REM master basic syllabus

Title:
502153 Operation of transmission and distribution networks

Credit value:
3 ECTS

Mandatory/Optional:
Mandatory

Semester:
2

Lecturer/s:
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University:
Universidad del País Vasco UPV/EHU

Department:
Department of Electrical Engineering

Rationale:
This course intends to analyze the operation and planning of transmission and distribution networks. This way, classical aspects regarding network operation, the different network states and their main features will be analyzed. New stakeholders, procedures and technologies will be studied. These aspects are currently being developed and will affect future network definition and operation. Special stress will be put on Smart Grids.

Objectives:
The main objective of the course is to provide students with the knowledge of the operation of distribution and transmission grids.

Skills: *(according to the list of skills provided)*

Subject skills	More Master Skills						
	L2.1	L2.2	L2.3	L2.4	L2.5	L2.6	L2.7
L3.1. To explain and demonstrate knowledge and understanding of the network operation principles, identifying the most significant parameters and understanding the causes of large disturbances and incidents of Power Systems.	X						
L3.2. To analyze, summarize and employ the theoretical concepts of lectures in order to solve numerical problems and practical questions, being able to understand both qualitatively and quantitatively the obtained results.		X			X		
L3.3. To acquire new skills, organize information and make effective reports						X	X
L3.4. To use communication skills in various forms: group discussion and exhibition						X	

Teaching and learning methods:
The course methodology includes various techniques as individualized and group learning methodology, combining both throughout the whole learning process. Lectures, essays, field visits and tutorials will be used:
1. Lecture format with oral and audiovisual presentations.
2. Together with the lectures, essays carried out in small groups related to some aspect developed in lectures will be developed.
3. Field visits will allow to verify the theoretical concepts analyzed in lectures.
4. Individual monitoring of the learning process is done through mentoring.

Allocation of student time:

	Attendance (classroom, lab,…)	Non attendance (lecture preparation, self study…)
Lectures	16 hours	16 hours
Field visits	4 hours	4 hours
Essays	10 hours	25 hours

Assessment:

Procedures for assessment of the course are:
1. Through assistance and active participation in class.
2. Through assistance and reports of field visits.
2. By conducting group work
3. By conducting a final exam.

Assessment Matrix:

Subject skills	Assessment method					
	Exam	Presentation	Essays	Report	…	…
L3.1.	50%		25%	25%		
L3.2.	50%		50%			
L3.3.			75%	25%		
L3.4.		100%				

Programme:

Lesson 1	***Transmission network operation*** Introduction, Power System, Energy Management System (EMS), Transmission system states and Ancillary services. *Distribution (4 h theory)*
Lesson 2	***Distribution network operation*** Network states, Demand characterization, Network infrastructures, Demand forecasting, Connection point determination, Management of demand supply connection applications, Development and planning criteria of distribution networks, Installations, Maintenance, Functioning criteria, Information, Emergency and Reliability indexes. *Distribution (2 h theory)*
Lesson 3	***Smart grids*** Definition, Characteristics, Solutions, Virtual Power Plants (VPP), Demand Side Management, Electric Vehicle, Prosumers and DMS Tools. *Distribution (2 h theory)*
Lesson 4	***Large disturbances*** Introduction and Case studies. *Distribution (3 h theory)*
Lesson 5	***Fault current limiters*** Introduction, Fault Current Reduction and Classification. *Distribution (1 h theory)*
Lesson 6	***HVDC grid operation*** Introduction, Topologies, HVDC Technologies, VSC-HVDC system operation, Faults in

	VSC-HVDC systems and HVDC grids. *Distribution (4 h theory)*

Resources:

Classrooms, Blackboard, laptop, projector, audio, computer room, laboratory, security issues,…
All the material necessary to follow the course is facilitated by teacher of the subject during the course development, through eGela platform (https://egela.ehu.eus/).
The resources used include: A suitable classroom for small group activities; blackboard; laptop with projector; photocopies; library; a computer room.

Bibliography:

Basic textbooks:
[1] A. Gómez Expósito, "Análisis y operación de sistemas de energía eléctrica", McGraw-Hill, 2002.
[2] A.J. Wood, B.F. Wollenberg, "Power generation, operation and control" John Wiley & sons, inc. EEUU, 1996.
[3] R. Allan y R. Billinton, "Probabilistic assessment of power system", proceedings of the IEEE, vol 82(2), pp 140-162, Feb. 2000.
[4] CIGRE task force 38.05.05, "techniques for power system planning under uncertainties", CIGRE abril 2000.
[5] EN 50160. Voltage characteristics of electricity supplied by distribution systems. Nov. 1994
[6] T. Gönen, "Modern power system analysis", Wiley, 1988.
[7] P. Anderson, "Analysis of faulted power system", Iowa state univ. press, 1978.
Deepening bibliography:
[8] C.R. Mason, "The art and science of protective relaying" GE publication, 1998.
[9] N. Hatziargyrius et al. "Control advice for power systems with large-scale integration of renewable energy sources". Proceedings of TE EWEC´99. Niza 1999.
[10] P. Kundur "Power system stability and control". McGraw-Hill, 1994.
[11] R. Criado et al. "Real experience in the connection of wind power production in distribution network", CIRED Proceeding, jun. 1997.
[12] P. Montane, "Protecciones en las instalaciones electricas". Marcombo, 1993.
[13] Stevenson, "Análisis de sistemas de potencia". McGraw-Hill, 1996.
[14] R. D. 1955/2000 por el que se regulan las actividades de transporte, distribución, comercialización, suministro y procedimientos de autorización de instalaciones de energía eléctrica. BOE 1 dic. 2000.
[15] Comité de distribución- comision tecnica UNESA "Guía sobre la calidad de la onda en las redes eléctricas, UNESA
[16] A. Medina, J. de la Casa, F. Jurado "Generación de Energía Eléctrica con Sistemas Fotovoltaicos conectados a la red". Printex SL. ISBN 978-84-92669-20-2. 2010
[17] J. Amantegui "monitoring, metering, recording and overall power system protection". CIGRE, AG5.3 report, 2006.
[18] "Electrical transmission and distribution reference book", Westinghouse electric corporation, 1964
[19] Larsson et al. "systems protection schemes in power networks". WG. 38. 02. 19, 2000.
[20] I. Rouco "Analisis y operación de sistemas de energía eléctrica". capitulo 10: "Estabilidad de ángulo y tensiones", McGraw-Hill, 2002.
[21] I. Zamora, J.F. Miñambres, J.M. Gallastegui, "Supervisión y ensayo de reles de protección" protecciones de los sistemas eléctricos de potencia. Iberdrola instituto tecnológico, 1994, pp. 401-423.
[22] J.L. Sancha "Common protection criteria in the spanish power system. A new dynamic analysis approach". CIGRE, 34-205, 1998. M. Van Der Meijden. "Asset management of transmission Systems and associated CIGRE activities, CIGRE, B 335, 2006.
[23] J. Amantegui "Utilities approach to protection and control refurbishment", CIGRE, 34-208, 2002.
[24] J. Amantegui "Characterisation of voltage dips in electrical network and their impact on customer installations" CIGRE, 36-104, 1998.
[25] J. Amantegui "First project within Iberdrola group using IEC 61850 for a complete substation. Final experiences and future expectations", CIGRE b5-108, 2006.

[26] A. Janssen “Changing network conditions and system requierements. Part I: the impact of distributed generation on equipment rated above 1 kV” CIGRE 3-335, 2006.
[27] Mackey “Optimisation of protection performance during systems disturbances”, CIGRE WG 34.09 final report, 2002.

Further comments: