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Catalogue for International Students

School of Industrial and ICT Engineering

Public University of Navarre

Pamplona Campus
Tudela Campus

June, 13th, 2017

Catalogue for International Students

Courses Taught in English

Bachelor's Degrees in Mechanical, Electrical and Industrial Engineering			
Code	**Name**	**Semester**	**ECTS**
242101	Mathematics I	Fall	6
242103	Computer Science	Fall	6
242104	Engineering Graphics	Fall	6
242105	Fundamentals of Physics	Fall	6
242106	Business	Fall	6
242201	Statistics	Spring	6
242203	Chemistry	Spring	6
242204	Further Studies in Physics	Spring	6
242205	Industrial Drawing	Spring	6
242206	Mathematics II	Spring	6
242301	Mathematics III	Fall	6
242303	Materials Science	Fall	6
242402	Mechanics	Spring	6
242403	Control Systems I	Spring	6
242502	Advanced Physics	Fall	3
242503	Materials Technology	Fall	3
242504	Machines Theory	Fall	6
242602	Numerical Methods	Spring	3
242606	Design and Testing of Machines	Spring	6
242614	Control Systems II	Spring	6
242702	Environmental Technology	Fall	3
242890	Bachelor's Thesis	Spring	12

Bachelor's Degrees in Computer Science and Telecommunications Engineering			
Code	**Name**	**Semester**	**ECTS**
240101	Mathematics I	Fall	6
240103	Computing	Fall	6
240106	Business	Fall	6
243105	Introduction to Engineering and Project Management	Fall	6
240201	Statistics	Spring	6
240206	Mathematics II	Spring	6
240207	Fundamentals Of Electronics	Spring	6
243205	Digital Systems I	Spring	6
243302	Electronic Circuits	Fall	6
240301	Theory of Algorithms	Fall	6
240403	Artificial Intelligence	Spring	6
240890	Bachelor's Thesis (Computer Science)	Spring	12
243890	Bachelor's Thesis (Telec. Engineering)	Spring	18

Master's Degree in Industrial Engineering			
Code	**Name**	**Semester**	**ECTS**
73290	Automation and Process Control	Fall	4.5
73050 + 73296	Master's Thesis	Spring	30

Online Courses			
Code	**Name**	**Semester**	**ECTS**
	Computational Engineering with Matlab	Spring	3
	Ecodesign by Life Cycle Assessment	Spring	3
	Green Logistics for Smart Cities	Spring	6

English Friendly Courses

The English Friendly Catalogue has been designed to help incoming students who have not reached yet full linguistic competence in Spanish to complete an attractive curriculum during their exchange program. Courses belonging to this category fulfil the following requirements:

- Lectures are delivered in Spanish. Mobility students taking them must have basic skills in this language.
- All learning materials (slides, class notes, exercises, books…) are available in English.
- Office hours are conducted in English, if the student requests so.
- Similarly, students have the right to be assessed in English.

Bachelor's Degrees in Mechanical, Electrical and Industrial Engineering

Code	Name	Semester	ECTS
242506	Industrial Electronics	Fall	6
242607	Power Electronic Converters	Spring	6
242612	Digital Systems	Spring	6
242707	Fluid Machines	Fall	3
242706	Theory of Structures	Fall	3
242814	Manufacture and Testing of Electronic Devices	Spring	6
242815	Industrial Systems and Domotics	Spring	6
242823	Operations Research	Spring	3
242821	Statistical Quality Control	Spring	3
242811	Advanced Electrical Drives	Spring	6
224802	Disturbances in Electrical Networks	Spring	3

Bachelor's degree in Telecommunications Engineering

Code	Name	Semester	ECTS
243502	Fundamentals of wireless networks	Fall	6

Master's Degree in Industrial Engineering

Code	Name	Semester	ECTS
73039	Marketing	Fall	4.5
73007	Structures, Construction and Building	Spring	6
73040	Simulation for Decision-Making	Fall	4.5
73043	Advanced Optimization	Fall	3

Master's Degree in Telecommunications Engineering

Code	Name	Semester	ECTS
73066	Embedded Systems and Integrated Systems	Spring	6
73084	Antennas and Radio Propagation Technologies	Fall	6

Master's Degree in Computational and Applied Mechanical Engineering

Code	Name	Semester	ECTS
720111	Noise	Spring	3
720113	Numerical methods for differential problems	Spring	3

Bachelor's Degree in Mechanical Design Engineering (Tudela Campus)			
Code	**Name**	**Semester**	**ECTS**
251504	Thermal machines	Fall	6
251505	Hydraulic machines	Fall	6
251704	Design and development of plastic and sheet-metal parts	Fall	6
251706	Ceramic materials	Fall	3
251705	Polymeric materials	Fall	3
251802	Ecodesign	Fall	6
251404	Operations management	Spring	6
251602	Machine calculation, testing and design	Spring	3
251603	Manufacturing engineering	Spring	3
251803	Computer-assisted engineering	Spring	6

Online Courses			
Code	**Name**	**Semester**	**ECTS**
	Technology and Innovation Strategy in Engineering	Spring	6
	Functional Coatings	Spring	3

Internships at local companies

Exchange students interested in an internship at a local company in Navarre can benefit from UPNA's Traineeship Program. Run by the UPNA's Foundation, this program allows hundreds of students every year to spend a semester getting trained in a member of UPNA's large list of industrial partners. During that time, they carry out their Bachelor's Thesis or their Master's thesis under the supervision of an UPNA professor.

Exchange students accepted in the program must enroll in two UPNA's courses: "Bachelor's/Master's Thesis" and "Internship Training". They will be graded in each one of them by an evaluation committee after an oral presentation of their work.

For further details, please contact jorge.elso@unavarra.es

Full Semesters

Semester in Electronic Engineering – Pamplona Campus - Spring	
Control Systems II: Building upon the foundations laid in “Automatic Control”, this subject shows how to design and implement a controller using a computer or a microcontroller.	6 ECTS, in English
Digital Systems: Unveiling the logic and architecture of program memory based digital systems. Low and high level language programming and project based learning using Microchip® PIC® microcontrollers, sensors and actuators.	6 ECTS, English Friendly
Design & Testing of Electronic Systems: Printed circuit board (PCB) design principles for digital, analog and power electronics using CAD software and experimental projects assembly.	6 ECTS, English Friendly
Industrial and Building Automation Systems: Aspects, devices and topological possibilities of home and building automatic systems (HBAS). Experimental and theoretical study of some commercial HBAS. Industrial control systems technology.	6 ECTS, English Friendly
Power Electronic Converters: This course deals with the main aspects of power electronics, including semiconductors, drives, cooling, sizing capacitors and inductors and design of the control loops, for the main structures of conversion: DC/DC, DC/AC, AC/DC and AC/AC. Finally, the main current applications are reviewed.	6 ECTS, English Friendly

Semester in Mechanical Engineering – Tudela Campus - Fall	
Thermal machines: Concepts, types, components, and calculations of internal combustion engines and gas and vapor turbines	6 ECTS, English Friendly
Hydraulic machines: Basic principles of storing up water under pressure, the arrangements for transmitting this power to a distance, and the various machines worked by means of the water pressure thus provided	6 ECTS, English Friendly
Design and development of plastic and sheet-metal parts: Concepts, types and selection of the most suitable materials during the process of design, manufacturing and finishing elements	6 ECTS, English Friendly
Ceramic materials: Crystalline structure, manufacture processes, traditional and advanced ceramic materials. Applications of different ceramic materials classified according mechanical, thermal, electronic, magnetic… properties	3 ECTS, English Friendly
Polymeric materials: Fundamental concepts. Polymerization techniques. Characterization and properties. Copolymers. Applications of different types of polymers: plastics, fibers, elastomers. Biomaterials	3 ECTS, English Friendly
Ecodesign: Fundamentals of Life Cycle Assessment (LCA). Application of LCA to improve environmental profile (Ecodesign) of industrial products.	6 ECTS, English Friendly
Bachelor’s Thesis	12 ECTS, in English

Semester in Industrial Design – Tudela Campus - Fall	
Design and development of plastic and sheet-metal parts: Concepts, types and selection of the most suitable materials durign the process of design, manufacturing and finishing elements	6 ECTS, English Friendly
Ceramic materials: Crystalline structure, manufacture processes, traditional and advanced ceramic materials. Applications of different ceramic materials classified according mechanical, thermal, electronic, magnetic… properties	3 ECTS, English Friendly
Polymeric materials: Fundamental concepts. Polymerization techniques. Characterization and properties. Copolymers. Applications of different types of	3 ECTS, English Friendly

polymers: plastics, fibers, elastomers. Biomaterials	
Ecodesign: Fundamentals of Life Cycle Assessment (LCA). Application of LCA to improve environmental profile (Ecodesign) of industrial products.	6 ECTS, English Friendly
Bachelor's Thesis	12 ECTS, in English

Semester in Mechanical Engineering / Industrial Design – Tudela Campus - Spring	
Operations management: A review of all the actions and plans made for running a company and its production, from designing the product, installations and procedures, to check the day-to-day evolution.	6 ECTS, English Friendly
Machine calculation, testing and design: Design of mechanical elements, failure prevention, vibrations, and integral design of mechanical machinery	6 ECTS, English Friendly
Manufacturing engineering: A view to diverse tecnics in modern Manufacturing: CAM Software, Manufacturing processes for Polymer materials	6 ECTS, English Friendly
Computer-assisted engineering: You will learn how to use Marc Mentat, finite element simulation program (FEM), friendly and graphical software that will help you to apply this method in the process of improving the product design	6 ECTS, English Friendly
Bachelor's Thesis	12 ECTS, in English

Study Abroad Programs

The School of Engineering at UPNA offers a catalogue of 11 Study Abroad programs for partner universities interested in short-term exchanges (2 to 4 weeks) of medium-large groups of students and professors. Usually scheduled during the spring and summer breaks, these programs are complemented with an introductory course to Spanish Language and Culture and visits to local companies and tourist landmarks.

COMPUTER SCIENCE COURSES

MECHANICAL, ELECTRICAL AND INDUSTRIAL ENGINEERING COURSES

Videogames and Virtual reality application development

FACULTY

Director
- Dr. Jesús Villadangos Alonso

Lecturers
- D. Iñaki Ayucar

COURSE OVERVIEW

Audience
- Undergraduates pursuing a bachelor in technical studies
- Undergraduates pursuing a minor in technical studies

Prerrequisites
- Basic knowledge on programming

Learning outcomes
- Develop a classical Game during the course
- Knowledge to develop Games using platform Scratch and Unity

Program

WEEK 1

Lecture	Title	Lecturer
1	Videogames and animation	Iñaki Ayucar
2	Time control and main loop in videogames	Iñaki Ayucar
3	Videogame assets I: 3D models, textures, sprites	Iñaki Ayucar
4	Graphical programming	Iñaki Ayucar
5	Game inputs: mouse, keyboard, gamepads	Iñaki Ayucar

WEEK 2

Lecture	Title	Lecturer
1	Game programming I	Iñaki Ayucar
2	Game programming II	Iñaki Ayucar
3	Virtual reality application programming	Jesús Villadangos Alonso
4	Game programming with Scratch II	Jesús Villadangos Alonso
5	Game programming with Scratch II	Jesús Villadangos Alonso

Build and pilot your UAV – Unmanned Aerial Vehicle

FACULTY

Director

- Dr. Jesús Villadangos Alonso

Lecturers

- D. Pablo Medrano Fernández
- Dr. Manuel Prieto Míguez
- D. Carlos Matilla Codesal
- Dr. Alfredo Pina Calafi

COURSE OVERVIEW

Audience

- Any interested person

Prerrequisites

- Interest on drones

Learning outcomes

- Build an UAV (multicopter)
- Configure an UAV (multicopter) to flight
- Plan an UAV autonomous flight
- Pilot an UAV (multicopter)

Program

WEEK 1

Lecture	Title	Lecturer
1	UAVs: Basic components	Pablo Medrano Fernández
2	UAVs: Flight control	Jesús Villadangos Alonso
3	UAVs: business models	Carlos Matilla Codesal
4	Build your UAV – I	Manuel Prieto Miguez
5	Build your UAV - II	Manuel Prieto Miguez

WEEK 2

Lecture	Title	Lecturer
1	Piloting your UAV	Pablo Medrano Fernández
2	Piloting your UAV	Pablo Medrano Fernández
3	Mission planning	Manuel Prieto Miguez
4	Autonomous flight	Pablo Medrano Fernández
5	UAVs in the education	Alfredo Pina Calafi

Practical introduction to data science with Python

FACULTY

Director
- Dra. Aranzazu Jurio

Lecturers
- Dr. Daniel Paternain

COURSE OVERVIEW

Audience
- Undergraduates pursuing a bachelor in Computer Science, Mathematics, statistics

Prerrequisites
- Programming, Basic calculus,

Learning outcomes
- In this course you will get an introduction to the main tools and ideas in the data scientist's toolbox. The course gives an introduction to data pre-processing, data visualization and knowledge discovery.
- The course is divided in 10 lessons of 4 hours each. In every lesson, theoretical aspects are explained in the beginning of the class and some practical examples are programmed using the Python libraries numpy, panda, matlplotlib and sci-kit learn.
- After the course the students should be able to build a data product using real-world data.

Program

WEEK 1

Lecture	Title	Lecturer
1	Python for data science. Introduction	Aranzazu Jurio
2	Specific libraries: numpy, panda, matplotlib and scikit-learn	Daniel Paternain
3	Analysis and data visualization	Aranzazu Jurio
4	Building data models	Aranzazu Jurio
5	Data pre-processing	Daniel Paternain

WEEK 2

Lecture	Title	Lecturer
1	Pre-processing: Feature selection, instance selection, noise and outliers.	Aranzazu Jurio
2	Knowledge discovery. Introduction to machine learning	Daniel Paternain
3	Classification	Daniel Paternain
4	Clustering	Daniel Paternain
5	Ensembles	Daniel Paternain

Genetic and bio-inspired algorithms

FACULTY

Director
- Dr. Mikel Galar

Lecturers
- Dr. Jose Antonio Sanz

COURSE OVERVIEW

Audience
- Undergraduates pursuing a bachelor in Computer Science, Mathematics

Prerrequisites
- Programming, Python and Basic calculus,
- Notions of optimization

Learning outcomes
- The objective of this course is that the students learn the foundations and practical aspects of optimization algorithms based on evolutionary strategies, specifically genetic algorithms.
- Genetic algorithm (GA) is a metaheuristic inspired by the process of natural selection. GA are commonly used to generate high-quality solutions to optimization and search problems.
- The course is divided in 10 lessons of 4 hours each. In every lesson, theoretical aspects are explained in the beginning of the class and some practical examples are programmed using the Python library (DEAP).
- After the course the students should be able to solve very complex optimization problems using genetic algorithms.

Program

WEEK 1

Lecture	Title	Lecturer
1	Introduction to optimization with evolutionary algorithms. Genetic algorithms.	Jose Antonio Sanz
2	Chromosome representation	Jose Antonio Sanz
3	Basic operands. Selection, crossing, mutation and replacement	Jose Antonio Sanz
4	Advanced aspects of GA	Mikel Galar
5	Performance analysis and advanced aspects	Mikel Galar

WEEK 2

Lecture	Title	Lecturer
1	Memetic algorithms. Genetic algorithms plus local search	Jose Antonio Sanz
2	Particle swarm optimization. Foundations	Jose Antonio Sanz
3	Particle swarm optimization. Parameters and advanced aspects	Jose Antonio Sanz
4	Algorithms based on differential evolution. Foundations	Mikel Galar
5	Algorithms based on differential evolution. Variants	Mikel Galar

Computer Vision and Deep Learning

FACULTY

Director

- Dr. Miguel Pagola

Lecturers

- Dr. Edurne Barrenechea

COURSE OVERVIEW

Audience

- Undergraduates pursuing a bachelor in Computer Science, Mathematics

Prerrequisites

- Programming (Python), Basic calculus,

Learning outcomes

- In this course you will get an introduction to the basics of computer vision and the application of deep learning to visual recognition systems.
- Computer vision has become ubiquitous in our society, with applications in search, image understanding, apps, mapping, medicine, drones and self-driving cars.
- The course is divided in 10 lessons of 4 hours each. In every lesson, theoretical aspects are explained in the beginning of the class and some practical examples are programmed using some Python libraries.
- After the course the students should be able to build a simple computer vision application using the algorithms explained during the course.

Program

WEEK 1

Lecture	Title	Lecturer
1	Introduction to Computer Vision	Edurne Barrenechea
2	Low level processing. Filters	Edurne Barrenechea
3	Low level features. Edges	Edurne Barrenechea
4	Segmentation	Edurne Barrenechea
5	Image classification. K-nearest neighbor and linear classification	Edurne Barrenechea

WEEK 2

Lecture	Title	Lecturer
1	Introducction to Neural Networks	Miguel Pagola
2	Convolutional neural networks	Miguel Pagola
3	Understanding and visualizing Convolutional Neural Networks	Miguel Pagola
4	Training Convolutional Neural Networks	Miguel Pagola
5	Final course project	Miguel Pagola

Cloud Computing and the Hadoop Ecosystem

FACULTY

Director

- Dr. José Enrique Armendáriz-Íñigo

Lecturers

- Mr. José Enrique Armendáriz Iñigo, PhD (Universidad Pública de Navarra)
- Mr. Joan Navarro Martín, PhD (Universitat Ramon Llull)
- Ms. Ainhoa Azqueta Alzuaz, M. Sc. (Universidad Politércnica de Madrid)
- Ms. Itziar Arrieta Salinas, M. Sc. (Gobierno de Navarra)
- Mr. José Ramón Juarez Rodriguez, PhD (Ikerlan

COURSE OVERVIEW

Audience

- Undergraduates pursuing a bachelor in Computer Scienc

Prerrequisites

- Programming, Operating Systems, Network programming, data bases

Learning outcomes

- Understand the basic concepts of the Cloud Computing paradigm
- Big data ETL
- Deploy and program an application to run in the different Hadoop projects covered in this course
- Basics of Hadoop system administration
- You will visit an R&D center Ikerlan (José Ramón Juárez), the data center facilities of the Government of Navarre (Itziar Arrieta) and the R&D center of another private company TBD.

Program

WEEK 1

Lecture	Title	Lecturer
1	Introduction to Cloud Computing	José Enrique Armendáriz
2	Introduction to the Hadoop Ecosystem	Joan Navarro
3	Introduction to HDFS, Yarn, Map/Reduce	Joan Navarro
4	Lab Work: Setting up a Hadoop cluster and how to run apps on it (Yarn, HDFS and the MapReduce paradigm)	Joan Navarro
5	Introduction to Data Management: HBase and Cassandra	Ainhoa Azqueta
6	Lab Work: Data storage, fetch and processing with HBase and Cassandra	Ainhoa Azqueta

WEEK 2

Lecture	Title	Lecturer
1	Introduction to data stream processing: Spark	José Enrique Armendáriz
2	Stream Programing with Spark and Twitter	José Enrique Armendáriz
3	The basics of Data Mining	Itziar Arrieta
4	Introduction to Data Mining with Hadoop: Mahout, Hive	Itziar Arrieta

Introduction to Big Data with Apache Spark

FACULTY

Director

- Dr. Mikel Galar

Lecturers

- Dr. Mikel Galar
- Dr. José Antonio Sanz
- Dr. Aránzazu Jurío
- Dr. Daniel Paternain

COURSE OVERVIEW

Audience

- Undergraduates pursuing a bachelor in Computer Science, Mathematics

Prerrequisites

- Programming and basic knowledge of Python language
- Notions of distributed computing

Learning outcomes

- In this course, the students will get a gentle introduction to Big Data, MapReduce paradigm and Apache Spark framework (including its basic data structures as RDDs and DataFrames). Moreover, they will learn how to tackle Big Data Mining problem using the integrated Spark Machine Learning library. Hence, the students will learn how to manage Big Data problems using Apache Spark, including Spark SQL and Spark ML packages.
- The students will have to deal with the problems arising when data is distributed across multiple machines and will learn how to take advantage of the MapReduce paradigm to solve data intensive problems.
- The course is divided in 10 lessons of 4 hours each. In every lesson, the theoretical aspects will be explained prior to the practical labs that will be carried out in order to put into practice all the concepts in several hands-on labs using Apache Spark.
- After the course the students should be able to manage and give efficient solutions to Big Data problems using Apache Spark.

Program

WEEK 1		
Lecture	**Title**	**Lecturer**
1	Introduction to Big Data: MapReduce and HDFS	Mikel Galar
2	Hands-on lab: Solving problems with MapReduce	Aránzazu Jurío
3	Introduction to Apache Spark: Spark RDDs	Mikel Galar
4	Hands-on lab: Dealing with Big Data using Apache Spark	Aránzazu Jurío
5	Introduction to Spark SQL: DataFrames and Datasets	Mikel Galar

WEEK 2		
Lecture	**Title**	**Lecturer**
1	Hands-on lab: DataFrames for data intensive applications	Daniel Paternain
2	Introduction to Data Mining and Machine Learning	José Antonio Sanz
3	Introduction to Spark ML: Machine Learning with Apache Spark	Mikel Galar
4	Hands-on lab: Data mining and Machine Learning problems I	Daniel Paternain
5	Hands-on lab: Data mining and Machine Learning problems II	José Antonio Sanz

Analogue and Mixed Signal Integrated Circuit Design

FACULTY

Director

- Dr. Antonio López Martín

Lecturers

- Dr. Antonio López Martín
- Dr. Carlos A. De la Cruz Blas

This training course introduces the design flows and tools required to successfully analyse and implement analogue and mixed signal designs.

COURSE OVERVIEW

Audience

- Undergraduates pursuing a bachelor in Electrical Engineering

Prerrequisites

- Knowledge of basic circuit theory, semiconductor devices and microelectronics technology.
- Experience using electronic EDA tools is advantageous

Learning outcomes

- Ability to design standard analog and mixed signal integrated circuits in CMOS technologies
- Application of a structured design methodology and ability to use commercial EDA tools for IC design

Program

WEEK 1

Lecture	Title	Lecturer
1	Introduction: IC design flow and CAD tools (I)	Antonio López Martín
2	Introduction: IC design flow and CAD tools (II)	Antonio López Martín
3	Analog IC design with Cadence DFWII (I)	Antonio López Martín/ Carlos De la Cruz
4	Analog IC design with Cadence DFWII (II)	Antonio López Martín/ Carlos De la Cruz

WEEK 2

Lecture	Title	Lecturer
1	Basic analog circuits	Antonio López Martín
2	Operational Amplifiers	Antonio López Martín
3	Integrated data converters (I)	Antonio López Martín
4	Integrated data converters (II)	Antonio López Martín

WEEK 3

Lecture	Title	Lecturer
1	Lab work (I): Schematic edition and simulation	Antonio López Martín/ Carlos De la Cruz
2	Lab work (II): Layout design and physical verification	Antonio López Martín/ Carlos De la Cruz

Applied wind turbine control

FACULTY

Director

- Dr. Jorge Elso Torralba (UPNA)

Lecturers

- Dr. Marta Barreras Carracedo (Gamesa Corporation)
- Dr. Javier Gil Soto (Acciona Windpower / UPNA)

COURSE OVERVIEW

Audience

- Engineers interested in the renewable energy field

Prerrequisites

- Basic control techniques: root locus, bode plots
- Matlab and Simulink fundamentals

Learning outcomes

- Familiarity with the operation of wind turbines
- Understanding the basic wind turbine dynamics
- Ability to design controllers for real machines

Program

WEEK 1: Modelling and Simulation

Lecture	Title	Lecturer
1	Presentation. The wind turbine industry.	Marta Barreras
2	Role of control engineers in the WT industry	Marta Barreras
3	Basic modelling of a wind turbine	Jorge Elso
4	Simulink implementation and linearization	Jorge Elso
5	Fore-aft dynamics and its effects	Jorge Elso
6	Simulink implementation and linearization	Jorge Elso
7	Introduction to FAST	Javier Gil
8	Simulation in FAST	Javier Gil
9	Linearization around equilibrium points	Javier Gil
10	Assessing fatigue	Javier GIl

WEEK 2: Wind Turbine Control

Lecture	Title	Lecturer
1	Control strategies and objectives. Certification.	Marta Barreras
2	Control regions.	Marta Barreras
3	Torque control loop	Jorge Elso
4	Design and simulation	Jorge Elso
5	Pitch control loop	Jorge Elso
6	Design and simulation	Jorge Elso
7	Drive-train damping strategies	Jorge Elso
8	Design and simulation	Jorge Elso
9	Tower damping strategies	Jorge Elso
10	Design and simulation	Jorge Elso

Wind Energy Conversion Systems

FACULTY

Director
- Dr. Jesús López (UPNA)

Lecturers
- Dr. Julio Pascual (UPNA)
- David Velasco (Ingeteam / UPNA)

COURSE OVERVIEW

Audience
- Engineers interested in the renewable energy field

Prerequisites
- Fundamentals of electrical machines
- Fundamentals of power electronics.

Learning outcomes
- Ability to understand the operation of wind turbine systems
- Control design of wind turbine power converters

Program

WEEK 1: Photovoltaic Systems

Lecture	Title	Lecturer
1	Wind technology and market	Jesús López
2	Wind turbine components	Julio Pascual
3	Fundamentals of aerodynamics	Julio Pascual
4	Power and speed control	Julio Pascual
5	Type A wind turbines (Directly coupled induction generator)	David Velasco
6	Type B wind turbines (Variable rotor resistance)	David Velasco
7	Type C wind turbines (Doubly-Fed Induction generator)	David Velasco
8	Type D wind turbines (Full converter with synchronous gen.)	David Velasco
9	Type D wind turbines (Full converter with SCIG)	David Velasco
10	Case study: Calculation of the power curve and estimation of the energy captured.	David Velasco

WEEK 2: Wind Turbines

Lecture	Title	Lecturer
1	Laboratory session: wind energy capture assessment	David Velasco
2	Laboratory session: Modelling of the drive chain	David Velasco
3	Laboratory session: Speed control	David Velasco
4	Laboratory session: Maximum Power Point Tracking	David Velasco
5	Visit to an experimental wind farm	Jesús López
6	Visit to an experimental wind farm	Jesús López

Visits

1	Ingeteam production facilities
2	Experimental Wind Farm “Vedadillo”
3	8 MW photovoltaic plant “Hondo Espartosa”

Photovoltaic systems

FACULTY

Director
- Dr. Jesús López (UPNA)

Lecturers
- Dr. Julio Pascual (UPNA)
- Javier Samanes (Ingeteam / UPNA)

COURSE OVERVIEW

Audience
- Engineers interested in the renewable energy field

Prerequisites
- Fundamentals of power electronics.

Learning outcomes
- Ability to understand the operation of a photovoltaic system
- Control design of power converters for photovoltaic systems

Program

WEEK 1: Photovoltaic Systems

Lecture	Title	Lecturer
1	Photovoltaic technology and market	Julio Pascual
2	Fundamentals of cells and modules	Julio Pascual
3	Introduction of photovoltaic systems	Julio Pascual
4	Review of power electronics	Javier Samanes
5	*Transformerless* structures and the common mode issue	Javier Samanes
6	Single-phase conversion structures	Javier Samanes
7	High frequency conversion structures	Javier Samanes
8	Losses in the conversion structure	Javier Samanes
9	Three-phase conversion structures	Javier Samanes
10	Control of a photovoltaic inverter	Javier Samanes

WEEK 2: Wind Turbines

Lecture	Title	Lecturer
1	Laboratory session: Open-loop operation of a photovoltaic inverter	Javier Samanes
2	Laboratory session: Closed-loop current control	Javier Samanes
3	Laboratory session: Closed-loop voltage control	Javier Samanes
4	Laboratory session: Control of the input boost converter	Javier Samanes
5	Visit to a 8MW photovoltaic plant	Jesús López
6	Visit to a 8MW photovoltaic plant	Jesús López

Visits

1	Ingeteam production facilities
2	Experimental Wind Farm “Vedadillo”
3	8 MW photovoltaic plant “Hondo Espartosa”