

STUDENT HANDBOOK

ERASMUS MUNDUS JOINT MASTER

DYNAMICS OF RENEWABLES-BASED POWER SYSTEMS (DREAM)



ECOLE CENTRALE DE NANTES



UNIVERSITATEA NATIONALA DE STIINTA SI
TEHNOLOGIE POLITEHNICA BUCURESTI



Hochschule für Technik
und Wirtschaft Berlin

University of Applied Sciences

HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT
BERLIN



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WELCOME

Welcome to the Erasmus Mundus Master DREAM. The purpose of this handbook is to explain how the DREAM Master's programme works and what you can expect from it. The information provided is intended to help you find your bearings and settle into postgraduate life as quickly as possible. The handbook outlines what you can expect at each stage of your studies, the resources available to you, the structure and staff within the member institutions, and the procedures for dealing with any problems you may encounter.

Please read this handbook carefully, as it is in your best interest to familiarise yourself with the regulations and procedures. Students who are uncertain about any information in this handbook should contact their course coordinator. We hope you will find your time as a member of the postgraduate community both rewarding and enjoyable.

The European Master in Dynamics of Renewables-based Power Systems (DREAM) is a two-year Master's programme that offers multidisciplinary education in the field of modern power systems. It trains students to tackle the current and future challenges of smart power systems in innovative ways. Core knowledge from the fields of Power Systems, Smart Grids, Renewable Generation, Automatic Control, and Power Electronics is combined to give students the opportunity to acquire a global "system view" of the dynamics of next-generation power systems.

DREAM aims to promote a more integrated way of thinking, preparing multidisciplinary specialists for the new jobs and challenges of future power systems. All course units of the DREAM Master's programme are taught in English.

DISCLAIMER

The Consortium has made every reasonable effort to ensure that the information contained in this publication is accurate and up to date at the time of publication. However, it accepts no responsibility for any errors or omissions. The Consortium reserves the right to revise, modify, or discontinue modules, and to amend regulations and procedures at any time, although every effort will be made to notify all concerned parties. Please note that not every module listed in this handbook will necessarily be available each year, and changes may occur in the module details.

DREAM-MASTERS AT A GLANCE

The *Dynamics of Renewables-based Power Systems (DREAM)* Master's programme is a joint, integrated Master's course conducted by four European institutions:

- École Centrale de Nantes (ECN) – France
- Hochschule für Technik und Wirtschaft Berlin (HTW) – Germany
- Universitat Politècnica de Catalunya (UPC) – Spain
- Universitatea Politehnica din Bucureşti (UNSTPB) – Romania

The programme benefits from strong collaboration with 11 industrial partners, providing students with professional exposure, research opportunities, and industry-driven insights in the field of renewable energy and power systems. Through these partnerships, DREAM ensures that students gain hands-on experience, access to cutting-edge research, and direct engagement with industry experts — preparing them for careers in the rapidly evolving energy sector.

The DREAM Master's programme is an Erasmus Mundus Joint Master's Degree funded by the European Commission under Grant Agreement No. 2019-1452/001-001 (Project No. 101049647 – ERASMUS-EDU-2021-PEX-EMJM-MOB), concluded between the Education, Audiovisual and Culture Executive Agency (EACEA) and École Centrale de Nantes on 1 August 2021.

The DREAM Master's programme leads to double or multiple Master's degrees. Degrees are awarded by all European institutions where the student has studied for at least one semester, including the co-supervision of the Master's thesis.

RESUME

Dynamics of Renewables-based Power Systems (DREAM) is a 2-year Master's programme that offers multidisciplinary education in the modern power systems field. It trains students to tackle the current and future challenges of smart power systems in a new way. Therefore, core knowledge from the fields of Power Systems, Smart Grids, Renewable Generation, Automatic Control and Power Electronics is combined to give the students the opportunity to acquire a global “system view” of the dynamics of next generation power systems.

DREAM is a 2-year joint master's programme implemented and fully supported by 4 major European Higher Education Institutions (HEI): Centrale Nantes, France, Universitat Politècnica de Catalunya, Spain, Hochschule für Technik und Wirtschaft, Germany and Universitatea Politehnica din Bucuresti, Romania.

DREAM Associated partners

The DREAM Consortium benefits from associated partners that bring extra academic and industrial perspectives.

Academic partners:

- Keio University, Japan
- Inha University, South Korea
- Nanjing University of Aeronautics and Astronautics, China
- National Institute of Technology, Warangal, India
- Indian Institute of Technology Madras, India
- Universidad de los Andes, Colombia
- University of Hawaii, United States
- Arab Academy for Science Technology and Maritime Transport, Egypt
- Universidad Pontificia Comillas, Spain
- Politechnika Warszawska – Warsaw University of Technology, Poland
- Swiss Federal Institute of Technology (ETH), Switzerland

Industrial partners:

- RTE-Réseau de Transport d'Electricité, France
- Opal-RT Europe SAS, France
- Knick Elektronische Messgeräte GmbH & Co.KG, Germany
- Enerkite GMBH, Germany
- Pepperl+ Fuchs GMBH, Germany
- Siemens R&D, Germany
- Siemens AG, Smart Infrastructure, Germany
- Green Power Monitor Sistemas de Monitorización, Spain
- iGrid T&D, Spain
- Tractebel Engineering SA, Romania
- Rolls-Royce Solutions, Germany

DREAM aims to promote a more integrated way of thinking in order to prepare multidisciplinary specialists equipped for the new jobs and challenges of future power systems. Student mobility within the DREAM programme takes place in a minimum of two EU countries, and possibly in three EU countries during the first three semesters. For the fourth semester, DREAM students may complete their mobility in partner countries, in accordance with the EACEA regulations for Erasmus Mundus scholarship holders.

The Master's thesis will be jointly supervised by ECN, HTW, UPC, and UNSTPB, with the valuable support and expertise of the programme's associated academic and industrial partners.

OBJECTIVES

DREAM is designed within the framework of the Erasmus Mundus programme to:

- train students to address the current and future challenges of smart power systems in innovative ways,
- enable them to acquire a global "system-level" understanding of the dynamics of next-generation power systems,
- promote an integrated mindset that prepares multidisciplinary specialists for the emerging jobs and challenges of future power systems.

Upon graduation, students completing the DREAM Master's programme will possess the comprehensive knowledge and skills required to tackle key issues faced by organizations driving the energy transition, including:

- transmission and distribution system operators,
- energy producers (renewable and conventional),
- manufacturers (power electronics, electric drives, turbines, solar panels),
- electricity regulatory authorities.

DREAM PROGRAMME : KEY ELEMENTS

The programme of study lasts two academic years (120 ECTS), split into four equally loaded semesters. DREAM student mobility paths will take place in minimum 2 EU countries, and possibly in 3 EU countries for the first 3 semesters. Students will spend their 1st semester in ECN (30 ECTS), the 2nd semester in UPC or HTW (30 ECTS) and the 3rd semester in ECN, UPC, HTW or UNSTPB (30 ECTS). For the 4th semester, the DREAM students may move to partner countries considering the EACEA regulations.

The proposed curriculum develops in the following way:

- 50% of the curriculum is common (the 1st term and 50% of the 2nd semester), the remaining 50% being at the discretion of each partner institution.
- Consequently the students joining an HEI (Higher Education Institution) for their 3rd semester display the same basic knowledge of the subject and are ready to attend the M2 teaching.
- The 3rd semester is dedicated to the specializations offered by each HEI, covering the whole theoretical field of electrical propulsion.
- The Master thesis is integrated. It is co-organized, co-directed and co-validated by the 4 partner HEIs and their academic and industrial partners: common defense and common harmonized assessment.

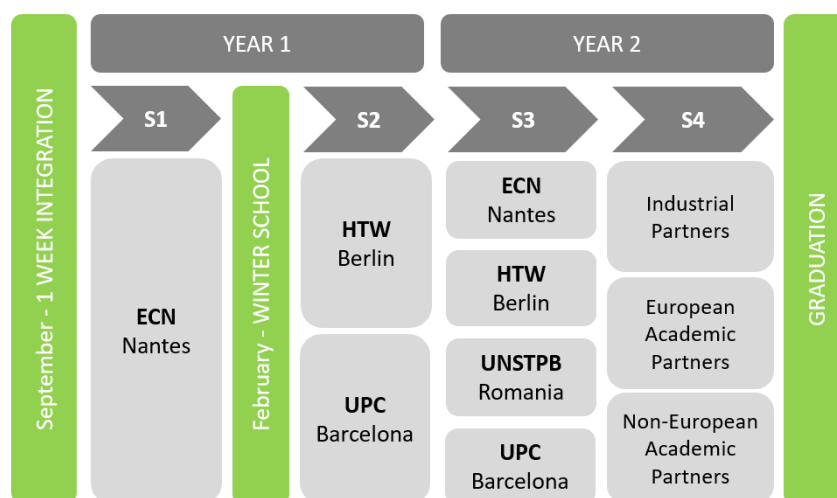


Figure 1. DREAM MASTERS mobility scheme

1.1. DEGREE AWARDED

Students graduating from the DREAM Master's course are awarded two (or three) Master's degrees from the institutions where they studied, as well as a Diploma Supplement. The degrees obtained are officially recognized and give full access to PhD study programmes.

Depending on the mobility carried out, two (or three) of the following Master's degrees will be awarded:

- **Centrale Nantes, France (ECN)**

Master in Automatic, Robotics

- **Universitat Politècnica de Catalunya Barcelonatech, Spain (UPC)**

Master in Energy Engineering

- **Hochschule für Technik und Wirtschaft Berlin, Germany (HTW)**

Master in Electrical Engineering

- **Universitatea Politehnica din București, Romania (UNSTPB)**

Master in Monitoring and control of electrical power systems

- **Diploma Supplement**

1.2. SUMMARY OF THE STUDY PROGRAMME

The language of instruction and examinations is English. The thesis is also written and defended in English. Students also have language and culture courses as a part of the first semester, the second and third semester. As a consequence, each student will use three languages (English and two local languages). Mastering the local language will be important if students carry on to work in one of the host countries.

During the first semester, the students will gain background knowledge in the disciplines mentioned above (power systems, automatic control and power electronics) needed to tackle the challenges of future power systems. It will allow all students to meet together and create the *student cohort*.

In the second semester they will receive a common core of classes in the 2 others HEIs of the consortium (HTW and UPC). By offering a partly uniform programme, the third and fourth semesters can build on specific knowledge regardless of the students' place of study during the second semester.

The third semester offers specialisations in each place: ECN in dynamics and control of power grids, HTW in control of RES, UPC in integration of power electronics in future power systems, UNSTPB in smart grids. The fourth semester is dedicated to the Master Thesis.

The fourth semester is dedicated to the Master's thesis. All industrial and academic partners will prepare and submit Master Thesis topics and will co-supervise the theses. The student carries out their research work under the joint supervision of at least two advisors from two different consortium institutions.

1.3. ADMISSION REQUIREMENTS

Background Relevance

The programme is open to students who already hold a first university degree with the equivalent of 180 ECTS credits (in the European system, or equivalent) after at least three years of studies, at Bachelor of Science level in one of the following fields:

- Electrical engineering
- Electronic engineering
- Energy engineering
- Automatic control and mechatronics
- Renewable energy engineering
- Applied mathematics and physics

Their graduation must take place before 31 July for non-European students and before 30 September for European students.

6.4 ENGLISH PROFICIENCY

Applicants must be fluent in English, both written and spoken. An applicant whose native language is not English is required to pass a recognized international English test:

- TOEFL: CBT 220, ITP 550, IBT 80
- Cambridge B2 First Test: 173 or higher
- Cambridge C1 Advanced Test: 160 or higher
- IELTS: 6.5 or higher
- TOEIC: 800

No other test is recognized. The results provided must not be older than 3 years at the time of the application.

Applicants who carried out their studies in English (official confirmation letter from their university is needed) are eligible without providing such a test result.

CALENDAR

Each institution will provide to students a precise calendar key dates with dates of exams, holidays. Usually first and third semester start on 1st September and finish end of January. The second and fourth semester usually start between mid-February and beginning of March and finish on 31st August.

IMPORTANT LINKS AND RESOURCES

DREAM students have an access to the following resources of the host institution:

- Library
- Rooms equipped with computers
- Wi-Fi
- List and contact of teachers/researchers involved in the program

Details and operating procedure will be precised by the host institution at the beginning of the academic year.

The receiving institution will guide incoming mobile participants in finding accommodation, according to the requirements of the Erasmus Charter for Higher Education. Further information and assistance can be directly provided by the following information sources:

Housing	
ECN	https://www.ec-nantes.fr/english-version/campus/accommodation
UNSTPB	https://international.upb.ro/about-us/campus-life/culture
UPC	https://www.upc.edu/en/university-life-and-services/accommodation
HTW	https://www.htw-berlin.de/en/studies/study-organisation/financing-your-studies/living-in-berlin/

ASSESSMENT RULES

To evaluate students' knowledge and understanding of the material presented in lectures and related practical sessions, assessment will be conducted through a combination of written examinations, oral presentations, essays, poster sessions, laboratory reports, and/or fieldwork reports. Summative assessment contributes to the final grade and typically includes both written examinations (held at the end of each study module) and coursework components such as essays, project reports, and computing exercises. The assessment of knowledge and understanding is primarily carried out through these summative methods. Additionally, students will receive feedback on all formally assessed work to support their academic progress.

1.4. PROGRESSION RULES

1.4.1. The following regulations apply to student progression from one semester to the next:

- A student must obtain a passing grade in all modules constituting that semester, as defined by the progression (or equivalent) regulations of the relevant institution. This requirement also applies to any officially recognized exemptions granted for previous coursework or prior learning completed outside the Programme, provided that such work has been formally accredited as equivalent to a component of the Programme in accordance with institutional regulations.
- Examinations passed and credits earned at one Party will be fully recognized by the other Parties in accordance with their recognition rules.

- In case of non-validation of one module of semester 1 to 3, student is allowed to pass to the next semester by validating the corresponding module or equivalent in the same institution or in the next hosting institution.
- By offering a partly uniform programme, Semester 3 and Semester 4 can build on specific knowledge regardless of the students' place of study during Semester 2.

1.4.2. In order to complete the programme, the following applies:

- In order to receive degrees from the hosting institutions, the student must validate 90 ECTS and their Master thesis.
- For each additional semester (more than 4) the students might need to pay the local registration fees to the hosting institutions they attended in the first two years, according to the local regulation.
- Unless permitted by the local regulations, the students are not allowed to defend their thesis if they do not acquire the 90 ECTS of the modules of the first three semesters.

1.5. MASTER THESIS RULES

- 1.5.1. Every student will have to submit a final draft of the thesis to be assessed by the Joint Masters Board (JMB) where thesis drafts are pre-assessed in order to be submitted for final evaluation.
- 1.5.2. Students have to confirm a master thesis project (subject and hosting institution) between March and October (ie during semester 2 and beginning of semester 3). They can chose among subjects distributed in the Master programme or they can bring themselves a proposal from outside the programme. The subject and the framework (hosting institute) should be compliant with the DREAM programme and should be validated by the consortium.
- 1.5.3. A principal supervisor(s) from the hosted HEI of the Semester 3 will be appointed for each candidate who will be responsible for ensuring that studies are carried out in line with the institution's good practice guidelines. A second, and additionally a third co-supervisor from the first year HEI will also be appointed. The defense will be fixed in accordance between supervisors from the two or three HEIs. All the hosting institution of the student must receive the Master thesis report.
- 1.5.4. The Master thesis is judged following the procedure agreed by the Academic Committee (AC) of the Party where the student presents the thesis. In addition, the thesis has to be written up and defended in front of a jury, consisting of representatives nominated by each AC, according to their respective regulations, and also an external reviewer, who will participate in the assessment processes either "in situ" or "virtually" (using some kind of online communication software).
- 1.5.5. In case of student mobility in the 4th semester to one of the three other partners institution, a principal supervisor(s) from the hosting institution of the Semester 4 will be appointed to the student who will be responsible for ensuring that studies are carried out in line with the institution's good practice guidelines. A second, and in some case also a third co-supervisor from the first year HEI will also be appointed. The defense will be fixed in accordance between supervisors from the two or three HEIs. All the hosting institutions of the student must receive the Master Thesis Report.

- 1.5.6. In case of student mobility in the 4th semester to an institution not among the parties, a principal supervisor(s) from the hosting institution of the 3rd Semester will be appointed to the student who will be responsible for ensuring that studies are carried out in line with the institution's good practice guidelines. A second, and in some case also a third co-supervisor from the first year HEI will also be appointed. The defense will be fixed in accordance between supervisors from the two or three HEIs. All the hosting institutions of the student must receive the Master Thesis Report.

1.6. GENERAL PRINCIPLE

In order to complete the program, the following applies:

- 1.6.1. In order to receive a degree from the hosting institutions, the student must validate 90 ECTS and their Master thesis. Students have to acquire 120 ECTS.
- 1.6.2. For each additional semester (more than 4) the students might need to pay the local registration fees to the hosting institutions they attended in the first two years, according to the local regulation.
- 1.6.3. Unless permitted by the local regulations, the students are not allowed to defend their thesis if they do not acquire the 90 ECTS of the modules of the first three semesters.
- 1.6.4. Appeals by a student against decisions of an Examination Board will be considered according to the Party's procedures applying where the decision, which is being appealed, was originally taken.
- 1.6.5. Re-take exams: students may have the possibility of re-taking exams in cases where progression requirements have not been met. The conditions and dates of re-takes exams will be as established by the existing internal rules and requirements at institutional level.
- 1.6.6. Students who are eligible to progress to the next semester shall not be allowed to repeat any module for which credit has been awarded in order to improve their performance.

1.7. MARKING CRITERIA

Due to the collaborative nature of DREAM, the Consortium is committed to the ECTS grading structure. Examinations and assessments will be marked out of a hundred. The marks equate to ECTS grades as given in table.

GRADING	ECN	UPC	HTW	UNSTPB	DEFINITION
A	A+, A, A-	9 - 10	1,0	10	EXCELLENT
B	B+, B, B-	7 - 8,9	1,3	9	VERY GOOD
C	C+, C	6 - 6,9	1,7/2,0/2,3	7 - 8	GOOD
D	C-	5 - 5,9	2,7/3,0/3,3	6	SATISFACTORY
E	D	N/A	3,7 / 4,0	5	SUFFICIENT
FX-F	F	0 - 4,9	5,0	1 - 4	FAIL

1.8. FINAL AWARD

- 1.8.1. At the end of each semester, the Examination Committee will be held to determine award decisions on students pursuing DREAM.
- 1.8.2. Appeals against award decisions shall be considered in accordance with the appeals procedures adopted by the Examination committee, and administered by the partner institution concerned in conjunction with their own awarding institutional regulations.
- 1.8.3. At the end of the second year successful students will be awarded a double or a triple Master degree from the first, second and third institutions where they studied in.
- 1.8.4. Degrees will be awarded according to national assessment structures, namely, for France, based on the average of M1 and M2 results: *Très Bien* (90-100), *Bien* (80-89), *Assez bien* (70-79), *Passable* (60-70).
- 1.8.5. The diploma of ECN should be delivered around April of the year after the graduation. The following certificates will be delivered before the original diploma to help the student looking for a job or PhD position:
 - Transcripts of M2: it will indicate if the semesters 3 and 4 are validated.
 - Certificate of success including the result of the master based on the average of the four semesters.
 - Diploma Supplement (will be delivered with the original diploma).

1.9. UNFAIR PRACTICE

- 1.9.1. Students must ensure that they do not engage in any form of unfair practice, whereby they take action which may result in them obtaining for themselves or others, an unpermitted advantage.
- 1.9.2. Unfair practice is defined as any act whereby a person may obtain for himself/herself or for another, an unpermitted advantage. An action shall be considered to fall within this definition whether occurring during, or in relation to, a formal examination, a piece of coursework, or any form of assessment undertaken in pursuit of DREAM.
- 1.9.3. Examples of unfair practice in examination conditions are as follows:
 - introducing into an examination room any unauthorised form of materials such as a book, manuscript, data or loose papers, information obtained via an electronic device such as a programmable calculator, pager, mobile phone, or any source of unauthorised information;
 - copying from or communicating with any other person in the examination room, except as authorised by an invigilator;
 - communicating electronically with any other person;
 - impersonating an examination candidate or allowing oneself to be impersonated;
 - presenting evidence of special circumstances to examination boards which is false or falsified or which in any way misleads or could mislead examination boards;

- presenting an examination script as your own work when the script includes material produced by unauthorised means. This includes plagiarism.

1.9.4. Examples of unfair practice in non-examination conditions are as follows:

- Plagiarism. Plagiarism can be defined as using without acknowledgment another person's work and submitting it for assessment as though it were one's own work, for instance, through copying or unacknowledged paraphrasing ;
- Collusion. Collusion can be defined as involving two or more students working together, without prior authorisation from the academic member of staff concerned (e.g Programme leader, lecturer etc) to produce the same or similar piece of work and then attempting to present this work entirely as their own. Collusion may also involve one student submitting the work of another with the knowledge of the originator.
- Falsification of the results of laboratory, field-work or other forms of data collection and analysis.

1.9.5. Examples of plagiarism are as follows:

- Use of any quotation(s) from the published or unpublished work of other persons which have not been clearly identified as such by being placed in quotation marks and acknowledged;
- Summarising another person's ideas, judgements, figures, software or diagrams without reference to that person in the text and the source in the bibliography;
- Use of the services of "ghost writing" agencies in the preparation of assessed work;
- Use of unacknowledged material downloaded from the Internet.

1.9.6. Students suspected of having engaged in unfair practice or assisting another student to engage in unfair practice, either in coursework or examination will be subject to the unfair practice procedures at the institution in which they are studying.

1.9.7. Institutions will investigate any cases of unfair practice identified at their institution, by means of their usual procedures and inform the Consortium of their results.

1.9.8. Students accused of engaging in unfair practice will be given an opportunity either in writing or in person to present their case.

1.9.9. Students found guilty of unfair practice will be subject to the following penalties:

- Annulment of the applicable examination or test or recognition of a course
- The institution where the student is registered will decide the solution to take for these cases.

1.9.10. Students have the right of appeal, against substantiated allegations of unfair practice, in accordance with the appeals procedure adopted by the Consortium Management Committee.

1.10. ATTENDANCE POLICY

The student must attend the whole Master program. The partner institution is responsible for checking the attendance of the students.

- 1.10.1. In case of non-attendance to the course, the local coordinator should contact the student to clarify the situation. The local coordinator informs the coordinator and the management committee which takes a decision on the actions to be taken depending on the reason of the extended absence.
- 1.10.2. In case of non-attendance to the examinations that the student cannot justify with medical certificates or for which permission has not been given by the local coordinator of DREAM, the student will be allowed to retake the exams, if they still does not show up, the student will score 0.

1.11. TRANSFERRING SCHEMES, SUSPENDING AND WITHDRAWING POLICY

- 1.11.1. Transferring schemes: students are assigned a mobility scheme in accordance with their choices on the application platform and with the management committee decision. Once this scheme is accepted by the student, no change will be accepted, except in case of force majeure. The requests are discussed by the management committee and derogation can be given depending on the reason of the student.
- 1.11.2. In case of suspending, the student has to transmit the reason for the suspending with all the supporting documents to the local coordinator within a period of five days after the beginning of the absence. The validity of the decision is left to the judgment of the academic jury semester.
- 1.11.3. In case of withdrawing, the student has to inform the local coordinator within five days by email. The student has to be in line with administrative aspects of the programme and fees, no official document will be delivered before.

1.12. DISCIPLINARY

In case of disciplinary issue, the local coordinator informs the coordinator and the management committee which takes a decision on the actions to be taken depending on the situation.

1.13. COMPLAINT AND APPEAL AGAINST NON-ACADEMIC DECISIONS

In case of complaint or appeal against non-academic decisions, the student shall address their request to the local coordinator who informs the coordinator and the management committee. The final decision is taken by the management committee.

STRUCTURE OF THE PROGRAMME

1.14. THE FIRST SEMESTER MODULES IN ECN (DETAILS IN ANNEX 1)

ECTS Distribution by Module		ECTS
		TOTAL
1	French language course	2
2	Control of electrical drive systems	4
3	Dynamic components of power systems	6
4	Mathematical modeling and identification	5
5	Nonlinear and switching dynamics	4
6	Optimization	5
7	Power systems dynamics	4
8	Conferences	0
TOTAL MASTER		30

Table S1. Subjects offered by ECN

1.15. THE SECOND SEMESTER MODULES (DETAILS IN ANNEX 2)

1.15.1. Second semester at UPC:

ECTS Distribution by Module		ECTS (*)
		TOTAL
1	Application of Power Electronics for Renewable Generation*	5
2	Analysis and Control of Modern Power Electronics Dominated Power Systems*	5
3	Dc Technology and Systems*	5
4	Project	10
5	Spanish-Catalan Language Course	5
TOTAL MASTER		30

Table S2.A. Subjects offered by UPC

* This module is offered at the two partner Institutions where students can spend the second semester. By offering a partly uniform programme, Semester 3 and Semester 4 can build on specific knowledge regardless of the students' place of study during Semester 2.

1.15.2. Second semester at HTW:

ECTS Distribution by Module		ECTS
		TOTAL
1	Renewable energy systems and sources*	5
2	Power electronics*	5
3	Grid control/ Smart grids*	5
4	Modern control engineering with applications	5
5	Electric vehicle drives and control	5
6	German as foreign language	5
TOTAL MASTER		30

Table S2.B. Subjects offered by HTW

** This module is offered at the two partner Institutions where students can spend the second semester. By offering a partly uniform programme, Semester 3 and Semester 4 can build on specific knowledge regardless of the students' place of study during Semester 2.*

1.16. THE THIRD SEMESTER MODULES (DETAILS IN ANNEX 3)

1.16.1. Third semester at ECN:

ECTS Distribution by Module		ECTS
		TOTAL
1	French language course	2
2	Advanced robust control	6
3	Analysis and damping of power systems oscillations	6
4	Conferences	n/a
5	Islanded power systems and microgrids	5
6	Power Systems with multiple dynamics	6
7	Analysis and control of power systems with high power electronics penetration	5
TOTAL MASTER		30

Table S3.A. Subjects offered by ECN

1.16.2. Third semester at UPC:

ECTS Distribution by Module		ECTS (*)
		TOTAL
1	Integration of renewables in the electric grid	5

2	Project	10
3	Power Quality*	5
4	Wind power*	5
5	Energy Storage*	5
6	Smart Grids	5
7	Data Science Applied to Electrical energy Systems	5
	TOTAL MASTER	30

Table S3. B. Subjects offered by UPC

* Subjects 1 and 2 are mandatory while Subjects 3 to 5 are elective.

1.16.3. Third semester at HTW:

ECTS Distribution by Module		ECTS
		TOTAL
1	Automation of renewable energy systems	5
2	Electrical power systems and mains protection	5
3	Flexible AC Transmission System (FACTS)	5
4	Electrical engineering project	15
	TOTAL MASTER	30

Table S3.C. Subjects offered by HTW

1.16.4. Third semester at UNSTPB:

ECTS Distribution by Module		ECTS
		TOTAL
1	Optimization methods	4
2	Power quality	4
3	The impact of distributed generation on electrical networks	4
4	Insulation coordination	4
5	Scientific research	10
6	- Disturbances and electromagnetic emissions in industrial installations*	4
	- Energy storage systems*	
	TOTAL MASTER	30

Table S3.D. Subjects offered by UNSTPB

* Subjects 1 to 5 are mandatory while student must choose one of the option for Subject 6.

10.4 THE FOURTH SEMESTER

The fourth semester is dedicated to the Master's thesis (30 ECTS).

ANNEX 1

SEMESTER 1 - ECN

FRENCH LANGUAGE		
Credits	2 ECTS	Semester 1 ECN
Lectures	0 h	
Tutorials	32 h	
Labs	0 h	
Exam	0 h	
Total	32 h	
Instructor		Silvia ERTL – silvia.ertl@ec-nantes.fr
Objectives		The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with: • Phonetics • Self-correcting exercises on our learning platform • Learning Lab activities • Project work • Tutoring Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources. Students will learn general French, develop language skills of oral and written comprehension and expression. After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Content	Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression. Learners will be able to use the foreign language in a simple way for the following purposes: 1. Giving and obtaining factual information: • personal information (e.g. name, address, place of origin, date of birth, education, occupation) • non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.) 2. Establishing and maintaining social and professional contacts, particularly: • meeting people and making acquaintances • extending invitations and reacting to being invited • proposing/arranging a course of action • exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life 3. Carrying out certain transactions: • making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities • making purchases • ordering food and drink
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CONTROL OF ELECTRICAL DRIVE SYSTEMS		
Credits	4 ECTS	Semester 1 ECN
Lectures	20 h	
Tutorials	6 h	
Labs	4 h	
Exam	2 h	
Total	32 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		• Know how to analyse stability and structural properties of a large-scale power system • Acquire bases for robust control for different grid objectives (control of generators, damping of grid power oscillations, ...)

Content	• Performances & robustness of large-scale systems ; loop-shaping and basic principles • Multi-input/multi output systems - o State-space form & DAE representations - o Structural properties & model reduction • Robust control techniques - o Methodologies (internal model principle, H2 control) of Power systems study cases: control for mixed local and grid objectives
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DYNAMIC COMPONENTS OF POWER SYSTEMS		
Credits	6 ECTS	Semester 1 ECN
Lectures	10 h	
Tutorials	20 h	
Labs	0 h	
Exam	2 h	
Total	32 h	
Instructor		Vinu THOMAS – vinu.thomas@ec-nantes.fr
Objectives		• To apply the knowledge gained on mathematical modelling of power system components and to utilize simulation software tools to develop simulation models of power system components in order to analyse the dynamic behavior of the power systems • To develop the fundamental skills required to carry out research work on power system dynamics
Content		The students do the project in groups of 3 to 5 members. A project topic is assigned to each group. An introductory session on the topic shall be provided by the instructor and there will be interactive sessions of the group with the instructor every few weeks. The students shall be assigned specific tasks related to the project topic, to be completed before the next interactive session. During the interactive sessions, additional tasks are assigned to enable the students to complete the objectives of the project topic. Towards the end of the semester, the students are supposed to complete all the tasks and develop a mathematical simulation model as per the topic and carry out case studies. Project assessment is done based on a final written report and oral presentations made by group members during the interactive sessions.

MATHEMATICAL MODELING AND IDENTIFICATION		
Credits	5 ECTS	Semester 1 ECN
Lectures	22 h	
Tutorials	4 h	
Labs	4 h	
Exam	2 h	
Total	32 h	
Instructor		Vinu THOMAS – vinu.thomas@ec-nantes.fr
Objectives		• To mathematically model power system components. • To take into account the model uncertainty using a probabilistic approach. • To develop system identification and state tracking methods using a probabilistic approach.
Content		Part 1 • Mathematical modelling – Types of modelling, Need for modelling • Mathematical description of a synchronous machine, review of magnetic circuit equations and basic equations of a synchronous machine, dq transformation, per unit representation, representation of magnetic saturation • AC Transmission: transmission line, characteristics and performance equations, two winding and three winding transformer representation, load modelling – static and dynamic, modelling of induction motors, representation in stability studies, synchronous motor models- acquisition of load model parameters • Modelling of excitation systems: modelling of excitation components and complete excitation systems, Prime movers and electricity supply systems –hydraulic, steam, thermal and wind turbines and governing systems • Voltage source converter modelling – averaged model, model in $\alpha\beta$ beta and dq frame Part 2 • Probability theory: random vectors, density, mean, variance. • Time analysis, frequency analysis: random signals, autocorrelation, power spectral density. • Classical estimation Theory, Bayesian estimation: maximum likelihood (ML) estimation, minimum mean square error (MMSE) estimator, maximum a posteriori (MAP) estimator, linear minimum mean square error (LMMSE). • Markov chains, Markov processes, Statistical filtering: Kalman

NONLINEAR AND SWITCHING DYNAMICS		
Credits	4 ECTS	Semester 1 ECN
Lectures	14 h	
Tutorials	4 h	
Labs	12 h	
Exam	2 h	
Total	32 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		• Have an introduction to nonlinear systems • How to analyze the stability and performance properties of nonlinear systems • Have an introduction to hybrid and switched systems and familiarize with their main behaviors • Acquire the main tools to analyze the stability of switched systems and provide main tools for their stabilization. • The obtained skills will be based on both extensions of linear tools as well as electrical applications and power converters.
Content		• Introduction to nonlinear dynamics and associated definitions • Stability of nonlinear systems with Lyapunov function theory • Introduction to a specific class of nonlinear systems: hybrid and switched systems. • Stability of switched systems. • Control design for switched systems.

OPTIMIZATION		
Credits	5 ECTS	Semester 1 ECN
Lectures	20 h	
Tutorials	2 h	
Labs	8 h	
Exam	2 h	
Total	32 h	
Instructor		Ina TARALOVA – ina.taralova@ec-nantes.fr
Objectives		Optimisation is transversal to all engineering fields, and beyond. The aim of the course is to get acquainted with iterative optimization methods in one dimensional and multidimensional case, linear or nonlinear, with or without constraints. Students will be given further analytical tools for the formulation and solution of PF and OPF problems, with numerical applications to benchmark problems in power systems such as congestion management in RTE.

Content	1. Introduction to optimization problems : Examples, definitions. Convex sets and convex functions. 2. Unconstrained optimization. Definition of convergence rate, complexity of the algorithm 2.0. Unconstraint optimization. Linear problem, Simplex method 2.1. Unidimensional problems 2.1.1 Derivative-based optimization methods (DBO) : Newton's method, Secant method 2.1.2. Derivative-free optimization methods (DFO) : Mini-Max problems, Dichotomy, Fibonacci, Golden section, Brent's method, "Economic" methods 2.2. Multidimensional problems 2.2.1 Direct search heuristic methods : Hooke and Jeeves, Nelder – Mead simplex method 2.2.2 Gradient-based method: Gradient, steepest descent, conjugate gradients, quasi-newton 3. Constrained optimization. Examples of constraints in Control. 3.1. Dual methods : Lagrange multipliers 3.2. Primary methods: Interior and exterior points Second part taught by RTE lecturers 4.1 Optimisation in power systems 4.2 Optimisation in electrical grids based on linear models (N-1 rule, Security Constrained Optimal Power Flow) 4.3 ACOPF : Alternative Current Optimal Power Flow 4.4 Real-time optimization for congestion management in RTE
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POWER SYSTEMS DYNAMIC		
Credits	4 ECTS	Semester 1 ECN
Lectures	18 h	
Tutorials	4 h	
Labs	8 h	
Exam	2 h	
Total	32 h	
Instructor		Vinu THOMAS – vinu.thomas@ec-nantes.fr
Objectives		Acquire the bases of the dynamic operation of power grids. After completing this module, students will be able to: • Understand and analyze the main dynamic phenomena of interconnected power systems • Know the basic and classic regulations of power grids • Use grid dedicated simulation softwares • Knowledge of the electricity sector (fields of activity of companies like RTE, EDF or equipment manufacturer such as, for example, Alstom, Siemens, ABB)

Content	• Electricity production and grid management (general notions) • Load flow • Basic dynamics (frequency/voltage) of a power grid; generation/consumption balance • Stability (voltage, frequency/transient, small-signal/oscillatory) • Primary/secondary/tertiary regulations; • Voltage & frequency system services • Zoom on the French and European grids
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CONFERENCES		
Credits	0 ECTS	Semester 1 ECN
Lectures	20 h	
Tutorials	0 h	
Labs	0 h	
Exam	0 h	
Total	20 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		Bring to students realistic study cases and experiences
Content		To be defined each year

ANNEX 2

SEMESTER 2 - UPC

ANALYSIS AND CONTROL OF MODERN POWER ELECTRONICS DOMINATED POWER SYSTEMS		
Credits	5 ECTS	Semester 2 UPC
Lectures	43 h	
Labs	0 h	
Exam	2 h	
Total	45 h	
Instructor		
Objectives		- Learn the fundamentals of analysis of modern renewable energy dominated systems - Understand the basic dynamics of the power system- Understand the basic dynamics of power converters - Learn different techniques to assess the dynamics of modern power systems - Learn how to simulate modern power systems - Learn potential interaction issues in modern power systems and how to assess them - Study innovative control techniques applied in modern power systems- Identify potential solutions to enable 100% renewable energy network
Content		1. VSC converter technology review 2. Conventional power system dynamics 3. Modern power system dynamics 4. Phasor-based simulation of modern power systems 5. EMT-based simulations of modern power systems 6. Trends in analysis and control of modern power systems 7. Tools to assess dynamics and interactions in modern power systems

APPLICATION OF POWER ELECTRONICS FOR RENEWABLE GENERATION		
Credits	5 ECTS	Semester 2 UPC
Lectures	43 h	
Labs	0 h	
Exam	2 h	
Total	45 h	
Instructor		Marc Cheah Mañé – marc.cheah@upc.edu
Objectives		Electrical aspects of renewable energy will be addressed, from the modelling and control of the required electrical machines to electrical grid integration issues. 1. Introduce the generation principles of the different renewable sources. 2. Introduce the different renewable energy sources focusing on photovoltaic solar and wind systems. 3. Delve into the the electrical aspects of the treated energy sources: induction and synchronous generators, PV panels, etc. 4. Work with energy conversion technologies to integrate renewable energies into the electrical grid or microgrid. 5. Focus on control techniques to maximise generation and control optimally the grid interconnection. 6. Analyse issues related to grid integration: voltage and frequency stability, effect of perturbations into the renewable source generation, etc. 7. Development of simulation-based exercises.
Content		1. Introduction to renewable generation 2. Photovoltaic generation systems 3. Wind generation systems 4. Grid integration of renewable generation

DC TECHNOLOGY AND SYSTEMS		
Credits	5 ECTS	Semester 2 UPC
Lectures	28 h	
Labs	15 h	
Exam	2 h	
Total	45 h	
Instructor		Eduardo Prieto Araujo - eduardo.prieto-araujo@upc.edu Oriol Gomis Bellmunt - oriol.gomis@upc.edu
Objectives		- Learn the basic fundamentals of DC technology and systems for renewable energy systems - Learn how to perform DC circuit calculations - Study the key parts of DC networks - Understand the differences between LCC and VSC technology - Analyze the fundamentals of Modular Multilevel Converters - Understand HVDC grid operation and contro - Analyze different protection systems - Learn how to simulate DC power convereters and power networks - Study key applications (renewable energy integration, islands interconnection, etc.) - Explore ongoing research topics in the field of HVDC (Offshore wind hubs, grid-forming operation, DC/DC converters, etc.)
Content		1. Course introduction 2. DC technology and systems role in future renewable energy dominated power networks 3. Main applications (offshore wind, high shares of renewable energy transfer, islands interconnection, etc.) 4. DC fundamentals (circuits) 5. Main system elements 6. AC vs DC technology 7. Key technology parts (converters, lines, cables) 8. MVDC and LVDC systems (medium and high voltage)

PROJECT		
Credits	10 ECTS	Semester 2 UPC
Lectures	0 h	
Labs	90 h	
Exam	0 h	
Total	90 h	
Instructor		Marc Cheah Mañé – marc.cheah@upc.edu
Objectives		- Starting to plan and manage engineering/research projects - Application of previous technical skills and knowledge acquired in the Bachelor's and Master's degrees - Improving generic skills such as: oral communication and writing skills, autonomous learning and efficiency to search information in the literature.
Content		Project development - A short engineering/research project will be defined for each student according to their interests and availability from lecturer. All projects should be based on power system and power electronics applied for energy topics. The student will learn and develop analytical methods or experimental approaches.

SPANISH-CATALAN LANGUAGE COURSE		
Credits	5 ECTS	Semester 2 UPC
Lectures	0 h	
Labs	90 h	
Exam	0 h	
Total	90 h	
Instructor		Marta Aguilar Perez – marta.aguilar@upc.edu
Objectives		MAIN OBJECTIVES The objective of this course is two-fold. On the one hand, it aims to introduce learners to Spanish and Catalan. On the other hand, both Spanish and Catalan cultures will be analysed, compared, and reflected upon from an intercultural communication perspective, aiming at promoting openness, reflection, ethnorelativism, diversity, and cultural and social awareness. SPECIFIC OBJECTIVE - Become acquainted with basic grammatical rules in Spanish and Catalan. We start with Spanish - Become acquainted with essential pronunciation rules in Spanish and Catalan - Become acquainted with Spanish and Catalan cultures, traditions, and ways of being and working - Use Spanish and Catalan for day-to-day activities and interactions - Identify, analyse, and reflect on the role of Intercultural Competence and global skills beyond stereotypes - Identify and explore nuance to better differentiate between languages and cultures, and enable a sense of belonging - Assess own bias and the impact it has on communication
Content		MODULE 1. A look at Romance languages: Spanish and Catalan as a case in point MODULE 2. Intercultural Communicative Competence

RENEWABLE ENERGY SYSTEMS AND SOURCES		
Credits	5 ECTS	Semester 2 HTW
Seminar	2 SWS ^{Erreur ! Signet non défini.}	
Labs	1 SWS ^{Erreur ! Signet non défini.}	
Exam	90min written exam (100%)	
Total	3 SWS ¹	
Instructor		Horst Schulte - schulte@htw-berlin.de
Objectives		• Know how to understand the generation of regenerative energies. • Exploitation of regenerative energies in general. • Knowing and calculating principles of conversion of wind energy into mechanical energy. • Knowing and calculating principles of photovoltaic power into AC power.
Content		• Sustainable energy supply concepts. • Photovoltaic energy conversion source. • Planning and design of solar systems. • Fundamentals of wind energy use. • Aerodynamic energy converters. • Wind Energy Systems. • Planning and design of wind power plants.

¹ SWS (= „Semesterwochenstunden“), i.e. hours per week that students must attend each week for a module during the lecture period of a semester (with 1 SWS representing a 45 minute lasting time unit).

POWER ELECTRONICS		
Credits	5 ECTS	Semester 2 HTW
Lectures	3 SWS	
Seminar	1 SWS	
Exam	90min written exam (80%) and 20% for seminar reports	
Total	4 SWS	
Instructor		Horst Schulte - schulte@htw-berlin.de
Objectives		Students gain detailed insight into the structure and operation of modern power semiconductor devices and the application of power electronic topologies. They are familiar with the structure and characteristic of basic self-controlled and line-/ grid-controlled power converters and are able to dimension essential power converter components. They are able to model, analyse and evaluate power converters in a structured manner using circuit simulation.
Content		(Within the lecture) Line-controlled converters: - Detailed analysis of control and commutation using the line-controlled six-pulse bridge. - Line current of 12-pulse line-controlled power converter. - Structure and characteristics of modern power semiconductors. - Self-controlled power converters: voltage-fed pulse converters (2-level). - Cooling of power semiconductors: static and transient thermal resistance. (Within the seminar) Simulation and analysis of power converters and thermally equivalent block diagrams in a structured manner: - Valve blocking voltage, control, commutation, reactive power curve and grid feedback of a line-controlled B6 - Line current and grid feedback of 12-pulse line-controlled power converters. - Voltage-fed 2-level pulse converter. - Static and transient thermally equivalent block diagrams.

GRID CONTROL/ SMART GRIDS		
Credits	5 ECTS	Semester 2 HTW
Seminar	3 SWS	
Labs	1 SWS	
Exam	90min written exam (100%)	
Total	4 SWS	
Instructor		Stephan Krämer - Stephan.kraemer@htw-berlin.de
Objectives		Students • can evaluate the relevance of defining ancillary services. • recognise the dynamic relationships in the operation of electrical grids and the relevant processes for grid load compensation. • are able to analyse the dynamic and static effects caused by the energy transition. • are able to describe the principle and effects of compensating processes and fluctuating renewable energy sources (wind energy and photovoltaic systems, control and compensating processes) on the electrical transmission and distribution grid. • recognise the relevance of using FACTS and DC equipment, as these are essential for the operation of electrical grids. • recognise the relevance of data and communication technology for the operation of the energy supply structure. • derive measures for the development of energy infrastructures, taking into account different energy distribution structures. • evaluate and derive questions regarding the design of future energy distribution structures. • can apply their existing and new knowledge to complex contexts, even on the basis of limited information.
Content		• (Within the seminar): • Providing technical expertise on grid control elements with regard to their function and specification. • Interaction of various operating equipment in the grid and the related compensating processes. • Consideration of the legislative regulations for the deployment of renewable energy sources, description of ancillary services and their relevance; grid code and grid connection requirements; become acquainted with and evaluate compensating processes; understanding the scope and application of FACTs and HVDC elements, become acquainted with the necessary infrastructure elements for a safe operation of electrical grids at all voltage levels.

	• (Within the laboratory course): • Providing technical expertise on grid control elements in terms of scope and specification, • Interaction of various operating equipment in the grid and the related compensating processes. • Calculation and design of specific grid control components.
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MODERN CONTROL ENGINEERING WITH APPLICATIONS		
Credits	5 ECTS	Semester 2 HTW
Seminar	3 SWS	
Labs	1 SWS	
Exam	90min written exam (100%)	
Total	4 SWS	
Instructor		Stephan Kusche - Stephan.Kusche@HTW-Berlin.de
Objectives		Students are able to describe dynamic systems in state space and determine the controllability and observability of systems. They are familiar with design methods for single and multi-signal systems as well as the design of robust state controllers with a sliding mode component. In the laboratory course, students apply various design methods to different closed-loop systems and compare them with each other. Modelling and design as well as the solution are realised using MATLAB/SIMULINK.
Content		• (Within the seminar): • System representation/ modelling in state space. • Controllability and observability. • Model-based design of state controllers for single- and multi-signal systems using pole assignment and optimal controller design (LQG). • Observer design for state reconstruction. • Augmentation of state controllers with PI structures; disturbance observers and dynamic pre-filters. • Robust control with sliding mode methods. • Application of convex optimisation algorithms for controller design. • Stability concept according to Lyapunov. • Lyapunov-based controller design. • Robust controller design with linear matrix inequalities. • (Within the laboratory course): • Modelling, simulation-based design and implementation of observer-based state controllers for unstable systems using the example of the inverted pendulum.

	• Modelling and simulation-based multi- signal control for a three-tank system. • Observer-based control of an elastic drive train.
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ELECTRIC VEHICLE DRIVES AND CONTROL		
Credits	5 ECTS	Semester 2 HTW
Seminar	2 SWS	
Labs	1 SWS	
Exam	90min written exam (50%) and 50% for a laboratory paper	
Total	3 SWS	
Instructor		Horst Schulte - schulte@htw-berlin.de
Objectives		Students • get a comprehensive overview of the challenges and solutions on the topic of electric vehicle drives. • learn about the most important parameters of electric drives and power electronic components in vehicle applications (typical applications and their voltage and power ranges, Z-v diagram, power converters, motor types, recuperators in railway applications, auxiliary converters and chargers). • can design and configure the necessary electrical devices. • are able to evaluate the overall context and derive solution concepts for drive train typology. • learn the basics for modeling, simulation and control design of electric vehicles. • can evaluate specific tasks relating to drive train technology, using them to develop their own ideas for future improvements.
Content		• (Within the seminar): Overview with modeling and contro of drive train technology, electrical components and energy storages for the following applications: • Electrical locomotive-hauled and multiple train units, suburban trains and trams. • Electric and hybrid cars, trolleybuses and overhead line trucks. • Electrically driven small vehicles (pedelec, scooter) • Recuperating and earthing in electric rail vehicles, driving and braking, service brakes. • Power converters, motors and drives used in these types of application. • (Within the laboratory course): • Experiments or simulations/computational exercises on electric vehicle drives.

GERMAN AS FOREIGN LANGUAGE		
Credits	5 ECTS	Semester 2 HTW
Seminar	4 SWS	
Labs	0 SWS	
Exam	written exam (100%)	
Total	4 SWS	
Instructor		Foreign language centre
Objectives		Taking into account all language skills (listening, speaking, reading and writing), the module enhances existing language skills with the following objectives: • Understanding diverse, extensive texts and identifying implicit meaning. • Fluid and spontaneous expression without extensive searching for appropriate phrases. • Flexible and effective communication in social, academic and professional contexts. • Clear, well-structured and detailed writing on challenging subjects, using standard information structures.
Content		

ANNEX 3

SEMESTER 3 - ECN

FRENCH LANGUAGE		
Credits	2 ECTS	Semester 3 ECN
Lectures	0 h	
Tutorials	32 h	
Labs	0 h	
Exam	0 h	
Total	32 h	
Instructor		Silvia ERTL – silvia.ertl@ec-nantes.fr
Objectives		The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with: • Phonetics • Self-correcting exercises on our learning platform • Learning Lab activities • Project work • Tutoring Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources. Students will learn general French, develop language skills of oral and written comprehension and expression. After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course, complete beginners can achieve an A1 level and some aspects of the A2 of the Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels. Those who already completed the first year of the French course will be prepared for working in a French business environment.

Content	Two different tracks are proposed: track 1 for students newly arrived at Centrale Nantes and track 2 for students who have completed the first year of the French course. Track 1: Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression. Learners will be able to use the foreign language in a simple way for the following purposes: 1. Giving and obtaining factual information: • personal information (e.g. name, address, place of origin, date of birth, education, occupation) • non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.) 2. Establishing and maintaining social and professional contacts, particularly: • meeting people and making acquaintances • extending invitations and reacting to being invited • proposing/arranging a course of action • exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life 3. Carrying out certain transactions: • making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities • making purchases • ordering food and drink Track 2: This track follows on directly from the first-year French course, developing and completing the concepts studied thus far. The main themes are: housing, health and work. These topics will help prepare students for their future work environment. For example, housing is explored in the form of a search for accommodation upon arrival in a new city. Special workshops for CVs and cover letters, elevator pitches and job interviews.
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ADVANCED ROBUST CONTROL		
Credits	6 ECTS	Semester 3 ECN
Lectures	18 h	
Tutorials	4 h	
Labs	8 h	
Exam	2 h	
Total	32 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		- Manage the H-infinity advanced robust control for MIMO systems - Apply it to power grids
Content		Optimal control Trade off robustness/performances Loopshaping with frequency weights H-infinity formalism with Riccati equations H-infinity control with LMI Applications to power grids

ANALYSIS AND DAMPING OF POWER SYSTEMS OSCILLATIONS		
Credits	6 ECTS	Semester 3 ECN
Lectures	18 h	
Tutorials	4 h	
Labs	8 h	
Exam	0 h	
Total	32 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		Understand power oscillations of modern power systems: - Inter-area modes - coupling modes between power electronics devices To be able to synthesize regulators to damp these oscillations
Content		Modal analysis - Eigenvalues, eigenvectors, modes, participation factors - Damping controller via classic phase shift method - Damping controller with advanced controls - Exhaustive modal analysis for power grids with power electronics

CONFERENCES		
Credits	0 ECTS	Semester 3 ECN
Lectures	36 h	
Tutorials	0 h	
Labs	0 h	
Exam	0 h	
Total	36 h	
Instructor		Bogdan MARINESCU – Bogdan.marinescu@ec-nantes.fr
Objectives		Bring to students realistic study cases and experiences.
Content		To be defined each year.

ISLANDED POWER SYSTEMS AND MICROGRIDS		
Credits	5 ECTS	Semester 3 ECN
Lectures	18 h	
Tutorials	4 h	
Labs	8 h	
Exam	2 h	
Total	32 h	
Instructor		Vinu THOMAS – vinu.thomas@ec-nantes.fr
Objectives		• To understand the operation of islanded power systems and to learn the control schemes deployed for them • To learn the concept of microgrids and their operating modes and control schemes

Content	• Islanded power systems- basic concepts –challenges - general structure of an islanded power system – control schemes – voltage and frequency dynamics- under-frequency load shedding schemes • Microgrid concept- Types of microgrids- AC Microgrids- DC Microgrids- Hybrid AC-DC Microgrids • Operation of microgrids - Microgrid control architecture– Hierarchical control scheme - Centralised and Decentralised control - Grid-connected and islanded operation- Islanding of microgrids - Islanding detection in microgrids • Microgrid Protection - Challenges - Impacts of microgrids – Techno-economic benefits of microgrids • Emergency control and load shedding in microgrids- Energy management in microgrids • Case studies of microgrid pilot projects
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POWER SYSTEMS WITH MULTIPLE DYNAMICS		
Credits	6 ECTS	Semester 3 ECN
Lectures	8 h	
Tutorials	22 h	
Labs	0 h	
Exam	2 h	
Total	32 h	
Instructor		
Objectives		• To understand the multiple dynamics of the power systems with higher penetration of renewable sources • To learn the impact of power electronic converters on the dynamics of power systems with the penetration of HVDC and FACTS devices
Content		Power system dynamics with conventional bulk power generation- Evolution of power systems with renewable energy sources- Challenges in primary and secondary voltage control, Challenges in primary and secondary frequency control - Effect of HVDC converters and FACTS devices on the voltage and frequency dynamics – Oscillations in power systems- Problems and Solutions- Simulation exercises using MATLAB/Simulink Simpowersystems.

ANALYSIS AND CONTROL OF POWER SYSTEMS WITH HIGH POWER ELECTRONICS PENETRATION		
Credits	5 ECTS	Semester 3 ECN
Lectures	18 h	
Tutorials	4 h	
Labs	8 h	
Exam	2 h	
Total	32 h	
Instructor		
Objectives		• To understand the challenges of high power electronics penetration in the power systems • To learn various control schemes such as grid-following and grid-forming control used in power electronic converters when connected to the grid
Content		• Power system stability challenges with high levels of power-electronics penetration- Reduction of system inertia- Short-circuit power levels- Rotor angle stability – Voltage stability • Grid-following inverters and grid-forming inverters- Comparison • Grid-following inverters – General structure – Ancillary services with grid following inverters- Frequency control – Reactive power compensaton – Voltage control • Grid-forming inverters – Power system requirements of grid-forming inverters- Control approaches – Virtual inertia concept - Ancillary services with grid forming inverters

SEMESTER 3 - HTW

AUTOMATION OF RENEWABLE ENERGY SYSTEMS		
Credits	5 ECTS	Semester 3 HTW
Seminar	3 SWS	
Tutorials	0 SWS	
Labs	1 SWS	
Exam	30min exam oral	
Total	4 SWS	
Instructor		Horst SCHULTE, schulte@htw-berlin.de
Objectives		Students learn about the specifications and design methods for automating selected renewable energy systems, using wind energy systems as an example. The focus is on the model-based controller design for the partial and full load range of a wind turbine operation. Based on a controller design model, the entire design process is conducted, from modelling and controller design in the frequency domain to controller verification on the design model and subsequently on the detailed overall plant model. Students learn how to design and parameterise an appropriate control engineering structure.
Content		(Within the seminar): - Introduction: Layout of a wind turbine. - Introduction to the control principals of wind turbines. - Characteristic curves: torque/speed, power and thrust characteristic curves. - Design of control-models for partial and full load range. - Controller design for the upper partial load and full load range. (Within the laboratory course): - Reduced modelling of a wind turbine plant and verification with Matlab/Simulink and FAST. - Simulation-based design and implementation of control strategies for wind turbines.

ELECTRICAL POWER SYSTEMS AND MAINS PROTECTION		
Credits	5 ECTS	Semester 3 HTW
Seminar	3 SWS	
Tutorials	0 SWS	
Labs	1 SWS	
Exam	90min written exam (80%) and 20% for laboratory exercises	
Total	4 SWS	
Instructor		Thomas GRÄF - Thomas.Graef@HTW-Berlin.de
Objectives		Students - are able to select appropriate protection systems for various electrical operation equipment and project them at a basic level. - are able to use protective testing equipment and protective relays. - can configure and activate protection systems. - can prepare test reports and interpret test results (including those from protective test reports provided). - can perform protective analysis. - are able to derive protective measures for the future development of energy infrastructures. - are able to formulate and evaluate questions regarding the protective design of future energy distribution structures.
Content		(Within the seminar): Providing technical expertise on protective systems in order to select and design them in terms of function, specification and specific operating conditions. This applies in particular to: - Measuring, counting and monitoring equipment. - Requirements for protective systems. - Protective equipment for line protection with various energy sources and consumer protection. - Transformer protective equipment. - Generator protective systems and emergency power generators, as well as motor protective systems. - Performing calculations using real applications, supported by software and computers. - Technical configuration of equipment and preparation of operational procedures. - Preparation of automated test procedures with modern protective testing equipment. - Implementation and verification of the results of the supporting exercise. - Acquire the ability to work with existing operation equipment, configure parameters and test own solutions. (Within the laboratory course):

	• Performing calculations and laboratory exercises using existing protective equipment, supported by software and computers. Acquire and practice operational procedures. • Technical configuration of equipment and preparation of operational procedures.
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FLEXIBLE AC TRANSMISSION SYSTEM (FACTS)		
Credits	5 ECTS	Semester 3 HTW
Lecture	3 SWS	
Tutorials	0 SWS	
Labs	0 SWS	
Exam	90min written exam (100%)	
Total	3 SWS	
Instructor		Stephan KRÄMER - Stephan.kraemer@htw-berlin.de
Objectives		Students - become familiar with the parameters of electrical power quality (EPQ) and learn how to carry out the relevant calculations. - get familiar with current circuits for improving electrical power quality and adjusting energy transmission. - learn how to calculate operating behaviour, dimension the main components and design the control system.
Content		- Electrical power quality (harmonics, imbalance, voltage fluctuations, flicker). - Dynamic reactive power compensation (flicker, harmonics, Q). - Grid and industrial compensation comprising TCR, TSC and FC. Calculation and design. - STATCOM; calculation and design. - Open- and closed-loop strategies. - Generators - Variable speed generators for grid control, structure/ layout, characteristics/ operation modes, design, open- and closed-loop strategies. - Static and rotating excitation equipment for synchronous generators. - High-voltage direct current transmission (HVDC): - Voltage DC link, calculation and design. - Current DC link, calculation and design. - Open- and closed-loop strategies. - Railway power supply - Compensation of asymmetric line earth faults - Railway converters - Designing circuit diagrams, terminal diagrams and cable diagrams. Layout of the system and components.

ELECTRICAL ENGINEERING PROJECT		
Credits	15 ECTS	Semester 3 HTW
Seminar	7,5 SWS	
Tutorials	0 SWS	
Labs	0 SWS	
Exam	Practical presentation, simulation and/or experimental setup (60%) and report (30%) and poster presentation (10%)	
Total	7,5 SWS	
Instructor		Horst SCHULTE - schulte@htw-berlin.de
Objectives		Students • improve their personal problem-solving expertise and solution strategy design. • enhance their discipline-specific knowledge and apply this to realistic industry-related applications. • improve their ability to work independently by completing the module. • improve their decision-making and problem-solving skills regarding technical tasks. • acquire and apply additional working techniques related to problem-solving strategies. • are able to compose and analyse scientific publications. • enhance their knowledge to generate application-oriented expertise. • realise and refine laboratory experiments from a scientific perspective. • develop project management skills for the successful realisation of projects. • are able to apply existing and new expertise in complex contexts. • are able to discuss subject- and disciplinary-specific issues with representatives from various academic and non-academic fields • can outline research objectives and interpret and critically evaluate research findings.
Content		• Projects and tasks related to electrical energy technology and automation. • The topics available are presented by lecturers at the beginning of each semester during a joint event. Students can also search for topics in advance in collaboration with these lecturers.

SEMESTER 3 - UPC

INTEGRATION OF RENEWABLE ENERGIES IN ELECTRICAL GRIDS		
Credits	5 ECTS	Semester 3 UPC
Lectures	43 h	
Tutorials	0 h	
Labs	0 h	
Exam	2 h	
Total	45 h	
Instructor		Oriol GOMIS BELLMUNT – oriol.gomis@upc.edu Eduardo PRIETO ARAUJO - eduardo.prieto-araujo@upc.edu Paula Muñoz PEÑA – paula.munoz.pena@upc.edu Montserrat MONTALÀ PALAU - montserrat.montala@upc.edu
Objectives		The course will focus on providing the knowledge and the tools needed to understand and analyze the interaction between renewable energies and power systems. Specific objectives include covering the following topics: - Analysis of power systems with a high penetration of renewables - Grid integration of renewables - Smart grids - Grid codes - Isolated and connected Microgrids - HVDC Supergrids for offshore wind - The role of energy storage and demand side management
Content		1. Introduction and overview of renewable generation technology 2. Modern power systems based on renewable generation 3. Grid support from renewable generation

PROJECT		
Credits	10 ECTS	Semester 3 UPC
Lectures	0 h	
Tutorials	0 h	
Labs	90 h	
Exam	0 h	
Total	90 h	
Instructor		Marc Cheah MAÑÉ – marc.cheah@upc.edu
Objectives		- Starting to plan and manage engineering/research projects - Application of previous technical skills and knowledge acquired in the Bachelor's and Master's degrees - Improving generic skills such as: oral communication and writing skills, autonomous learning and efficiency to search information in the literature.
Content		Project development - A short engineering/research project will be defined for each student according to their interests and availability from lecturer. All projects should be based on power system and power electronics applied for energy topics. The student will learn and develop analytical methods or experimental approaches.

POWER QUALITY		
Credits	5 ECTS	Semester 3 UPC
Lectures	28 h	
Tutorials	0 h	
Labs	15 h	
Exam	2 h	
Total	45 h	
Instructor		Joan MONTAÑA PUIG – joan.montanya@upc.edu Luis SAINZ SAPERA – luis.sainz@upc.edu
Objectives		At the end of the course the students should be able to: - Identify the effects of different types of disturbances and the most common mitigation techniques. - Understand the origin of the harmonics, assess its effects and propose solutions.

	- Understanding the origin, magnitude and effects of transients. Study of mitigation. - Know the quality parameters of the voltage supply. Study of variations in voltage and frequency. - Identify the origin, modelling and understand the impact of interruptions and voltage sags. - Knowing the regulatory framework, with special attention to the renewable generation.
Content	1. Introduction 2. Periodic perturbations 3. Non-periodic disturbances

WIND POWER		
Credits	5 ECTS	Semester 3 UPC
Lectures	43 h	
Tutorials	0 h	
Labs	0 h	
Exam	2 h	
Total	45 h	
Instructor		
Objectives		The course will focus on providing the knowledge and the tools needed to understand and analyze wind power generation systems. Steady-state and dynamic analysis of wind turbines and wind power plants will be conducted. At the end of the course the students will be able to: - Understand the principles of electrical generation with wind turbines - Determine the steady state conditions of a given wind power generation system - Analyze the dynamic behavior of wind turbines - Understand how wind turbines can be aggregated in wind power plants - Size and pre-design wind turbines and wind power plants

Content	1. Introduction to wind energy 2. The wind resource 3. Principles and components of wind turbines 4. Fix-speed wind turbines 5. Variable speed wind turbines 6. Wind power plants
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ENERGY STORAGE		
Credits	5 ECTS	Semester 3 UPC
Lectures	28 h	
Tutorials	0 h	
Labs	15 h	
Exam	2 h	
Total	45 h	
Instructor		
Objectives		The objective is to gain basic knowledge on energy storage systems in systems based on renewable energies, emphasizing in electromechanical systems (flywheels, pumped-hydro installations and compressed-air installations), electric devices (supercapacitors and SMES), electrochemical systems (bateries) and chemical systems (hydrogen-based ones). Learning results At the end of the course, the student: - Should know the principal characteristics of the diverse energy storage systems that can be applied in systems based on renewable energies. - Should know the mathematical expressions (high level ones) so as to size an energy storage system from the energy demands in systems based on renewable energies. - Should know the management and monitoring mechanisms of energy storages. - Should achieve a global vision of the energy storage possibilities in systems based on renewable energies, with the objective of addressing the suitability of using one or another storage device according to their particular application. - Should gain capacities in modeling and simulation of energy systems including storages, as for the case of systems based on renewable energies. - Should gain the knowledge and skills so as to define a project related to the conception, sizing and/or utilization of energy storages in systems based on renewable energies.

Content	1. Introduction to the systems based on renewable energies and electrical markets 2. Energy storage technologies 3. Cost models for energy storage systems 4. Applications of energy storage systems in systems based on renewable energies 5. Regulation and business models 6. Recycling and natural resources
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SMART GRIDS		
Credits	5 ECTS	Semester 3 UPC
Lectures	28 h	
Tutorials	0 h	
Labs	15 h	
Exam	2 h	
Total	45 h	
Instructor	Andreas SUMPER – andreas.sumper@upc.edu Paula GONZÁLEZ FONT DE RUBINAT - paula.gonzalez.font.de.rubinat@upc.edu Vinicius GADELHA – vinicius.gadelha@upc.edu	
Objectives	Knowing the basics of power system operation. Knowing the basic properties and components of the Smart Grid. Being able to apply novel techniques and technologies to the power system.	
Content	1. Equipment of transmission & distribution systems 2. Smart Grid Technical systems	

DATA SCIENCE APPLIED TO ELECTRICAL ENERGY SYSTEMS		
Credits	5 ECTS	Semester 3 UPC
Lectures	28 h	
Tutorials	0 h	
Labs	15 h	
Exam	2 h	
Total	45 h	
Instructor		Mònica ARAGÜES PEÑALABA – monica.aragues@upc.edu Sara BARJA MARTÍNEZ – sara.barja@upc.edu

Objectives	1) Understand the main concepts around Big Data and Machine Learning 2) Understand the potential applications of Machine Learning in the electrical energy sector 3) Learn how to develop a Machine Learning model 4) Explore the main Machine Learning types (Supervised and Unsupervised) 5) Get used to Python coding for Machine Learning applications 6) Develop Machine Learning models for electrical energy problems
Content	1. Introduction to Big Data and Machine learning applications to the electrical energy sector. 2. Creation of a Machine Learning Model: Introduction to Python 3. Descriptive statistics 4. Supervised learning I: classification 5. Supervised learning II: regression 6. Unsupervised learning: clustering and dimensionality reduction 7. Electric power system applications

SEMESTER 3 - UNSTPB

OPTIMIZATION METHODS		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	28 h	
Tutorials	14 h	
Exam	2 h	
Total	100 h	
Instructor		Prof. Dr. Ion NECOARĂ – ion.necoara@upb.ro
Objectives		During the course, students will become familiar with the basic principles and fundamental methods used for the numerical solution of Big Data optimization problems. The course focuses on correctly formulating optimization problems—defining objective functions, constraints, and related concepts—and on acquiring core techniques for solving non-linear and large-scale numerical optimization problems relevant to energy systems. Two key components are highlighted throughout: the development of accurate mathematical models and the selection of appropriate solution methods, which together lead to optimal decisions within complex scenarios. Each chapter is accompanied by at least one application example for a better understanding. Laboratory sessions are designed to strengthen students’ ability to choose and apply suitable solution techniques, including those enhanced by Big Data analytics, to identify optimal solutions in real-world power system contexts. The labs cover all key areas of the course and extend the study to important case-specific applications. Students will also gain practical experience with MATLAB, developing proficiency in using it as a tool for modelling, simulating, and solving large-scale optimization problems involving complex datasets. A major goal of the laboratory component is to enhance students’ problem-solving autonomy and decision-making skills. Throughout the course, students are provided with rigorous theoretical foundations and well-explained examples to support their understanding. During lab work, each student is expected to independently formulate and solve optimization problems—initially using standard tools such as calculators and notes, and progressively applying algorithmic thinking and computational techniques suited for modern energy systems.
Content		Introduction: - Mathematical formulation of optimization problems for processing Big Data - Fundamental notions for optimization - Convex analysis: characterization and properties of convex sets and functions. Unconstrained optimization problems for Big Data: - Basic properties of solutions of optimization problems and of numerical optimization methods - Necessary and sufficient conditions for optimality

	Analysis of optimization methods specialized for Big Data processing: gradient method and its variants (coordinate descent, stochastic gradient), Newton method, Gauss-Newton for nonlinear least-squares. - Rules for selecting the step size (Armijo, Wolfe, backtracking) - Applications in Big Data optimization: dimensionality reduction of data, matrix factorization, clustering, estimation and regression. Constrained optimization problems: - Necessary and sufficient conditions for optimality (Kuhn-Tucker type conditions) - Methods based on penalty functions and barrier functions (interior-point methods) - Decomposition methods for large-scale separable problems: alternating direction method of multipliers and stochastic primal-dual methods Applications: - Formulation of DC/AC optimal power flow as constrained optimization problem and solving with different optimization algorithms - Applications in signal processing, machine learning and other areas: matrix completion, data classification and clustering, training neural networks.
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POWER QUALITY		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	14 h	
Tutorials	14 h	
Exam	2 h	
Total	28 h	
Instructor		Prof. Dr. Eng. Radu-Florin PORUMB - radu.porumb@upb.ro
Objectives		The course aims to train the power engineer in the field of safe and economical design and operation of both electricity distribution networks and the use of electricity and electrical installations. Addressing these issues is in the context of modernization concerns. systematization and protection of the environment, reduction of power quality disturbances and introduction of deregulation of the energy industry from the perspective of the interconnected operation with the EU and the energy market. The applications are meant to help the student to apply the theoretical notions acquired in the course. The applications consist of a variety of activities (performing measurements in the laboratory, performing simulations using specialized computer programs and performing class assignments) through which the student acquires skills that will help him to adapt later to any job. . The laboratory is developed by teams of 2-3 students to develop team spirit. The team is led by a manager appointed by the team members, thus aiming to learn human resources coordination skills. In addition to acquiring specialized knowledge, it is encouraged to learn skills such as: defining the stages of a project, consulting the literature, interpreting the results obtained, choosing a solution based on technical and economic criteria.
Content		• Identification of different types of disturbances in electrical installations : harmonics, interharmonics, asymmetries, voltage variations , flicker ; • The causes and effects of disturbances on the electrical system and on electricity consumers; • The quantification and evaluation of the damages of the disturbances on the electric energy system and on the users of electricity; • Evaluation of observability and the controllability of the electromagnetic states that define the Efficient Use of Electric Energy • Normative limits of variation of quality indicators; Normative limits of variation of quality indicators • Presentation of the possibilities of identifying disruptive consumers • Identification of disruptive consumers and their mathematical modeling

THE IMPACT OF DISTRIBUTED GENERATION ON ELECTRICITY NETWORKS		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	14 h	
Tutorials	28 h	
Exam	2 h	
Total	42 h	
Instructor		Lect. Dr. Eng. Alexandru MANDIS – corneliu.mandis@upb.ro
Objectives		The course presents basic notions regarding the distributed generation of electricity. The main systems of distributed generation of electricity, their connection schemes, as well as aspects related to their integration in electrical networks are studied. The main influences of distributed electricity generation systems on operation are analyzed electrical networks to which they are connected. The conditions that must be met for the improvement are presented functioning electrical networks in the presence of distributed generation sources. The applications aim to consolidate the theoretical knowledge transmitted during the course. Based on a class theme, the normal and disturbed operating regimes of electrical networks in the presence of distributed generation are studied and the optimization of their normal operating regimes is aimed at. Specialized calculation programs are used such as: NEPLAN, GenDist, Reconf , etc.
Content		The course begins with an introduction to the concept of distributed electricity generation, outlining the general principles behind this approach. It highlights both the advantages and disadvantages of distributed production, presents different classifications of distributed generation sources, and discusses current development directions in electricity production. The second part focuses on distributed power generation systems. It examine the technologies suited for distributed electricity production, the role of energy storage systems, and the potential of hybrid systems that combine multiple sources of generation. Attention is then given to the integration of distributed generation into electrical networks. This includes an overview of the energy conversion systems used by distributed sources, the various connection schemes available, and the specific conditions that must be met to connect distributed sources to public electrical networks. The course also addresses the calculation of steady-state operation in electrical networks with distributed generation. The ascending–descending method, specific to distribution networks, is introduced, followed by adaptations of this calculation technique for different types of distributed generators. The resulting modifications in power flow and power losses are analyzed. Voltage regulation in the presence of distributed generation is another important topic. Students learn how the connection of distributed sources can alter voltage levels within networks, as well as the strategies for coordinating different voltage regulation methods.

	The influence of distributed sources on short-circuit currents is studied through the calculation of fault currents, the evaluation of the contribution of distributed generators, and the analysis of their impact on network protection systems. The course then covers the evaluation of distributed generation capacity. This includes determining the optimal power output and location of distributed sources, assessing capacity based on voltage quality (such as voltage level and fluctuations), and considering the technical limits of the network elements. Finally, the influence of distributed sources on electricity quality is examined. Students explore the types of disturbances that can occur in power systems, the key indicators used to evaluate power quality, issues related to continuity of supply, and the operational aspects of distributed sources.
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INSULATION COORDINATION		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	14 h	
Tutorials	14 h	
Exam	2 h	
Total	28 h	
Instructor		Associate Dr. Eng . Marian COSTEA - marian.costea@upb.ro
Objectives		During the course, the students will become familiar with the notions related to the methodology of coordinating the insulation of equipment, lines and electrical stations and will acquire the ability to apply the algorithms for choosing the insulation, according to current standards and regulations. Knowing the behavior of different categories of insulations (gaseous, liquid, solid, mixed) under different dielectric stresses, the phenomena that lead to the degradation of insulations and the quantities that allow the assessment of their condition is another target of the course. In the laboratory, the students will acquire notions regarding the structure and the requirements imposed on the equipment for producing and measuring high test voltages. They will verify the behavior of different categories of insulation under high voltage stresses of a standardized form, they will understand the requirements regarding the realization of an experimental arrangement specified in in order to carry out a reproducible, industrial-type laboratory test, as well as the methodology of processing the results of a test and evaluating the insulation condition of the equipment based on these results.

Content	This course introduces the fundamentals of insulation coordination and the methods used in practice. It covers the coordination of insulation in overhead lines, including the dimensioning of insulator chains, as well as the distribution of dielectric stresses in three-phase transformer insulation. Attention is given to insulation coordination in electrical substations and the evaluation of protection zones ensured by surge arresters. Different types of insulation are studied in detail: gas insulation and its breakdown mechanisms, with dimensioning under various electric field structures; solid insulation, including breakdown processes, characteristic parameters, and diagnostic methods; and liquid insulation, with a particular focus on the environmental challenges posed by high-voltage installations.
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SCIENTIFIC RESEARCH		
Credits	10 ECTS	Semester 3 UNSTPB
Exam	2 h	
Total	168 h	
Instructor		-
Objectives		Within this discipline, students will engage in scientific research activities focused on the integration of renewable energy sources (RES) into power transmission systems, through the development of a dedicated technical-scientific project. They will apply advanced theoretical and practical knowledge from their field of study to address challenges related to system modeling, dynamic performance, and stability under varying operating conditions. The course promotes creativity and critical thinking—both essential in formulating and evaluating innovative engineering solutions. Students will learn how to design a coherent research plan, use modern simulation tools (e.g., DIgSILENT PowerFactory, MATLAB/Simulink) and analytical methods, and interpret results in the context of current energy transition needs. Through hands-on activities and guidance from academic staff, they will be encouraged to develop, simulate, and assess technical strategies that support the efficient and secure integration of renewable energy into the power grid.
Content		Literature Review and Theoretical Background • Overview of RES integration in transmission networks – technical characteristics • Centralized vs. decentralized generation • Operational challenges: intermittency, power fluctuations, lack of inertia • Grid codes and regulatory framework (e.g., ENTSO-E, national TSO requirements) System Modeling and RES Integration • Selection of a test network (IEEE 9-bus, IEEE 39-bus or simplified real grid) • Integration of renewable sources (e.g., PV, wind) into the model

	• Selection of simulation software and rationale Detailed parameterization of components Power Flow Analysis and Impact Evaluation • Steady-state power flow simulations with and without RES • Identification of critical operating points (overloads, voltage imbalance) Comparison of different RES penetration levels (10%, 30%, 50%) Stability Analysis • Voltage and frequency stability analysis • Time-domain simulation of small and large disturbances Inverter behavior, frequency response, and fault ride-through mechanisms Fault Ride-Through and Protection Interaction • Simulation of single-phase and three-phase faults • Behavior of RES units during and after faults Interaction with protection schemes (distance relay, under/over-voltage and frequency protection) Solution Proposal for Improved Integration • Introduction of energy storage systems • Advanced inverter control (e.g., virtual inertia, power curtailment) Redispatch strategies and coordination with grid operators Final Report and Presentation • Drafting the final research report • Formulation of conclusions and technical recommendations Preparation of oral presentation and graphical materials
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ENERGY STORAGE SYSTEMS (optional)		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	14 h	
Tutorials	28 h	
Exam	2 h	
Total	42 h	
Instructor		Prof. Dr. Ing. Mihai-Vasile SANDULEAC - mihai.sanduleac@upb.ro
Objectives		The course aims to train future specialists in the field of electric energy storage technologies and technologies related to the electric vehicle, from the point of view of storage and the influence on the energy system.
Content		The course explores the changing energy paradigm enabled by storage technologies and electric vehicles. It presents the classification of storage systems and examines technologies for medium- and long-term storage, as well as short- and very short-term storage solutions and their applications. The role of storage in supporting low-carbon power systems is analyzed, alongside an introduction to electric vehicles, their history, storage technologies, performance, and future perspectives. The course also discusses charging stations, their impact on power systems, and the integration of storage and electric vehicles into smart cities and communities, with extensions to trains, aviation, and naval applications. Finally, it addresses system architectures and networks that rely heavily on storage, such as microgrids and prosumer-based systems.

DISTURBANCES AND ELECTROMAGNETIC EMISSIONS IN INDUSTRIAL INSTALLATIONS		
(optional)		
Credits	4 ECTS	Semester 3 UNSTPB
Lectures	14 h	
Tutorials	28 h	
Exam	2 h	
Total	42 h	
Instructor		Associate Phd. Eng. Marian Costea - marian.costea@upb.ro
Objectives		The course aims to engage the students in activities related to identifying and characterizing the sources of electromagnetic disturbances, artificial and natural, which can act on the weak current components of an electrical installation.
Content		The course will enable students to understand and model the non-functional electromagnetic emissions produced by electrical installations and the technical ways of reducing their level at the source, as well as the methods and technical means applicable to ensure the electromagnetic immunity of the equipment in an electrical installation. Students will acquire a series of practical knowledge aimed at the characterization and evaluation through measurements of different categories of disruptive electromagnetic emissions, conducted and radiated, of low and high frequency and they will be able to practically verify the effectiveness of the methods and means of ensuring electromagnetic immunity to conducted and radiated disturbances