Mixed-integer lineal programming techniques
   - 2.3. Non-linear programming techniques
   - 2.4. Commercial optimization software
3. **Centralized optimal solutions for smart grids (0,6 ECTS)**
   - 3.1. Volt/Var control of MV networks
   - 3.2. MV Network reconfiguration
   - 3.3. Optimization in smart LV networks
4. **Dynamic Modelling of Energy Systems (0.3 ECTS)**
   - 4.1. Static vs. dynamic modelling
   - 4.2. Dynamic modelling requirements
   - 4.3. Renewable Distributed Generation (DG)
   - 4.4. Distributed Storage (DS)
5. **Real-time control of optimal management of Energy Systems (0.3 ECTS)**
   - 5.1. Advanced analytics and control algorithms
   - 5.2. Control actions and coordination
   - 5.3. Grid resilience and reliability
   - 5.4. Integration of renewable energy sources

5.5. Model Predictive Control (MPC) of energy systems

Practical classes:

1. Simulation activity: MV network reconfiguration. **(0,2 ECTS)**
2. Simulation activity: Volt/var control by using utility assets. **(0,2 ECTS)**
3. Working group in computer lab: Role-play for optimal operation of smart grids by using utility and third-parties assets in balanced grids **(0,4 ECTS)**
4. Working group in computer lab: Role-play for optimal operation of smart grids by using utility and third-parties assets in balanced grids **(0,5 ECTS)**
5. Experimental testing in scaled-down distribution networks **(0,2 ECTS)**
6. Visit to a company implementing optimization tools in ADMS **(0,3 ECTS)**
7. Simulation activity: Dynamic modelling of a distributed generation system (0.3 ECTS)
8. Working group in computer lab: Model Predictive Control of a distributed generation system (0.6 ECTS)

Outpul profile /Competences adquired

- Key concepts in the optimal operation of smart grids: time scale, objective functions, control elements and nature of the resulting optimization problem.
- Different control schemes for intelligent network management: centralized versus decentralized. Advantages and disadvantages
- Knowledge of the different techniques to solve optimization problems depending of the nature of their variables and equations
- Knowledge of the reconfiguration problem and Volt/var control in MV networks
- Optimization of the LV operation
- Modelling techniques of dynamical systems. Application to modern distribution grids
- Real-time control of optimal management of smart grids

Teaching and Learning Methodology

- Classroom lectures
- Simulation of application of optimal tools to distribution smart grids.
- Illustration the optimal operation of smart grids in scaled-down smart grid lab
- Role-play working groups on the use of different flexible resources to optimize the whole power systems by using utility and third-parties assets

Assessment

- Technological aspects will be assessed by written examination (40%). Minimum score of 3.5 out of 10
- Report of practical and simulation activities (30%). Compulsory attendance to the practical classes
- Report and presentation of the activities developed in the group work sessions. (30%)

Bibliography

1. Building and solving mathematical programming models in engineering and science. E Castillo, AJ Conejo, P Pedregal, R Garcia, N Alguacil. John Wiley & Sons. 2011
2. Handbook of Optimization in Electric Power Distribution Systems. Resener, Mariana, Rebennack, Steffen, Pardalos, Panos M and Haffner, Sérgio. Springer International Publishing. 2020

Name	Optimization and Digitalization of Smart Cities
ECTS workload	15
Semester	S2
Compulsory/elective	Compulsory
Objectives	This is a compulsory module including digitalization, and system, structure, and device optimisation. Different kinds of applied optimisation algorithms are to be covered, including artificial intelligence, big data, and system interactions enabling the implementation of a city smart management
PLOs	See annex 4
Brief description of contents	Optimization and Digitalization Smart Cities • AI (Artificial Inteligencie) • Domotics and Building Management Systems • Fault Tolerant Capability Systems • Data models: (PostgreSQL, Cassandra, MongoDB • Automatic Control • Digital Twins and Cyberphysical Systems • microservices // Docker // Kubernetes • Optimization Techniques • Internet of Things (internet of Energy) • Monitoring and control of Electric Power systems • Advanced Metering Infrastructure • Communication protocols • Sensors - Perception, data gathering and interpretation • Optimization Techniques • Strong Programming Skills • Modelling and simulation. • Advanced Math fundamentals • Control of Python libraries • Knowledge in Tensorflow • Software Skills (used in the professional scope) • Digital Twins and Cyberphysical Systems
Offered by	USE
Teaching Team	Mainly USE and TUKE, with the participation of teachers/trainers from UCA

	Associated partners and external experts Volunteer students
Language	English
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning methodology	• Lectures • Seminars and tutorials • Project/challenge-based learning • Visits to companies, facilities and public administration • Laboratory and practical learning of experimental methods and techniques
Assessment	Some technical aspect will be assessed by written examination. To bring real world to students, they will face practical and real situations using software simulation and simulation in labs. To foment interdisciplinarity, students in groups will face interdisciplinary projects covering the whole module. Groups will present written reports and make oral presentation of them, in a seminar format. The evaluation process will consider design thinking, leadership, role in groups, etc. These projects will be an important percentage of the assessment. Roleplay situation, were each student or group face one aspect related to a real project about Smart grid and renewable energy

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*IT infrastructure for Smart Cities*
Module:	*Optimization and Digitalization of Smart Cities*
ECTS Workload:	*6 ECTS*
Semester:	*2nd semester*
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic knowledge of smart city concepts and their infrastructure components (water systems, energy, lighting, transport, etc.).
- Computer science basic knowledge: programming languages, operating systems, and network communications.
- Knowledge about basic data types and data represent3ation.

Description of content

Theoretical classes (2 ECTS):

1. **Information Technology (IT) infrastructure and platforms for smartcities (0.2 ECTS)**
    1. Introduction of IT infrastructures for smartcities.
    2. The Internet of Things (IoT) and Internet of Energy (IoE) paradigm.

2. **Hardware Technologies (0.4 ECTS)**
    1. Virtualization technologies
    2. Cloud / MEC / EDGE Computing

3. **Communications technology related with IT infrastructures (0.2 ECTS)**
    1. Network protocols, services, and configuration
    2. Service oriented architectures

4. **Data Storage for smartcities (0.4 ECTS)**
    1. Database paradigms
    2. Database technologies

5. **Architecture Models for smartcity applications (0,4 ECTS)**
    1. Energy
    2. Transport and Mobility

6. **Cybersecurity (0.4 ECTS)**
    1. Importance of resilience to faults (induced or unintentional) in smartcity infrastructures.
    2. Cybersecurity in critical infrastructures.
    3. Ethical Hacking in Operational Technology (OT) environments.
    4. Fault Tolerant Systems

Practical classes (4 ECTS):

Topic 2: Hardware Technologies (0.8 ECTS)

1. Activity: Virtualization (0.6 ECTS)

2. Activity: Cloud /MEC/EDGE Computing (0.2 ECTS)

Topic 3: Communications technology related with IT infrastructures (0.8 ECTS)

3. Activity: Networks protocols and services. (0.2 ECTS)
4. Activity: Service oriented architecture. (0.2 ECTS)
5. Activity: SOA Technologies and enterprise buses. (0.4 ECTS)

Topic 4: Data Storage for smartcities (1 ECTS)

6. Activity: Data Storage. (0.2 ECTS)
7. Activity: Big Data. (0.4 ECTS)
8. Activity: Decentralized infrastructures. (0.4 ECTS)

Topic 5: Architecture Models for smartcity applications (0.3 ECTS)

9. Activity: Smartcity platform providers (0.3 ECTS)

Topic 6: Cybersecurity (1.1 ECTS)

10. Activity: Cybersecurity in critical infrastructures. (0.2 ECTS)
11. Activity: OT Threats, Attacks and Countermeasures (0.4 ECTS)
12. Activity: IoT Cybersecurity. (0.2 ECTS)
13. Activity: Fault Tolerant Systems (0.3 ECTS)

Outpul profile /Competences adquired

- Knowledge of methodologies and procedures for the design and implementation of computer applications for the design and implementation of computer application.
- Skills to development and management platforms of services for citizens and governance.
- Ability to describe the security needs of a computer application as a basis for the management of a service where sensitive data is stored, managed, and transmitted.
- Capacity to conceive, design and manage the implementation of intelligent information applications to the smart cities management.
- Competences to solve urban management problems using knowledge, methodologies and procedures for the design and implementation of computer applications for different types of environments (web, mobile, cloud) and with different paradigms.
- Knowledge of attack types for critical infrastructures.
- Fundamentals of industrial networks and basic network security concepts.
- Setting of the knowledge about the process of developing fault tolerant in smart grids, smart cities, and energy management systems in general.

Teaching and Learning Methodology

The training activities will be fundamentally based on a practical development based on projects. Throughout the course, various infrastructure design and/or deployment challenges will be proposed that students must solve, either individually or in groups (4.0 ECTS).

A flipped-classroom methodology will also be proposed, in which groups of students will prepare specific advanced technologies related to IT architectures for smartcities, of which they will make a presentation and a class debate will be established (2.0 ECTS).

There will also be evaluations of the theoretical contents of the subject.

Assessment

The evaluation will be carried out based on the planned training activities, assuming the individual projects 40% of the final grade, the group work another 40% and the evaluations 20%.

The minimum score will be 3 points out of 10 to make the average.

The subject will be passed by obtaining a minimum of 5 points out of 10.

Bibliography

F. Ye, *Smart grid communication infrastructures: big data, cloud computing, and security*, 1st edition. Hoboken, New Jersey: John Wiley & Sons, 2018. doi: 10.1002/9781119240136

M. Portnoy, *Virtualization essentials*, Second edition. Indianapolis, Indiana: Sybex, 2016.

L. Moffitt, *Architecture's Model Environments*. UCL Press, 2023.

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I. Bashir, *Mastering blockchain: distributed ledger technology, decentralization, and smart contracts explained*, Second edition. Birmingham: Packt Publishing Ltd, 2018.

C. Ballard, *Database strategies using Informix XPS and DB2 Universal Database*, 1st ed. en Redbooks. San Jose, Calif: IBM Corp., International Technical Support Organization, 2005.

M. T. Jakóbczyk, *Practical Oracle Cloud Infrastructure Infrastructure as a Service, Autonomous Database, Managed Kubernetes, and Serverless*, 1st ed. 2020. Berkeley, CA: Apress, 2020. doi: 10.1007/978-1-4842-5506-3

L. Huawei Technologies Co, *Database Principles and Technologies – Based on Huawei GaussDB*, 1st ed. 2023. Singapore: Springer Nature, 2023. doi: 10.1007/978-981-19-3032-4

B. Azarmi, *Scalable Big Data architecture: a practitioners guide to choosing relevant Big Data architecture*, 1st edition. en The Expert's Voice in Big Data. Berkeley, CA: Apress, 2016. doi: 10.1007/978-1-4842-1326-1

Shaping the Future of the Fourth Industrial Revolution: A guide to building a better world Schwab, Klaus. Publicado por Portfolio Penguin (2018) ISBN 10: 0241366372 ISBN 13: 9780241366370

The Smart Enough City: Putting Technology in Its Place to Reclaim Our Urban Future (Strong Ideas) 18 Febrero 2020, Ben Green (Author), Jascha Franklin-Hodge (Foreword)

Smart Cities (The MIT Press Essential Knowledge series) Parte de: The MIT Press Essential Knowledge (94 libros) | por Germaine Halegoua

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Facility Automation Systems*
Module:	*Optimization and Digitalization of Smart Cities*
ECTS Workload:	*3 ECTSs*
Semester:	2nd semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic knowledge of smart city concepts and their infrastructure components (water systems, energy, lighting, transport, etc.).
- Computer science basic knowledge: programming languages, operating systems, and network communications.
- Knowledge about basic data types and data representation.
- Basic knowledge of dynamic systems modelling and automatic control.

Description of content

Theoretical classes (1 ECTS):

- Introduction to smart facility automation systems and their relation to smart Cities: smart buildings, smart homes, smart industrial, smart transport stations, etc. (0,2 ECTS)
- Communication Protocols and Networking Technologies for automation systems. (0,2 ECTS)
  - KNX
  - BACnet
  - Modbus
  - ZigBee & Matter
- Facility automation system tools. (0,2 ECTS)
- Sensors, control and actuators for smart facilities (0,4 ECTS)
  - Delay system problems in smart facilities
  - Control algorithms for delay systems
  - Energy Efficiency and Sustainability in smart facilities
  - Distributed control algorithm design

Practical classes (2 ECTS):

- Smart facility automation systems and their relation to Smart Cities (0,2 ECTS)
- KNX Communication Protocols: Topology and Devices Interconnection (0,4 ECTS)
- BACnet Communication Protocols: Topology and Devices Interconnection (0,2 ECTS)
- Modbus Communication Protocols: Devices communication (0,4 ECTS)
- Facility automation system tools: Building Automation System (0,2 ECTS)
- Control algorithms for delay systems: control of delay communication systems (0,2 ECTS)
- Analysis and design of a motor control in a home automation system with communication delay (0,2 ECTS).
- Design of distributed control in a communication system (0,2 ECTS).

Outpul profile /Competences adquired

- Have knowledge to understand the concepts of smart facilities and their relation to the development of smart cities.
- Ability to implement smart facilities automation systems, including their infrastructures (electricity, water, air conditioning, lighting, data networks, mobility, security, etc.).
- Develop the ability to evaluate, control and optimize the performance of smart facility systems.
- Have knowledge of the common software tools, standards, communication protocols and networking technologies for the management of modern facilities.
- Ability to design controllers that consider real implementation issues such as delay.
- Have knowledge to Identify the importance of energy efficiency and sustainability in smart facilities and its relation to smart city goals.

Teaching and Learning Methodology

The training activities will be organized on three main activities:

- Theoretical concepts (1 ECTS). Lectures and seminars on the theoretical concepts and technology behind the automation systems of smart facilities.
- Practical labs activities (1.5 ECTSs). Practical activities (with real standardized devices and/or simulation software) to introduce the practical aspects of the automatization of smart facilities.
- Practical development based on projects (0.5 ECTS). It will be the most relevant work and will be organized as several group activities in which the student (under the teacher supervision) develops and expose an automation solution.

Assessment

The evaluation will be carried out based on the three planned training activities:

- 30% Theoretical concepts evaluation by written exams
- 30% Practical lab activities
- 40% Group presentation of an automation project

Bibliography

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- Habibi, Shahryar - Building Automation and Digital Technologies, 2022, ISBN: 9780128221297
- KNX Association; KNX Basic Course 2022; 2022; ISBN: 9798833822630
- KNX Association; KNX Handbook for Home and Building Control; 2013; ISBN: 9781983267352
- Modbus.org; MODBUS Application Protocol Specification
- Modbus.org; MODBUS over Serial Line Specification & Implementation guide
- Modbus.org; MODBUS messaging on TCP/IP
- The Art of Service - BACnet Publishing; BACnet A Complete Guide - 2021 Edition; 2021; ISBN: 9781867444930
- Chonggang Wang, Tao Jiang, Qian Zhang; ZigBee® Network Protocols and Applications; 2019; ISBN: 9780367378783
- Time-Delay Systems, Vladimir L. Kharitonov, SpringerLink, 2013. ISBN: 9780817683665
- Bullo, Francesco, Jorge Cortés, and Sonia Martinez. Distributed control of robotic networks: a mathematical approach to motion coordination algorithms. Vol. 27. Princeton University Press, 2009. ISBN: 0691141959

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Artificial Intelligence for Smart Cities*
Module:	*Optimization and Digitalization of Smart Cities*
ECTS Workload:	*3 ECTS*
Semester:	*2nd semester*
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic mathematical background
  - Multivariate differential calculus
  - Lineal algebra
- Basic programming skills and computer science knowledge

Description of content

1. Introduction (theoretical: 0,2 ECTS)
   1. Historical Evolution of Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL)
   2. Characterization
   3. Some cases of use / Success in AI
   4. Limits or AI
      1. Current ill-solved or non-solved problems
      2. Ethical considerations
2. Machine Learning (theoretical: 0,5 ECTS, practical: 0.4 ECTS)
   1. Evaluation
   2. Data wrangling
   3. Feature extraction
   4. Visualization
   5. Some common techniques
   6. Application exercises
3. Dynamic and Real Time Machine Learning (theoretical: 0,6 ECTS, practical: 0.4 ECTS)
   1. Ridge Regression for time varying systems
   2. State space methods: Forecasting and decision making.
   3. Application exercises
4. Deep Learning (theoretical: 0,5 ECTS, practical: 0.4 ECTS)
   1. Perceptron, non-linear activations and backpropagation
   2. Layers description
   3. Structures description
   4. Architectures description
   5. Application exercises

Output profile /Competences adquired

- Understand different purposes of AI techniques and be able to select the most appropriate for each case.
- Understand the pitfalls of evaluation of trained algorithms and learn to avoid them.
- Know the adaptation of AI techniques for dynamical systems and real time systems.

Teaching and Learning Methodology
The subject is designed with “learning by doing” approach. The materials are distributed in interactive notebooks, and they are used in two phases. In the first phase, there is an exposition of the topics related to the session and later, in the second one, the students run the examples, modify parameters, try derived experiments and draw conclusions. In addition to the experimental classes, students will be required to develop one or more projects in which they will have to demonstrate their understanding of the topics covered.
Assessment
The evaluation will be based on items in three categories whose weights will vary according to the annual planning of the course: class assignments, projects and written evaluation. Each of these blocks will have a minimum weight of 20% and a maximum weight of 40% of the final grade. The minimum score will be 3 points out of 10 to make the average. The subject will be passed by obtaining a minimum of 5 points out of 10.
Bibliography
• Jiang, Hui; *Machine Learning Fundamentals: A Concise Introduction*; Cambridge: Cambridge University Press; 2021. • Murphy, Kevin P.; *Probabilistic Machine Learning. An Introduction*. MIT Press; 2022. • Brunton, Steven L.; Kutz, J. Nathan; *Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control*; Cambridge University Press; 2019. • Goodfellow, Ian; Yoshua Bengio; Aaron Courville; *Deep Learning*. Cambridge, Massachusetts, 2016. • Zhang, Aston; Lipton, Zachary C.; Li, Mu; Smola, Alexander J.; *Dive into Deep Learning*; 2021.

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Digital Twins*
Module:	*Optimization and Digitalization of Smart Cities*
ECTS Workload:	*3 ECTSs*
Semester:	2nd semester
Compulsory/Elective:	*Compulsory*

Required Knowledge / Input profile

- Basic knowledge of smart city concepts and their infrastructure components (water systems, energy, lighting, transport, etc.).
- Computer science basic knowledge: programming languages, operating systems, and network communications.
- Knowledge about basic data types and data representation.
- Basic knowledge of dynamic systems modelling and automatic control.

Description of content

Theoretical classes (1 ECTS):

1. **Introduction to the Digital Twin. Historical review of the concept. (0,125 ECTS)**
   1.1. Concept of digital twin.
   1.2. Historical evolution of the digital twin.
   1.3. Applications of digital twins in different fields.

2. **ISO 23247 and Digital twins for the built environment (0,125 ECTS)**
   2.1. Key principles and requirements outlined in the standard ISO 23247.
   2.2. Parts of the standard.

3. **Techniques for making Digital Models (0,125 ECTS)**
   3.1. Modelling and system identification
   3.2. Artificial intelligence techniques.
   3.3. Visual representation and phisical engines.

4. **Synchronisation in the Digital Twin (0,125 ECTS)**
   4.1. Sensor integration and data flow
   4.2. Communication protocols.

5. **Data quality assurance (0,125 ECTS)**
   5.1. Data validation and filtering.
   5.2. Anomaly detection and Integrity and reliability.
   5.3. Data analysis methods.

6. **Digital twins for control (0,125 ECTS)**
   6.1. Simulation of complex systems.
   6.2. Model Predictive Control design.
   6.3. Use of DT for estimation.

7. **Virtualisation of controllers. IEC 61499 Standard (0,125 ECTS)**
   7.1. IEC 61499 standard.

7.2. Soft PLCs.

8. **City Digital Twin. Digital Twin Ecosystems (0,125 ECTS)**
   8.1. infrastructure management and resource optimisation.
   8.2. Case studies of successful implementation.

Practical classes (2 ECTS):

Topic 3: Techniques for making Digital Models (0.5 ECTS)

Activity: Modelling and system identification using MATLAB
Activity: Neural networks and neurofuzzy systems.
Activity: introduction to UNITY 3D.

Topic 6: Digital twins for control (0.5 ECTS)

Activity: Model Predictive Control design using MATLAB
Activity: Use of DT for estimation.
Activity: Modelling and control of infrastructure.

Topic 7: Virtualisation of controllers. IEC 61499 Standard (0.5 ECTS)

Activity: Introduction to EAE /Schneider Electric)

Activity: Soft PLCs design.

Topic 8: City Digital Twin. Digital Twin Ecosystems

Activity: Control of critical infrastructure (project design)

Activity: Optimisation of systems and interaction with human being.

Outpul profile /Competences adquired

- Understanding of the digital twin concept and its application in Smart Cities.
- Knowledge of the ISO 23247 framework for industry and proposed architectures for buildings.
- Knowledge of programming environments for simulation.
- Knowledge of system modelling techniques.
- Knowledge of data quality and accuracy assurance techniques for synchronisation of the model and the physical entity.
- Use of Digital Twin for predictive control and estimation.
- Programming virtual controllers under IEC 61499

Teaching and Learning Methodology

- Lectures and presentations
- Group work and discussions around specific topics or questions
- Research project and presentations

Assessment

- Questionnaire on content covered in class– 25%
- Practical exercises in class – 15%
- Research project and presentations – 60%

Bibliography

- Ganguli, R., Adhikari, S., Chakraborty, S., & Ganguli, M. (2023). Digital Twin: A Dynamic System and Computing Perspective (1st ed.). CRC Press. https://doi.org/10.1201/9781003268048
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- Khaled, Pattel, B., & Siddiqui, A. (2020). Digital twin development and deployment on the cloud : developing cloud-friendly dynamic models using Simulink/Simscape and Amazon AWS. Academic Press.

Name	Mobility and Transport in Smart Cities
ECTS workload	12
Semester	S2
Compulsory/elective	Elective
Objectives	This is an elective module that includes city mobility, electric vehicles, logistics, and traffic management, among other topics.
PLOs	See annex 4
Brief description of contents	Mobility. Traffic people, goods and vehicles • Traffic Management • Electric vehicles • Transport Systems • Autonomous systems • Mobility • Logistics • Electric-powered vehicles and infrastructure
Offered by	USE
Teaching Team	Mainly USE and TUKE, with the participation of teachers/trainers from UCA Associated partners and external experts Volunteer students
Language	English
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning methodology	• Lectures • Seminars and tutorials • Project/challenge-based learning • Visits to companies, facilities, and public administration • Laboratory and practical learning of experimental methods and techniques • Access to an online library of commercial projects • Commercial software for simulation • Social media and media news about smart city topics for discussions
Assessment	Some technical aspect will be assessed by written

	examination. To bring real world to students, they will face practical and real situations using software simulation and simulation in labs. To foment interdisciplinarity, students in groups will face interdisciplinary projects covering the whole module. Groups will present written reports and make oral presentation of them, in a seminar format. The evaluation process will consider design thinking, leadership, role in groups, etc. These projects will be an important percentage of the assessment. Roleplay situation, were each student or group face one aspect related to a real project about mobility and transport in smart cities

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Traffic Management and Transport Planning in smart Cities*
Module:	*Mobility and Transport in Smart Cities*
ECTS Workload:	4.5
Semester:	2nd
Compulsory/Elective:	*Elective*

Required Knowledge / Input profile

It is recommended to have a basic understanding of the following topics:

- Optimization: Familiarity with basic concepts of optimization, such as maximizing or minimizing linear and nonlinear functions, constraints.
- Statistics: Fundamental knowledge of statistics, statistical tests and probability distributions.
- Programming skills, it is beneficial to have proficiency in some programming language (e.g. Python or Matlab).

These knowledge areas will enable students to comprehend and apply optimization techniques in designing and improving intelligent transportation systems, city logistics, as well as utilize statistical methods to analyze traffic data and evaluate the impact of new forms of mobility.

Description of content

1. Basic concepts and principles of smart cities and their relationship with transportation and mobility (theoretical: 0.2 ECTS)
2. Land use and transport planning: the relationship between land use patterns, trip generation, and transportation demand (theoretical: 0.3 ECTS, practical: 0.2 ECTS)
3. Traffic control systems (theoretical: 0.3 ECTS, practical: 0.2 ECTS)
4. Urban Traffic Management: signal phasing. Isolated intersections. Arterial control, Network control. Integrated systems. Traffic coordinating architectures. Detectors and Management centre (theoretical: 0.2 ECTS, practical: 0.3 ECTS)
5. Intelligent Transportation Systems (ITS) (theoretical: 0.2 ECTS, practical: 0.3 ECTS):
    a. Definition and overview of ITS
    b. Technologies used in ITS (e.g. sensors, cameras, GPS)
    c. Application of ITS in traffic management and transport planning.
6. Travel behaviour and demand forecasting techniques in urban transport planning (theoretical: 0.6 ECTS, practical: 0.4 ECTS)
7. Transit-oriented development and its role in urban transport planning (theoretical: 0.2 ECTS, practical: 0.3 ECTS)
8. Sustainable transport policies and practices in urban areas (theoretical: 0.2 ECTS, practical: 0.1 ECTS)
9. Evaluation and monitoring of urban transport systems and policies (theoretical: 0.1 ECTS, practical: 0.4 ECTS)

Output profile /Competences adquired

- *Data Collection and Analysis*: Gain valuable insights into techniques for collecting and analyzing urban transport data. Learn how to effectively gather data and interpret it to make informed decisions.
- *Urban Transport Planning and Land Use*: Explore the critical relationship between urban transport planning and land use planning. Understand how these two aspects impact the development of sustainable transport systems. Develop a solid foundation in the principles that guide effective urban transport and land use integration.
- *Evaluation and Monitoring Tools*: Familiarize yourself with the tools and methods used for evaluating and monitoring urban transport systems. Gain practical knowledge on how to assess the performance of transport solutions and make evidence-based recommendations for improvement. Acquire the skills necessary to identify key performance indicators and effectively evaluate the success of urban transport initiatives.
- *Design the Future of Urban Mobility*: Develop the skills to design intelligent transportation systems that will transform the way we move in the city. Plan efficient routes, implement smart traffic control systems, and optimize transportation infrastructure. Imagine the impact you can have on people's quality of life and the efficiency of cities!
- *Collaborate and succeed together as a team*: Smart urban mobility requires collaboration among diverse experts and stakeholders. Our course emphasizes teamwork and collaborative skills, preparing you to excel in multidisciplinary environments and manage joint projects.
- *Bridge Theory and Practice*: Our course bridges the gap between theoretical knowledge and practical application. By immersing yourself in simulation-based assessments, you'll enhance your understanding of how theoretical concepts translate into real-world implications.

Teaching and Learning Methodology

- *Lectures*: To introduce basic concepts and theories of traffic and urban transportation planning.
- *Group discussions and case analyses*: to foster critical thinking and analysis of complex urban transport planning situations.
- *Hands-on training*: with macroscopic and microscopic simulation software: Students practice using simulation software through guided exercises and tutorials.
- *Simulation scenarios*: Students work in groups to design, simulate different urban transport scenarios using simulation software and analyse the simulation results.
- *Guest lectures*: by urban transport planning experts to learn about new trends and technologies.

Assessment

- *Lecture participation*:Active participation in the development of the subject.
- *Tests and Exercises:* Resolution of theoretical and practical exercises, questionnaires, evaluation tests and/or comments on the contents of the course.
- *Individual work*: Elaboration and/or oral or written presentation of works, reports or projects of the subject.

Evaluation strategies/methodologies	
	Percentag
e CLASSROOM PARTICIPATION	30 %
PRACTICAL ASSUMPTIONS or TEST TYPE	30 %
INDIVIDUAL/COLLECTIVE ACADEMIC OR RESEARCH WORK	40 %

Bibliography

- Elefteriadou L. (2014). An Introduction to Traffic Flow Theory. Springer.
- Gordon R.L., Tighe W. (2005) Traffic Control Systems Handbook. FHWA-HOP06-006
- Kessels K (2019). Traffic Flow Modelling Introduction to Traffic Flow Theory Through a Genealogy of Models. Springer.
- Ortuzar, J. D., Willumsen L.G. (2023). Modelling Transport. Wiley, 5th Edition.

DESCRIPTION OF THE SUBJECT

GENERAL INFORMATION

Subject:	*City Logistics: Transport and Mobility*
Module:	*Mobility and Transport in Smart Cities*
ECTS Workload:	3
Semester:	2nd
Compulsory/Elective:	*Elective*

Required Knowledge / Input profile

It is recommended to have a basic understanding of the following topics:

- Optimization: Familiarity with basic concepts of optimization, such as maximizing or minimizing linear and nonlinear functions, constraints.
- Statistics: Fundamental knowledge of statistics, statistical tests and probability distributions.
- Programming skills, it is beneficial to have proficiency in some programming language (e.g. Python or Matlab).

These knowledge areas will enable students to comprehend and apply optimization techniques in designing and improving intelligent transportation systems, city logistics, as well as utilize statistical methods to analyze traffic data and evaluate the impact of new forms of mobility.

Description of content

1. Transport Logistics (goods and people): introduction, objectives, activities (theoretical: 0.1 ECTS)
    a. Elements, structures and strategies
    b. Theories
    c. Planning models
2. Optimization of logistic systems: models (theoretical: 0.5 ECTS, practical: 0.5 ECTS)
    a. Infrastructure optimization (warehouses, interchanges, terminals)
    b. Facility location and allocation
    c. Mode & Means optimization: intermodality
3. City and urban logistics: goods, people, policies, regulations, models (theoretical: 0.1 ECTS, practical: 0.1 ECTS)
4. Urban transport intermodality (theoretical: 0.2 ECTS)
5. System reliability (theoretical: 0.2 ECTS)
6. Influencing factors (theoretical: 0.2 ECTS, practical: 0.3 ECTS)
    a. Measuring & Evaluation
7. Green Logistics (theoretical: 0.2 ECTS, practical: 0.1 ECTS)
8. Case studies and Policies (theoretical: 0.2 ECTS, practical: 0.3 ECTS)
    a. Further tendencies & potentialities

Output profile /Competences adquired

- Interpret and know how to apply new methods of technological innovation in the sector and analyze their impact.
- Interpret and be able to apply the scientific method to analyze and make judgments, whether experimental and/or theoretical, in the field of City freight transport logistics and the mobility of people, as well as the operations management involved.
- Differentiate and compare the different stages that make up the different logistics structures and typologies with a high vector of transport activity and the possibilities of improving their efficiency through the optimal design of solutions.
- Comprehensive Understanding of Urban Logistics: Gain insights into the complexities of urban logistics, including the management of transportation networks, warehousing, and last-mile delivery. Develop a holistic perspective on the logistics challenges specific to urban environments, such as traffic congestion, limited space, and sustainability.
- Innovative Solutions for Efficient Delivery: Explore cutting-edge technologies and innovative approaches that optimize delivery processes in urban smart cities. Discover how advances in autonomous vehicles, drone deliveries, and smart tracking systems can revolutionize last-mile logistics. Gain the ability to identify and implement sustainable and efficient delivery solutions tailored to the unique requirements of smart cities.
- Integration of Data and Analytics: Harness the power of data and analytics in smart city logistics. Learn to effectively collect, analyze, and interpret data to optimize routes, predict demand, and enhance supply chain operations. Acquire skills in leveraging real-time data, IoT sensors, and predictive analytics to make data-driven decisions that drive efficiency and sustainability in urban logistics.

Teaching and Learning Methodology

- Master classes, seminars and multimedia exhibitions, which can be face-to-face or remote, either synchronously or asynchronously with the appropriate tools of the virtual teaching platform.
- Classes of exercises and resolution of practical cases, case studies and discussion of works and articles, which can be face-to-face or remotely, either synchronously or asynchronously with the appropriate tools of the virtual teaching platform.
- Work supervision (exercises, text comments).
- Scheduled individual and/or group tutorials.
- Personal study of the student: reading of recommended bibliography, carrying out works, bibliographic reviews, questionnaires, tests, exercises, and preparatory exam.

Assessment

- *Lecture participation*: Active participation in the development of the subject.
- *Tests and Exercises:* Resolution of theoretical-practical exercises, questionnaires, evaluation tests and/or comments on the contents of the subject.
- *Individual work*: Elaboration and/or oral or written presentation of works, reports or projects of the subject.

Evaluation strategies/methodologies	
	Percentag
e CLASSROOM PARTICIPATION	30%
PRACTICAL ASSUMPTIONS or TEST TYPE	30%
INDIVIDUAL/COLLECTIVE ACADEMIC OR RESEARCH WORK	40%

Bibliography

- Hao Zhang, 2022. *Reliability Optimization of Urban Logistics System*. Springer.
- Taniguchi E. 2014. *City Logistics. Mapping the future*. CRC Press.
- Taniguchi E., Thompson R. G., Yamada T., van Duin R. 2001. *City Logistics.Network Modelling and Intelligent Transport Systems.* Emerald, Inc.

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	**New autonomous air and ground mobility concepts**
Module:	*Mobility and Transport*
ECTS Workload:	*4,5 ECTS*
Semester:	2nd Semester
Compulsory/Elective:	*Compulsory / Elected*

Required Knowledge / Input profile

It is recommended to have a background in STEM studies. Specifically, it is recommended (but not mandatory) to have the following knowledge:

- Basic knowledge of statistics.
- Basic knowledge of optimization problems.
- Basic knowledge of informatics: for example, Matlab, Linux, C++, Python, ROS or others
- Basic knowledge of electronics.

Description of content

Indicar contenido detallado de la asignatura, número de horas por lección/actividad y el carácter teórico/práctico de la acción.

1. Introduction to Smart, Connected and Autonomous Vehicles (SCAV).
   - Smart Mobility.
   - Historical context: mobility in the past, mobility in present time.
   - Keys Areas.
   - Involved Roles.

2. Technology in urban Mobility.
   - Requirements.
   - Vehicles: ground and air vehicles.
   - Infrastructures.
   - Emerging Technologies.
   - Human Factors and Ethical Considerations.
   - Autonomous vehicles.

3. Communications.
   - Overview of communication systems.
   - Communications theory.
   - Wireless technologies.
   - Wired technologies.
   - Vehicle networking.

4. Sensor Fusion, Localization and Mapping.
   - Sensors.
   - Filters: linear filters and non-linear filters.
   - Navigation approaches.
   - Position estimation.
   - Map representation.
   - Simultaneous localization and mapping (SLAM).

5. Navigation and guidance systems
    - Path planning.
    - Path following.
    - Guidance approaches.
    - Cooperative guidance and collision avoidance.

6. Intelligent Mobility Systems
    - Autonomous Systems and Artificial Intelligence (AI).
    - AI Algorithms.
    - Automated Reasoning.
    - Decision Making for Autonomous Vehicles.

7. Airspace management and Regulatory frameworks.
    - Introduction to Air Traffic Management (ATM) and Air Traffic Control (ATC).
    - Flight rules, airspace structures and classifications, air traffic service.
    - ATC Technologies.
    - ATC Procedures.
    - Capacity and delay models of airport and air routes
    - Air traffic flow management (ATFM) models
    - ATM automation decision support tools.

8. Future and latest advancements.

Outpul profile /Competences adquired

Upon completion of this course, students will be able to:

- Understand the key concepts and technology behind smart, connected, and autonomous vehicles including the potential impact on the environment, economy, and social behaviour. How, it can positively contribute to a multimodal mobility system. Furthermore, understanding as a safe, sustainable, and convenient solution. Besides, Evaluate the human factors and ethical considerations related to the use of autonomous vehicles.
- Design and implement intelligent systems for autonomous vehicles that can make safe and efficient decisions. Moreover, analyze and design algorithms for sensor fusion, localization, and mapping of autonomous vehicles.
- Identify the role of smart transportation infrastructure and communications (different communication protocols and networking technologies) in the deployment and use of autonomous vehicles. Furthermore, identify the advantages and disadvantages, including sustainability, energy consumption, normative, policies, education, and awareness campaigns.
- Collaborate effectively in group work, communicating ideas, providing feedback, and respecting diverse perspectives. Additionally, improve oral communication skills in public presentations.

Teaching and Learning Methodology

The teaching and learning activities for this course will include:
Lectures and seminars on the theoretical concepts and technology behind smart, connected and autonomous vehicles.

- Site visits
- Develop a sustainable mobility project, including setting goals, designing strategies, and managing resources.
- Collaborate effectively in group work, communicating ideas, providing feedback, and respecting diverse perspectives.
- Debate to discuss and highlight the human factors and ethical considerations related to the use of autonomous vehicles.
- Group presentations

Assessment

The assessment methods for this course will include: - Participation in class – 15% - Group work and discussions around specific topics or questions – 40% - Research project and presentations – 45%
Bibliography
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Name	Energy Efficiency and Smart Buildings
ECTS workload	12
Semester	S2
Compulsory/elective	Elective
Objectives	This is an elective module including buildings, smart management, new building materials, etc.
PLOs	See annex 4
Brief description of contents	Energy efficiency and smart buildings • Energy efficient heating and cooling system • Domotics and building management systems • Treatment of water in buildings • Energy efficiency directive • Energy efficiency certification • Renewable energy systems integration in buildings
Offered by	USE
Teaching Team	Mainly USE and TUKE, with the participation of teachers/trainers from UCA Associated partners and external experts Volunteer students
Language	English
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning methodology	• Lectures • Seminars and tutorials • Project/challenge-based learning • Visits to companies, facilities, and public administration • Laboratory and practical learning of experimental methods and techniques • Access to an online library of commercial projects • Commercial software for simulation • Social media and media news about smart city topics for discussions
Assessment	Some technical aspect will be assessed by written examination. To bring real world to students, they will face practical

	and real situations using software simulation and simulation in labs. To foment interdisciplinarity, students in groups will face interdisciplinary projects covering the whole module. Groups will present written reports and make oral presentation of them, in a seminar format. The evaluation process will consider design thinking, leadership, role in groups, etc. These projects will be an important percentage of the assessment. Roleplay situation, were each student or group face one aspect related to a real project about energy efficiency and smart buildings

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Passive buildings and physics*
Module:	*Energy Efficiency and Smart Buildings*
ECTS Workload:	*4*
Semester:	2nd semester (elective)
Compulsory/Elective:	*Theoretical / practical*

Required Knowledge / Input profile

- Basic knowledge of building plans and spatial vision
- Simple concepts related with building in use. Thermal comfort, energy consumption, etc.
- Elementary understanding of buildings constructive systems

Description of content

Theoretical classes:

1. **Energy efficiency directive for buildings (0.3 ECTS)**
   - 1.1. Net Zero Energy Buildings
   - 1.2. Positive Energy Buildings and Districts
   - 1.3. Buildings directive and certification

2. **Comfort and climate (0.3 ECTS)**
   - 2.1. Climate
     - 2.1.1. Fundamental climate variables
     - 2.1.2. Climate classification
     - 2.1.3. The urban climate. Microclimate
   - 2.2. Thermal Comfort
     - 2.2.1. Concepts
     - 2.2.2. Milestone research
     - 2.2.3. Comfort model of ASHRAE Handbook of Fundamentals
     - 2.2.4. Adaptive comfort models

3. **Building physics. Envelope, openings, materials (0.8 ECTS)**
   - 3.1. Thermal characterization
   - 3.2. Thermal transmittance
   - 3.3. Airtightness
   - 3.4. Thermal bridges
   - 3.5. Openings features
   - 3.6. Low impact constructive materials

4. **Passive strategies (0.3 ECTS)**
   - 4.1. Spatial distribution
   - 4.2. Passive strategies
   - 4.3. Winter. Passive heating strategies
   - 4.4. Summer. Passive cooling strategies

5. **Sustainability assessment (0.3 ECTS)**

5.1. Life-cycle assessment (LCA)
5.2. Economical, environmental and social impact indicators and methodologies
5.3. Life-cycle sustainability assessment of buildings

Practical classes (simulations tools):

1. **Generic bioclimatic strategies (0.15 ECTS)**
2. **Interface, location, decisions at first stages of design. (0.3 ECTS)**
3. **Template definition, envelope, openings and activities. (0.3 ECTS)**
4. **Thermal characterization of building envelopes: Infrared Thermography (0.3 ECTS)**
5. **Environmental impact assessment of a building. (0.3 ECTS)**
6. **Simulation of the actual state of the building. (0.15 ECTS)**
7. **Economic impact assessment of a building. (0.3 ECTS)**
8. **3D laser scanning and Building Information Modelling (BIM) (0.2 ECTS)**

Outpul profile /Competences adquired

- Knowledge of the European directives and certificactions to identify the conditions for buildings with near zero consumption and positive energy.
- Identification of methodologies for determining the types of climates at a European level and their effect on buildings.
- Knowledge of thermal comfort models applied to building occupants.
- Understanding of heat and mass transfer models for the quantification of thermal demand in buildings.
- Ability to analyze the thermal evolution of a building.
- Knowledge in the management of thermal simulation tools for buildings.
- Knowledge of the thermal signatures of building envelopes using infrared thermography.
- Ability to use infrared thermography for building diagnostics, considering both standards and good practice from scientific literature.
- Understanding of environmental impact assessment methodologies and their application to buildings.
- Understanding of economical impact assessment methodologies and their application to buildings.
- Ability to use Terrestrial Laser Scanning (TLS) to survey existing buildings and support BIM projects.

Teaching and Learning Methodology

- Classroom Lectures
- Technical visit to laboratories
- Simulation activities in computer labs

Assessment

- Technical aspect will be assessed by written examination. 10%
- Oral presentation (in groups) of the real cases simulated by students. 50%
- Final written report. 40%

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DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Active systems and Energy Conservation Measures (ECM) in buildings*
Module:	*Energy Efficiency and Smart Buildings*
ECTS Workload:	*4*
Semester:	2nd semester (elective)
Compulsory/Elective:	*Theoretical / practical*

Required Knowledge / Input profile

- Simple concepts related with energy saving measures in buildings
- Basic knowledge of with active systems in buildings
- Elementary understanding energy performance in buildings

Description of content

Theoretical classes:

1. **Building systems. HVAC, operable buildings (0.45 ECTS)**
   - 1.1. Thermal loads
   - 1.2. Direct expansion systems
   - 1.3. Indirect expansion systems
   - 1.4. Air Handling Units (AHU)
   - 1.5. Ducts
   - 1.6. Diffusers

2. **Energy conservations measures (ECM) in active systems (0.65 ECTS)**
   - 2.1. Operation schedules
   - 2.2. Indoor air quality
   - 2.3. Heating, Ventilation and Air Conditioning (HVAC)
   - 2.4. Heat recovery systems
   - 2.5. Intelligent building optimization
   - 2.6. Lighting

3. **Holistic assessment of strategies (0.45 ECTS)**
   - 3.1. Life-cycle perspective
   - 3.2. Holistic sustainability assessment of energy efficiency strategies
   - 3.3. Evaluation at urban-scale

4. **Future perspectives, trends and R&I (0.45 ECTS)**
   - 4.1. Adaptive energy consumption
   - 4.2. Energy poverty alleviation
   - 4.3. Climate change mitigation
   - 4.4. Tentative class

Practical classes (simulations tools):

1. **Simulation of the energy in use in buildings. (0.3 ECTS)**
2. **Simulation of ECM, passive vs. active design. (1 ECTS)**
3. **Outputs, graphical representations. (0.3 ECTS)**
4. **Holistic evaluation of improvement proposals from life-cycle perspective. (0.5 ECTS)**

Outpul profile /Competences adquired

- Knowledge and ability to identify the most common air conditioning and ventilation systems in buildings.
- Knowledge and identification of energy saving measures through passive heating and cooling techniques.
- Knowledge and identification of energy saving measures through active heating and cooling techniques working on air conditioning, ventilation and lighting equipment.
- Ability to evaluate energy efficiency improvement proposals from a holistic sustainability viewpoint

Teaching and Learning Methodology

- Classroom Lectures
- Technical visit to laboratories
- Simulation activities in computer labs

Assessment

- Technical aspect will be assessed by written examination. 10%
- Oral presentation (in groups) of the real cases simulated by students. 50%
- Final written report. 40%

Bibliography

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Management 3 (2005) 605–615. https://doi.org/10.1016/j.soildyn.2004.11.005.

DESCRIPTION OF THE SUBJECT	
GENERAL INFORMATION	
Subject:	*Renewable Energy Systems (RES) in buildings*
Module:	*Energy Efficiency and Smart Buildings*
ECTS Workload:	*4*
Semester:	2nd semester (elective)
Compulsory/Elective:	*Theoretical / practical*

Required Knowledge / Input profile

- Basic knowledge on heat transfer, thermal energy engineering and heat exchangers.
- Knowledge about photovoltaic and wind energy systems.

Description of content

Theoretical classes:

1. **Solar source as primary energy(0.3 ECTS)**
   1.1. Solar radiation characteristics
   1.2. Methods for calculating incident solar radiation on a surface.

2. **Renewable energy systems integration (1.5 ECTS)**
   2.1. Solar hot water domestic systems
   2.2. Photovoltaic
   2.3. Micro Combined Heat and Power (CHP)
   2.4. Micro wind energy
   2.5. Energy Storage Systems. Vehicle 2 Home

3. **Future perspectives, trends and R&I (0.2 ECTS)**

Practical classes (simulations tools):

1. **Introduction to simulations tools for Solar Systems (0.8 ECTS)**
2. **Simulation of RES in buildings. (1 ECTS)**
3. **Outputs, graphical representations, final proposal presentations. (0.2 ECTS)**

Outpul profile /Competences adquired

- Ability to calculate the energy provided by the renewable source.
- Ability to design renewable energy systems and their integration into the energy consumption of the building.
- Identification of valid energy storage systems for buildings in order to improve their energy management.

Teaching and Learning Methodology

- Classroom Lectures - Technical visit to laboratories - Simulation activities in computer labs
Assessment
- Technical aspect will be assessed by written examination. 10% - Oral presentation (in groups) of the real cases simulated by students. 50% - Final written report. 40%
Bibliography
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Name	Specialization
ECTS workload	27
Semester	S3
Compulsory/elective	Elective
Objectives	The Specialization module is oriented towards a further specialization in smart cities by means of elective courses. Also, this module brings the students the opportunity to know the latest aspects related with smart cities.
PLOs	See annex 4
Brief description of contents	Each partner university offers elective courses for students to acquire a deeper understanding of the technical aspects and specific competences related to smart cities. This module enables students also to keep up with the latest research and innovation developments in the field and brings the latest challenges in the sector so that students can grasp what the future of smart cities will look like.
Offered by	All partners universities
Teaching Team	All partners universities, Associated partners and external experts Volunteer students
Language	English
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning methodology	• Lectures • Seminars and tutorials • Project/challenge-based learning • Visits to companies, facilities, and public administration • Laboratory and practical learning of experimental methods and techniques
Assessment	Some technical aspect will be assessed by written examination. To bring real world to students, they will face practical and real situations using software simulation and

	simulation in labs. To foment interdisciplinarity, students in groups will face interdisciplinary projects covering the whole module. Groups will present written reports and make oral presentation of them, in a seminar format. The evaluation process will consider design thinking, leadership, role in groups, etc. These projects will be an important percentage of the assessment. Roleplay situation, were each student or group face one aspect related to a real project about the whole module

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*NUMERICAL CARTOGRAPHY AND GIS*
ECTS:	*5 ECTS*
Semester:	3rd semester- UniGe- University of Genoa
subject type:	*Elective*

SUBJECT CONTENTS

The teaching provides the necessary tools for the management and analysis of the different spatial data sources available today relating to both the terrestrial and marine environment, including the newest and highest resolution ones such as Lidar digital terrain models and satellite images. Several areas of application of the exercises will be addressed through the software GIS (Geographic Information System), for planning, management and monitoring the environment.
The use of free and open source geographic software (GFOSS) and the expertise acquired in the management of geographic data ensure that the teaching contributes to the following Sustainable Development Goals of the UN 2030 Agenda:

- Goal 4: Provide quality, equitable and inclusive education and learning opportunities for all
- Goal 10: Reduce inequality within and between nations
- Goal 15: Protect, restore and promote sustainable use of the earth's ecosystem

LEARNING OUTCOMES

The course provides the necessary tools for the management and analysis of the various spatial data available today relating to the terrestrial, marine and aerial environment, including the most recent and high-resolution ones such as LiDAR Digital Terrain Models and satellite images. Several applications supporting the management of the environment will be addressed through GIS (Geographic Information System) software.
Main learning outcomes are related to:

- Theoretical and practical acquisition of the techniques for the treatment of georeferenced data, as a tool to support environment management as well as decision support system.
- Capacity of results analysis depending on the metric resolution of data.
- Use of free and open source software in accordance with the directive of the Minister for Innovation and Technology, December 19, 2003 to encourage the use of these technologies.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

Theoretical lectures will be developed together with practical lectures on the computer (50% each).

ASSESSMENT SYSTEMS (with their minimum and maximum percentage weighting in relation to the total)
The students are required to form small groups (from 2 to 4 persons) and produce a technical report on the practical activities developed during the course. The presentation of the report and its critical discussion during the final examination will be evaluated, together with the knowledge of theoretical concepts essential for proper management of geographic data. The quality of the oral and written presentation will be evaluated, because considered preparatory to the students' future working life, enabling them to better acquire the ability to share ideas and work as a team.

GENERAL INFORMATION	
Subject:	*SUSTAINABLE PLANNING*
ECTS:	*5 ECTS*
Semester:	3rd semester- UniGe- University of Genoa
subject type:	*Elective*
SUBJECT CONTENTS	
The course aims to present the main issues related to sustainability at urban and territorial level. In particular, it deepens the main institutional competences and the related procedures. The course also illustrates virtuous experiences on the international scene.	
LEARNING OUTCOMES	
Students will have to be able to analyze the Plans and Programs and formulate logical links between them, developing a greater sensitivity towards the disciplines of the territory. Sustainable Planning aims to: - Analyze planning and programming tools and distinguish the different themes present in urban realities - develop greater sensitivity towards the territorial discipline - propose and compare choices of social and economic redevelopment and revitalization of the territory - evaluate sustainability in all its dimensions. The course will lead the student to: - present and integrate the fundamental planning issues in the civil-construction-environmental field, useful for the engineering activity; - develop key-topics (through works on case studies) stimulating a greater awareness of the various critical issues and solutions.	
TEACHING AND TRAINING ACTIVITIES **(with their weight in hours and percentage of attendance)**	
The 40-hour teaching consists of lectures (about 70%), followed by guided thematic works, required by single student or by small groups of students (about 30%). Attendance is mandatory.	
ASSESSMENT SYSTEMS **(with their minimum and maximum percentage weighting in relation to the total)**	

The assessment will be carried out through an oral test, in which the overall subject knowledge and the group work carried out during the course will be evaluated.
The oral exam will mainly focus on the topics dealt with in the lectures and will have the purpose of evaluating not only if the student has reached an adequate level of knowledge, but if he has acquired the ability to critically analyze territorial problems.
The oral exam consists of two parts (50% each):
- the first: the exposition of the topics illustrated during the lessons
- the second: the presentation and subsequent discussion of the results acquired on a chosen topic, that is considered as an integral part of the oral assessment

GENERAL INFORMATION	
Subject:	*CONSTRUCTION TECHNIQUES, DAMAGE AND DETERIORATION OF BUILDINGS*
ECTS:	*10 ECTS*
Semester:	3rd semester- UniGe- University of Genoa
subject type:	*Elective*

SUBJECT CONTENTS

The course aims to introduce the students to the main construction techniques adopted in existing buildings, in relation to their technical, structural and energy performance, and to identify the main pathologies and degradation phenomena to which they may be subject. The two modules of the course refer to the most common types of constructive in the European territory: the load masonry structures and those in reinforced concrete.
The course is formed by two submodules:

- REINFORCED CONCRETE BUILDINGS
- TRADITIONAL MASONRY BUILDINGS

LEARNING OUTCOMES

REINFORCED CONCRETE BUILDINGS is intended to provide students with the basic knowledge to understand the main technical characteristics of a building with a reinforced concrete structure. In this regard, all those aspects related to the design, execution and correct maintenance of the constructive elements will be examined in depth.
At the end of the course, students will be able to
- recognise those historical evolutionary factors that have favoured the diffusion of reinforced concrete as the primary construction material;
- understand the chemical-physical properties of building materials in order to use them in design consciously;
- being able to discretise the entire building into its construction elements, being able to analyse its structure, function and state of preservation;
- be capable of recognising and assessing the leading causes of degradation of building elements in the reinforced concrete building.

TRADITIONAL MASONRY BUILDINGS provides the specialized knowledge to intervene on traditional buildings in load-bearing masonry affected by problems of decay, structural failure and performance deficits. Such knowledge is also necessary to correctly set up any new intervention that interferes with existing structures.

At the end of the course, students will be able to:
- Describe and graphically represent, albeit schematically, the construction characteristics of historic buildings, with particular attention to load-bearing elevation structures and roofing systems, windows and doors, and floor finishes.

- Recognize and correctly describe the forms of degradation, disruption and functional deficits that affect existing buildings.
- Identify the causes and concomitant causes that have caused them.
- Select the main techniques of maintenance, rehabilitation, consolidation, upgrading and energy improvement of buildings and their component parts.
- Correctly set design problems by applying the knowledge acquired.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course mainly involves frontal lectures. However, the course also includes further supplementary activities such as seminars by external guests, visits to building and civil engineering sites, and on-site tours of companies producing building materials and components subject to study.

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

The exam will be splitted in two different examinations (50% each).
The first module evaluation will be based on an oral exam that allows to verify the ability to analyse and understand the pathologies and the problems of degradation and deficit that affect traditional buildings, in order to correctly set up projects of recovery. Parameters of evaluation for the first module exam will be:
- the ability to set up a critical reasoning related to the state of conservation of an entire building or its parts, starting from the recognition of construction techniques and the structural role of the different components;
- ownership of the technical vocabulary regarding materials, working and laying techniques, phenomena of degradation or structural failure;
- the ability to set a design problem (maintenance, conservation or consolidation, in general improvement) and to choose the most appropriate ways of intervention;
- the ability to identify possible ways of transformation compatible with the conservation of historical-architectural and material values.

The second module examination consists of a written test and an oral discussion.
The written test consists of a series of questions on the topics covered during the course, with open-ended and multiple-choice questions.
The oral discussion may be optional and consists of discussing the written test by analysing the errors made by the student and addressing other topics from the course aimed at assessing the adequate preparation of the learner.

GENERAL INFORMATION

Subject:	*TECHNIQUES FOR BUILDING REHABILITATION*
ECTS:	*5 ECTS*
Semester:	3rd semester- UniGe- University of Genoa
subject type:	*Elective*

SUBJECT CONTENTS

The module aims to provide the basic knowledge needed to deal with an existing building rehabilitation project. Specifically, knowledge will be provided regarding the methodological approach for studying the existing building conditions and identifying design solutions; different rehabilitation techniques will be described in detail, and a focus will also be made on the main materials used.

LEARNING OUTCOMES

The course will illustrate the methodological and technical problems present in a refurbishment project concerning the building envelope, with particular attention to materials and construction techniques.The main expected learning outcomes are:

- to know how to critically analyze an existing building and assess the need for rehabilitation work
- to apply the acquired knowledge to a rehabilitation project of the existing building and to know how to choose different solutions and materials while qualitatively assessing their impact and achievable benefits

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course is conducted through in-class activities, traditional lectures and independent study.
The main topics discussed during the course are:

- climate change and sustainable development with a special focus on the construction sector
- sustainability-oriented design approach
- methodologies for analyzing existing buildings and individuating design solutions
- types of interventions for upgrading the building envelope
- techniques and materials for the rehabilitation of existing buildings

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

Evaluation of theoretical, methodological applied knowledge is carried out through an oral exam.

GENERAL INFORMATION

Subject:	*LIFE CYCLE ASSESSMENT AND ECODESIGN*
ECTS:	*5 ECTS*
Semester:	3rd semester- UniGe- University of Genoa
subject type:	*Elective*

SUBJECT CONTENTS

Learn about sustainability, life cycle thinking and life cycle assessment as a tool to evaluate potential impacts along the life-cycle of a product for ecodesign purpose.

LEARNING OUTCOMES

The Module "Life Cycle Assessment and Ecodesign" covers key elements of Life cycle assessment (LCA), a tool for evaluating the environmental impacts of a product or process over a defined life cycle, and ecodesign, systematically incorporating environmental considerations into the design process..
On successful completion of this study, through lessons attendance and training activities such as oral lessons and exercises, the student should be able to:

- Demonstrate an understanding of the key steps of ecodesign
- Apply competently the basic principles of Life Cycle Thinking
- Design and assess the sustainability of a product or a process plant using simulation tools
- Work effectively as a member of an ecodesign team developing making judgements, learning and communication skills illustrating an industrial case study

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course foreseen traditional lectures, exercises and group works, educational field trips, use of simulation software.
Novel tools will be used for the active learning of students. The goal is to increase students' skills via interactive, experience-based, learning methodologies (e-learning, teamwork, etc.) for enhanced student participation, using an advanced level of communication that makes the student more aware and indipendent.

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

The learning outcomes are assessed through the presentation of a project ecodesign and an oral exam.
The project design consists of the following steps:

- Choose a process/plant/supply chain within the following: traditional processes (steel mills, refineries, glass and cements production plants, waste treatment), “innovative” processes (photovoltaic, fuel cell, bioplastic, biofuels, circular economy)
- Analyze the process through a Life Cycle Assessment study, retrieving data by scientific literature, publications, public reports using spreadsheets and modeling software.
- Identify one or more aspects (substances, materials, emissions, waste) significant from an environmental point of view
- Propose one of more plant/process/supply chain alternatives and study the obtained improvements
- Draw up a sustainability report showing: case study, methodology and results

The ecodesign project will be presented during the oral examination.
The exam aims to evaluate skills to apply the learning to specific case studies and to critically analyze processes from a comprehensive and holistic point of view. Quality of the presentation, correct terminology, and critical thinking skills will also be evaluated.

Name	Transversal Skills
ECTS workload	27
Semester	S3
Compulsory/elective	Elective
Objectives	The Transversal skills module contains a set of transversal training courses and activities dealing with innovation, high level digital skills, communication skills, and languages, complemented with Ulysseus Educational Activities
PLOs	See annex 4
Brief description of contents	• Innovation (business management, intellectual property rights, entrepreneurship, creativity, leadership) • Activities related to use the "cities as living labs" and activities within the living labs integrated in the Ulysseus IH • High level digital skills • Communication skills • Languages (at least the six partner countries language courses, plus English) • Ulysseus single-partner and joint Educational Activities: i.e., specific academic courses, visits (to the IH, public administrations, related companies and research centers), seminars, summer/winter schools, volunteering, civic engagement activities (i.e., open classes, science shops, Science fairs, Researchers night) or activities related to the promotion of the European values, among others.
Offered by	All partners universities
Teaching Team	All partners universities, Associated partners and external experts Volunteer students
Language	English, local languages of the country partner universities
Teaching format	Onsite / online / hybrid (onsite & online)
Teaching and Learning	• Lectures

methodology	• Seminars & Tutorials • Independent study • Laboratory and Practical learning • Trip Field • Problem-Based
Assessment	Specific criteria shall apply depending on the courses offered by each partner, to be described in the course description and available to students prior to registration.

DESCRIPTION OF THE SUBJECTS OF THE CURRICULUM

SUBJECT FACT SHEETS

GENERAL INFORMATION

Subject:	*Transversal Skills / Protecting My Ideas - Identifying, protecting and managing intellectual property as a business asset*
ECTS:	*5*
Semester:	3rd semester – MCI- Management Center Innsbruck
subject type:	*Elective*

SUBJECT CONTENTS

Purpose of the course: promote familiarity and understanding of Intellectual Property Rights (IPRs) and provide the good reflexes to students when dealing with intellectual property. This course will be articulated around the following questions:

Why should I think about protecting my ideas?

- Why do IPRs matter: importance of intellectual property and the rights attached to it (IPRs) for businesses and entrepreneurs.

I have created/invented something valuable: Can I protect my creation/idea? Which options/rights are available to me?

- Patents
- Copyrights
- Industrial Designs
- Databases
- Trademark

I want to protect my creation/my idea: what should I do? Where should I go?

- Introduction to application procedures (patents, trademarks, designs).

I have protected my creation/idea (I now have IPRs): How can I make use of them? How do I valorise my creation/idea? How do I create value for my business?

- Introduction to IPRs management (strategies, enforcement, licensing & assignment).

I would like support to know when/how to protect my creation/idea: who can help me?

Available support for young entrepreneurs/innovators & SMEs in matters related to IP (at EU, regional and national level) – Guests from the relevant IP support services (if feasible).

LEARNING OUTCOMES

- Understand the importance of IPRs for businesses, entrepreneurship & innovation
- Know how to identify and distinguish the different IPRs and their respective regimes
- Understand the different possibilities in terms of IPRs management
- Know the relevant processes related to IPRs and how to inquire/use existing support for IP, particularly for young entrepreneurs and SMEs.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

- 150 hours
- 75% attendance

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

The assessment will consist in small cases to solve/open questions

SUBJECT FACT SHEETS

GENERAL INFORMATION

Subject:	*Transversal Skills / Real Life Simulation - Methods*
ECTS:	*5*
Semester:	3rd semester – MCI- Management Center Innsbruck
subject type:	*Elective*

SUBJECT CONTENTS

- Laying the foundation for smart cities
- Implementation strategies
- Stakeholder Analysis
- Methods to measure impact and how to steer regional and city governments towards smart cities policies
- Financing
- Behavioural economics
- Project Management

LEARNING OUTCOMES

- Students understand how to plan and execute a project that has to align to academic standards and to practitioners' expectations.
- Students are able to consider and apply quality and evaluation criteria in the planning of their projects.
- Students are familiar with selected tools to plan, implement, and evaluate projects and programs as well as to continuously adapt them to the local context.
- Students know how to manage the expectations of real life managers.
- Students will apply political economy analysis tools enabling them to tailor projects to specific contexts.
- Students will apply a stakeholder analysis as a basis for projects and its large-scale implementation in smart cities.
- Students will understand the principles of behavioural economics and its possible applications to promote smart cities.
- Students will understand how to harness a networking event.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course comprises an interactive mix of lectures, discussions and individual and group work.

- 125 hours
- 75% attendance

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

Course-immanent examination or final exam or combination of both examination types.

SUBJECT FACT SHEETS

GENERAL INFORMATION

Subject:	*Transversal Skills / Real Life Simulation - Practice*
ECTS:	*5*
Semester:	3
subject type:	*Elective*

SUBJECT CONTENTS

- Students work on provided background material at real life solutions
- Logical Framework Approach

LEARNING OUTCOMES

- Students understand elements of a multi-stakeholder, multidisciplinary and multifaceted approach to develop smart cities
- know how to prepare a professional presentation of their project results.
- Students learn handle a live streamed project presentation with immediate feedback via social media (live-streamed presentations, Twitter-wall, live-streamed Q&A).

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course comprises an interactive mix of lectures, discussions and individual and group work. ▪ 125 hours ▪ 75% attendance
ASSESSMENT SYSTEMS **(with their minimum and maximum percentage weighting in relation to the total)**
Course-immanent examination or final exam or combination of both examination types.

-> MCI International Short Programs

SUBJECT FACT SHEETS	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Entrepreneurship*
ECTS:	*3*
Semester:	3rd semester – MCI- Management Center Innsbruck
subject type:	*Elective*
SUBJECT CONTENTS	

1. Entrepreneurial Mindset Chapter 1 Learning Objectives 01: To introduce the concept of entrepreneurship and explain the process of entrepreneurial action. 02: To describe how structural similarities enable entrepreneurs to make creative mental leaps. 03: To highlight bricolage as a source of entrepreneurs' resourcefulness. 04: To introduce effectuation as a way expert entrepreneurs sometimes think. 05: To develop the notion that entrepreneurs cognitively adapt 06: To introduce sustainable entrepreneurship as a means of sustaining the natural environment and communities and developing gains for others.
2. Generating and Exploiting New Entries Chapter 3 Learning Objectives 01: To understand that the essential act of entrepreneurship involves new entry. 02: To be able to think about how an entrepreneurial strategy can first generate, and then exploit over time, a new entry. 03: To understand how resources are involved in the generation of opportunities. 04: To be able to assess the attractiveness of a new entry opportunity. 05: To acknowledge that entrepreneurship involves making decisions under conditions of uncertainty. 06: To be able to assess the extent of first-mover advantages and weigh them against first-mover disadvantages. 07: To understand that risk is associated with newness but there are strategies that the entrepreneur can use to reduce risk.
3. Creativity and the Business Idea Chapter 4 Learning Objectives 01: To identify various sources of ideas for new ventures. 02: To discuss methods available for generating new venture ideas. 03: To discuss creativity and creative problem solving techniques. 04: To discuss the importance of innovation. 05: To understand and be able to develop an opportunity assessment plan. 06: To discuss the aspects of the product planning and development process. 07: To discuss aspects of e-commerce.
4. Protecting the idea Chapter 6 Learning Objectives 01: To identify and distinguish intellectual property assets of a new venture including software and websites. 02: To understand the nature of patents, the rights they provide, and the filing process. 03: To understand the purpose of a trademark and the procedure for filing. 04: To learn the purpose of a copyright and how to file for one. 05: To identify procedures that can protect a venture's trade secrets. 06: To understand the value of licensing to either expand a business or start a new venture. 07: To recognize the implications of new

legislation that affects board of directors and internal auditing processes for public companies. 08: To illustrate important issues related to contracts, insurance, and product safety and liability.

5. The Business Plan: Creating and Starting the Venture Chapter 7 Learning Objectives 01: To define what the business plan is, who prepares it, who reads it, and how it is evaluated. 02: To understand the scope and value of the business plan to investors, lenders, employees, suppliers, and customers. 03: To identify information needs and sources for each critical section of the business plan. 04: To enhance awareness of the value of the Internet as an information resource and marketing tool. 05: To present examples and a step-by-step explanation of the business plan. 06: To present helpful questions for the entrepreneur at each stage of the planning process. 07: To understand how to monitor the business plan. 08: To understand the importance of contingency planning
6. The Marketing Plan Chapter 8 Learning Objectives 01: To understand the relevance of industry and competitive analysis to the market planning process. 02: To describe the role of marketing research in determining marketing strategy for the marketing plan. 03: To illustrate an effective and feasible procedure for the entrepreneur to follow in engaging in a market research study. 04: To define the steps in preparing the marketing plan. 05: Understanding how to prepare a marketing budget. 06: To illustrate different creative strategies such as social media that may be used to differentiate or position the new venture's products or services.
7. The Organizational Plan Chapter 9 Learning Objectives 01: To understand the importance of the management team in launching a new venture. 02: To understand the advantages and disadvantages of the alternative legal forms for organizing a new venture. 03: To explain and compare the S corporation and limited liability company as alternative forms of incorporation. 04: To understand the implication.

LEARNING OUTCOMES

This module aims to provide students with a core understanding of entrepreneurship, theory and practice through a blend of theoretical and experiential learning activities. This course explores and develops an understanding of entrepreneurship and the wider enterprise business environment. The course explores and covers theoretical concepts relating to entrepreneurship, idea development, creativity and innovation management, market analysis, strategic planning, resource management, operations management, financial planning, ethical/social enterprise, marketing and the role of the digital environment, as well as growth and internationalisation.
Illustrated with real-life examples, this course aims to provide students with a critical understanding of the process of entrepreneurship both in theory and in practice.

Specifically, the course aims to:
• To raise awareness of the importance of entrepreneurship in the 21st century.
• Introducing students to establish and emerging entrepreneurship methodologies.
• Provide a deeper understanding of contemporary issues related to entrepreneurship theory and practice.
• Demonstrate the role and importance of entrepreneurship to the Global economy.
• Illustrate the ways in which entrepreneurship occurs in a variety of contexts.
• Develop an understanding of entrepreneurial fundamentals (from opportunity identification and idea development to marketing and operations).
• Develop student knowledge of the internal environment of the enterprise and its operations.
• Enable students to acquire and develop an understanding of key entrepreneurial skills and tools.
• Understand how businesses grow and the changing role of the entrepreneur.
• Provide the opportunity to practice some entrepreneurial skills.
• Provide practical experience of setting up a business
• Develop understanding of organisational forms and structures.
• Introduce students to the marketing function and business planning.
• Develop student understanding of the interconnectedness between core elements of the business and its operation.
• Enable students to acquire and develop understanding, knowledge and skills related to managing an entrepreneurial venture.
• Enhance business skills via an understanding of the practical application of theoretical knowledge through assessment and guest speakers.
• Engagement with the wider entrepreneurial ecosystem
• To assist the development of skills (particularly critical evaluation of academic research, diagnostic,

problem solving, team/group working, communication, written, presentation and IT skills) through both formative classroom based work and summative assessment.

The course involves lectures and tutorials, both of which will be highly interactive. Class participation is compulsory both in individual and group activities which encourages creative thinking and 'learning by doing'. Class participation is highly rewarded and expected. Moreover, this class is designed to operate as a stepping stone for other classes in the second and third year of your studies. Therefore, you are expected to immerse yourself in its integrated design. Lectures provide the theory, the assignments are linked to practice and tutorials bridge the gap between the theory and practice.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

The course comprises an interactive mix of lectures, discussions and individual and group work.

- 75h
- 75% attendance

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

project work

SUBJECT FACT SHEETS

GENERAL INFORMATION

Subject:	*Transversal Skills / Innovation & Start Up*
ECTS:	*3*
Semester:	3rd semester – MCI- Management Center Innsbruck
subject type:	*Elective*

SUBJECT CONTENTS

1. New products as innovations connecting technology and marketing (Day 1) 1.1 NPD strategy: combining Marketing and Technology strategy: 1.2 User value. Identifying customer needs 1.3 Innovation: adoption and use. Key factors behind product innovation
2. The innovation process and its sources (Day 1) 2.1 The sources that stimulate innovations 2.2. Lead users (von Hippel) 2.3 New Product Development as an innovation process: the "Innovation Journey" 2.4 BIG Idea case classroom discussion (pre-reading required)
3. The business network surrounding product development (Day 1) 3.1 The interaction model and business relationships. 3.2 The ARA model. 3.3 Markets-as-Networks 3.4 Product development in business networks
4. Presentations of students' own innovation cases (Day 1 & Day 2)
5. Combining resources for product development (Day 2) 5.2 Resource interactions around the product 5.2 The 4Rs model 5.3 Furniture cases: Edsbyn's El-Table, IKEA's Lack table and Billy bookshelf 5.4 Classroom discussion of the three furniture cases
6. Exploiting innovations in a network (Day 2)
7. Disruptive technologies and new ventures (Day 2) 7.1 The "innovator's dilemma" (Christensen) 7.2 Mechanisms of disruption 7.3 The "innovator's solution" as new corporate ventures
8. Entrepreneurship as starting up new businesses (Day 3) 8.1 Identifying business opportunities (Kirzner's alertness) 8.2 Creating business opportunities (Schumpeter's creativity)
9. New-technology based firms (Day 3) 9.1 Spin-offs & start-ups 9.2 Starting up in networks 9.3 Challenges of science-based firms: the ParAllele case 9.4 Classroom discussion of the ParAllele case

10. Planning a start-up (Day 3) 10.1 Modelling a new business with "Business Model Canvas" 10.2 Value creation, "Unique Selling Proposition" (UPS) and protection via IPRs (Intellectual Property) 10.3 Market and financial forecasts: estimating profitability (Net Present Value, NPV analysis) 10.4 Interacting with Venture Capitalists
11. Role play venture capitalists Vs entrepreneurs with own business ideas (Day 3 & Day 4)
12. Responsible entrepreneurship (Day 4) 12.1 From profit vs sustainability to profits AND sustainability 12.2 Environmental and social responsibility 12.3 Embracing external stakeholders and Building & sharing values internally 12.4 Classroom discussion of the Body Shop International case (pre-reading required)

LEARNING OUTCOMES

Business success and competitive advantage are increasingly based on innovation, rather than merely price competition and cost efficiency. Innovating includes also identifying, creating and seizing new commercial opportunities, especially through the creation of start-ups and new ventures. Therefore, managers at all levels and entrepreneurs need to understand the dynamics and mechanisms of innovation. This includes being able to handle the following issues: where do innovative ideas comes from? how can they be transformed into successful products launched on the market? which barriers and opportunities emerge during the innovation process? how can the creativity, uncertainty and risk in this process be managed? how can start-ups and innovations be developed in a socially responsible and sustainable way?
The course addresses the issues above in both theory and practice. The relevant models and concepts are first introduced by the teacher and then applied by students to a series of practical cases, discussed either in pair or by the whole class. Participants will also train in developing and defending their own start-up ideas in front of panel of peers during an "entrepreneur-venture capitalist" roleplay. To successfully complete the course, participants will have to prepare, analyse and deliver to the teacher an own case of innovation or start-up process.

TEACHING AND TRAINING ACTIVITIES
(with their weight in hours and percentage of attendance)

Face-to face teaching. In addition, group work and class assignments will complement the overall teaching load to enable students to apply theory to professional practice. Class assignments include individual and pairwise case discussions, presentation of own example/ mini-cases and role-plays.

- 75h
- 75% attendance

ASSESSMENT SYSTEMS
(with their minimum and maximum percentage weighting in relation to the total)

Exam
Exam
Course assessed by continuous evaluation

SUBJECT FACT SHEET

GENERAL INFORMATION

Subject:	*Transversal Skills / Learning Culture in Organisations*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*

SUBJECT CONTENTS
• Learning and organisational competitiveness • Different approaches to learning • From knowledge to competences • Learning processes and practices • Supportive learning environment • Organizational culture that enhances learning
LEARNING OUTCOMES
Different approaches to learning and learning culture in organisation, as well as environment, processes and practices that enhance learning. Students are encouraged to reflect and develop practices that promote learning in their own organisations. grade 1 The student knows different approaches to learning and how learning can be enhanced in organizations. The student can describe processes related to learning and identify barriers and enablers to learning in the workplace. grade 3 In addition to the competences described in Grade 1, the student can apply different learning concepts and approaches in her/his own organization. The student can describe processes related to learning and define both learning enablers and learning barriers in the workplace. The student can turn barriers to learn into the development prospects. grade 5 In addition to the competences described in Grades 1 and 3, the student can analyse her/his own organization from the different learning perspectives and give well-grounded development suggestions based on the findings. The student can analyse and compare different learning approaches and their connections to the organisational competitiveness.
TEACHING AND TRAINING ACTIVITIES
1. Contact lessons 24 h and independent learning 111 h 2. Virtual course and independent learning 135 h 3. RPL and benefiting RPL during the course is to be agreed with responsible lecturers.
ASSESSMENT SYSTEMS
Module 1. Assignment (grading 1-5, 20 % of the final grade) Module 2. Exam (grading 1-5, 20% of the final grade) Module 3. Exam (grading 1-5, 20% of the final grade) Module 4. Development assignment (grading 1-5, 40% of the final grade). All lessons and learning assignments need to be completed and passed to pass the course

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Evolving Organisations*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*
SUBJECT CONTENTS	

- The future of changing work
- Agency and job craftin
- Human and social capital in an organization
- Organisational design
- New ways of organizing
- Organisational tensions
- Organisational development and ethics

LEARNING OUTCOMES

grade 1
The student is able to recognize some trends affecting the future of work and reflect her/his own work and role against the changes. S/he recognises the elements of organisational design and is able to explain some tensions in organisations. The student recognises different organisational concepts and ways to organise. S/he can define some approaches to organisational development and plan how to apply them in a development plan. S/he writes professional text.

grade 3
In addition to competences described in grade 1, s/he is able to identify ways how to develop agency at work. S/he can compare different organisational designs and their elements. S/he is able to distinguish different kinds of tensions and their consequences in organisations and explain how they emerge. S/he can select and compare different approach for organisational development and take multiple perspectives into account when planning how to apply them in practice. S/he recognises and reflects ethical questions related to change and development work. The level of student's academic writing is mostly correct.

grade 5
In addition to competences in grade 1 and 3, the student can distinguish multiple perspectives affecting the future of work and able to evaluate which factors and trends will affect her/his own job and career. The student is able to critically assess the factors that affect her/his own work, organisational design and organisational development from different perspectives. This is demonstrated in reports comparing, justifying and using of different theoretical frameworks. The level of student's academic writing is correct.

TEACHING AND TRAINING ACTIVITIES

This is an intensive course in flipped classroom style. It requires students to prepare for the classes before and between the three contact days and attend classes. The teaching methods include readings, active learning approaches, class discussions, short lectures and (critical) reflection of students' past and current experiences with work practices and organisations. These learning methods have been designed to foster the following meta competences: complex problem solving, critical thinking, people management, coordinating with others and congnitive flexibility. Please note that there is a pre assignment for the course. Instructions will be sent to registered students three weeks before the first contact day.

ASSESSMENT SYSTEMS

Portfolio: The portfolio consists of individual assignments and reflection of and group activities in the class.
Assessment components in the portfolio and their weights:
Preassignment 20%
Interim assignments 10%
Final assignment 20%
Documentation and reflection of the intensive days 50%

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Responsible Business and Sharing Economy*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*

SUBJECT CONTENTS

- Responsible business and sustainable development
- Effects of a sharing economy on business and customer behaviour
- Strategic responsibility and creation of shared value
- Stakeholder analysis and stakeholder dialogue
- Responsibility communication and reporting
- Development of a responsible organisation culture

LEARNING OUTCOMES

After completing the course, the student is able to:
- apply the key concepts of a responsible business and sharing economy in her/his thinking and reasoning
- recognise business opportunities related to strategic responsibility and the creation of common value
- analyse the purpose of an organisation's stakeholders and their role in responsible business and in creating shared value
- describe and assess business and management from the viewpoint of stakeholder thinking and responsible business
- acknowledge responsibility and value questions in strategy work
- produce critical thinking and problem solving in a changing operational environment

TEACHING AND TRAINING ACTIVITIES

- Virtual activities

ASSESSMENT SYSTEMS

Assessment criteria - grade 1
The student is able to define the key concepts of a responsible business and sharing economy. S/he recognises the main stakeholders and their purpose in a responsible business. S/he can describe business and management from the viewpoint of responsible business and stakeholder thinking.

Assessment criteria - grade 3
In addition to the competences in grade 1, the student can apply the key concepts of a responsible business and sharing economy in her/his thinking and reasoning. S/he can utilise the models of stakeholder analysis and dialogue. S/he is able to acknowledge responsibility and value questions in strategy work.

Assessment criteria - grade 5
In addition to the competences in grades 1 and 3, the student can analyse the purpose of an organisation's stakeholders and their role in responsible business and in creating shared value. S/he develops business and management from the viewpoints of stakeholder thinking and responsible business. S/he is able to think critically and solve problems in a changing operational environment.

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Conscious Leader*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*

SUBJECT CONTENTS

- Enabling vs. restrictive beliefs and stories
- Emotional intelligence
- Balancing between being and doing modes
- Personal triggers of behaviour
- Presence and mindfulness as a means to bring clarity into action
- Whole person paradigm
- Intention and experimental mode of action as a path towards trust and results
- Creating favourable conditions for personal and organisational transformation towards meaning and joy

LEARNING OUTCOMES

The course supports students in finding their own unique potential and serves as a platform for exploring and engaging in key areas of personal leadership and transformation with a direct interface to the student's own professional development and other areas of life. Participation does not require a formal leadership position but improves the ability to act as a leader.

TEACHING AND TRAINING ACTIVITIES

- Contact lessons
- Independent studies
- Individual work, group and peer discussions and assignments as well as individual mindfulness practice.

ASSESSMENT SYSTEMS

Assessment criteria - grade 1
The student becomes aware of his/her own thinking patterns and forms of behaviour. The student realises the influence of their own beliefs and their emotional mode on relationships, action and results on a general level, and finds ways to express him/herself genuinely and constructively in less challenging situations. The student increases his/her own resilience and finds ways to stay grounded despite shortcomings and incompleteness. The student can apply tools to take responsibility for his/her own professional life and situations and recognises their own vision of the natural mode of operation in different situations.

Assessment criteria - grade 3
In addition to previous competences (grade 1), the student is aware of his/her own thinking patterns, emotional modes and forms of behaviour and recognises their connection to everyday organisational drama. The student realises the potential of using everyday life as an opportunity to practice self-awareness and growth in a curious and mindful manner. The student discovers resources behind all kinds of feelings and is able to put them into intended action. The student realises new ways of becoming an organic part of organisational culture, recognising his/her own change and finding new openings to serve and promote organisational goals

Assessment criteria - grade 5
In addition to grades 1 and 3, the student is aware of everyday organisational drama, its drivers as well as his/her own and others involvement in it. The student is able to see more clearly the challenges

and potential of different situations. The student recognises his/her own patterns to control difficult situations and is able to alter his/her approach and, based on the situation, express oneself in a candid and constructive manner. Based on his/her own experience and insight, the student is able to understand and empathise with others while honouring personal borders and responsibility. The student profoundly understands that she/he provides their own security, control and approval, which enables freedom to be authentic, while at the same time appreciating and respecting challenges.

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Achieving Sustainable Development Goals*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*

SUBJECT CONTENTS

· UNWTO's Sustainable Development Goals (SDGs)
· Key stakeholders of SDGs
· SDGs from individual, business, community and global point of view
· Sustainable business strategies in business
· SDGs in business operations
· Solving SDGs related case in business

LEARNING OUTCOMES

After completing the course, the student:
· has a holistic view of Sustainable Development Goals (SDGs)
· has a an understanding of the roles of different stakeholders in reaching SDGs in tourism
· is able to understand and apply the key concepts of SDGs in her/his thinking and reasoning
· can assess the appropriateness of SDGs in tourism business
· is able to understand the relevance of SDGs for tourism business
· can enhance SDGs in her/his (future) role in tourism business

TEACHING AND TRAINING ACTIVITIES

- Virtual activities

ASSESSMENT SYSTEMS

Assessment criteria - grade 1
The student is able to define the key concepts of Sustainable Development Goals (SDGs), and its main stakeholders and their roles in the development work. She/he can assess the appropriateness of SDGs in business to some extent.

Assessment criteria - grade 3
In addition to the competences in grade 1, the student can apply the key elements of SDGs in her/his thinking and reasoning. She/he can apply SDGs in business operations.

Assessment criteria - grade 5

In addition to the competences in grades 1 and 3, the student can recognize business opportunities related to SDGs in business. She/he is able to think critically and solve problems in a changing Course grading 1) Pre-assignment (10% of grade) 2) Quizz (30 % of grade) 3) Case study based essay (50% of grade) 4) Post assignment (10% of grade)

SUBJECT FACT SHEET	
GENERAL INFORMATION	
Subject:	*Transversal Skills / Futures Research Goals*
ECTS:	*5*
Semester:	3rd semester (elective) Haaga-Helia University of Applied Sciences
Teaching:	*Theoretical / practical*
SUBJECT CONTENTS	
- Futures orientation - characteristics and concepts related to the future - Approaches, data collection and analysing methods in futures research - Futures research and change	
LEARNING OUTCOMES	
The student can observe a phenomenon from a future perspective by using key concepts, methods and tools from futures research and to some extent make use of futures insights in practice. The student understands the connection between futures research and strategical work. In addition to the competences in grade 1, the student can analyse phenomena from a futures perspective, making benefit of literature related to the topic in her/his job and use suitable methods and tools for understanding the future. The student makes use of futures research in strategy work. In addition to the competences in grades 1 and 3, the student ideates and looks for creative solutions that can produce practical examples, makes creative use of methods and tools in work and can critically assess his/her own work. The student can critically apply and assess the results of futures research in strategy work.	
TEACHING AND TRAINING ACTIVITIES	
• Virtual activities	
ASSESSMENT SYSTEMS	

Assessment criteria - grade 1
The student can observe a phenomenon from a future perspective by using key concepts, methods and tools from futures research and to some extent make use of futures insights in practice. The student understands the connection between futures research and strategical work.

Assessment criteria - grade 3
In addition to the competences in grade 1, the student can analyse phenomena from a futures perspective, making benefit of literature related to the topic in her/his job and use suitable methods and tools for understanding the future. The student makes use of futures research in strategy work.

Assessment criteria - grade 5
In addition to the competences in grades 1 and 3, the student ideates and looks for creative solutions that can produce practical examples, makes creative use of methods and tools in work and can critically assess his/her own work. The student can critically apply and assess the results of futures research in strategy work.

Name	**Traineeship**
ECTS workload	15
Semester	S4
Compulsory/elective	Compulsory
Objectives	Students will put into practice the skills acquired throughout the programme and gain skills to complement their profiles and get ready to enter the labour market or research career
PLOs	See annex 4
Brief description of contents	Two main traineeship options are available: • In a company/public administration (i.e., the city halls). The Ulysseus associate partner network ensures the availability of traineeships for students to learn about the sector from the inside. • In a research group of one of the six university partners, where the students can work in research and innovation projects facing the challenges of the smart cities of future.
Offered by	All partners universities
Teaching Team	All partners universities, Associated partners and external experts
Language	English, local languages of the country partner universities
Teaching format	Onsite
Teaching and Learning methodology	• Laboratory and Practical learning • Problem-Based • Project • Learning through research
Assessment	• Research-based reports • Research-informed position papers • "In company reports" More information will be available at the Traineeships guidebook.

Name	Master Thesis
ECTS workload	15
Semester	S4
Compulsory/elective	Compulsory
Objectives	The master's programme design is highly committed to the acquisition of transversal competences. The master thesis aims at providing answers to a realistic challenge project from an innovative and interdisciplinary point of view.
PLOs	See annex 4
Brief description of contents	• The master thesis It can be business- or research-oriented and combined with the traineeship period. Students will receive a joint supervision between researchers from the partner universities and external experts (if research-oriented) or associated partners (if professionally oriented). External experts and Associated partners will be also involved in the evaluation committee of the master thesis dissertations. The master's thesis for a student will be part of a very big common project to be developed partially by several students. This requires the coordination among professors and disciplines, as well as a group allocation that is consistent with the programme's objectives. The master thesis will boost contact between professors and students and will allow students to develop it from any of the 6 institutions by means of digital collaboration.
Offered by	All partners universities
Teaching Team	All partners universities, Associated partners and external experts Volunteer students
Language	English, local languages of the country partner universities

Teaching format	Onsite / hybrid (onsite & online)
Teaching and Learning methodology	• Laboratory and Practical learning • Problem-Based Project • Learning through research
Assessment	• Short Master Thesis Project: must be approved by the Master Academic Committee • Master Thesis Dissertation: public defense at any Ulysseus partner university. The joint Evaluation Committee will be formed by academics from Ulysseus partner universities as well as associated partners and invited experts. More information will be available at the Master Thesis guidebook.