

Faculty of Electrical Engineering / / FACTS and HVDC power electronic components

Course:	FACTS and HVDC power electronic components			
Course ID	Course status	Semester	ECTS credits	Lessons (Lessons+Exercises+Laboratory)
13272	Mandatory	3	4	3+1+1
Programs				
Prerequisites	There are no prerequisites with other subjects.			
Aims	The course is designed to familiarize students with flexible systems for the control of alternating voltages and currents (FACTS), as well as with high-voltage direct current systems (HVDC).			
Learning outcomes	Upon completion of this course, the student will be able to: - Understand the working principles of flexible systems for voltage and current regulation, - Understand the operation of HVDC systems, - Predict the negative impacts of the elements of the HVDC system on the network, - Perform a selection of HVDC and FACTS system configurations.			
Lecturer / Teaching assistant	Assistant prof Martin Čalasan, MSc Mihailo Micev and MSc Milos Jelovac			
Methodology	Lectures, calculation exercises, demonstrative examples. Consultations.			
Plan and program of work				
Preparing week	Preparation and registration of the semester			
I week lectures	Introduction to FACTS and HVDC systems. High-power semiconductor elements.			
I week exercises	Synchronous machines, asynchronous machines, and transformers as consumers/producers of reactive energy.			
II week lectures	Devices for compensation of reactive energy. Static compensation devices. Synchronous compensator.			
II week exercises	Devices for compensation of reactive energy. Static compensation devices. Synchronous compensator.			
III week lectures	Parallel compensation. Basic principles of compensation. Thyristor-controlled reactance (TCR). Thyristor switched capacitors (TSC).			
III week exercises	Parallel compensation. Basic principles of compensation. Thyristor-controlled reactance (TCR). Thyristor switched capacitors (TSC).			
IV week lectures	Series compensation. Thyristor-controlled series compensators (TCSC). Thyristor switched series compensators (TSSC).			
IV week exercises	Series compensation. Thyristor-controlled series compensators (TCSC). Thyristor switched series compensators (TSSC).			
V week lectures	Regulation transformers. Thyristor-regulated transformers.			
V week exercises	Regulation transformers. Thyristor-regulated transformers.			
VI week lectures	Colloquium			
VI week exercises	Colloquium			
VII week lectures	Introduction to HVDC systems. Comparison of AC and DC transmission systems.			
VII week exercises	Introduction to HVDC systems. Comparison of AC and DC transmission systems.			
VIII week lectures	Current and voltage-controlled converters. Line-commutated converters. Harmonicas. Basic topologies.			
VIII week exercises	Current and voltage-controlled converters. Line-commutated converters. Harmonicas. Basic topologies.			
IX week lectures	Multilevel DC/DC conversion.			
IX week exercises	Multilevel DC/DC conversion.			
X week lectures	Line-commutated current controlled converters (CSC). Components of the CSC HVDC system. CSC-HVDC system configurations. Control of the CSC HVDC transmission system.			
X week exercises	Line-commutated current controlled converters (CSC). Components of the CSC HVDC system. CSC-HVDC system configurations. Control of the CSC HVDC transmission system.			
XI week lectures	Line-commutated HVDC topology.			

XI week exercises	Line-commutated HVDC topology.					
XII week lectures	Voltage-controlled HVDC systems (VSC). Components of the VSC-HVDC system. Configurations of VSC HVDC systems. Management of the VSC HVDC transmission system.					
XII week exercises	Voltage-controlled HVDC systems (VSC). Components of the VSC-HVDC system. Configurations of VSC HVDC systems. Management of the VSC HVDC transmission system.					
XIII week lectures	VSC and CSC multi-level HVDC systems.					
XIII week exercises	VSC and CSC multi-level HVDC systems.					
XIV week lectures	Grounding of the HVDC system.					
XIV week exercises	Grounding of the HVDC system.					
XV week lectures	Colloquium					
XV week exercises	Colloquium					
Student workload						
Per week			Per semester			
4 credits x 40/30=5 hours and 20 minuts 3 sat(a) theoretical classes 1 sat(a) practical classes 1 excercises 0 hour(s) i 20 minuts of independent work, including consultations			Classes and final exam: 5 hour(s) i 20 minuts x 16 =85 hour(s) i 20 minuts Necessary preparation before the beginning of the semester (administration, registration, certification): 5 hour(s) i 20 minuts x 2 =10 hour(s) i 40 minuts Total workload for the subject: 4 x 30=120 hour(s) Additional work for exam preparation in the preparing exam period, including taking the remedial exam from 0 to 30 hours (remaining time from the first two items to the total load for the item) 24 hour(s) i 0 minuts Workload structure: 85 hour(s) i 20 minuts (cources), 10 hour(s) i 40 minuts (preparation), 24 hour(s) i 0 minuts (additional work)			
Student obligations						
Consultations						
Literature			1. M. Čalasan, "Kompenzacija reaktivne energije u EES", Elektrotehnički fakultet Podgorica, skripta, 2021. godine 2. M. Čalasan, "HVDC sistemi", Elektrotehnički fakultet Podgorica, skripta, 2021. godine 3. R.M. Mohan, K.V. Rajiv, Thyristor based FACTS controllers for electrical transmission systems, IEEE Press, 2002. 4. J. Arrillaga, Y.H. Liu, N.R. Watson, Flexible Power Transmission- The HVDC Options, John Wiley & Sons Ltd, 2007.			
Examination methods			Test I - 50 points, Test II - 50 points.			
Special remarks			No			
Comment			If necessary, classes can also be conducted in English.			
Grade:	F	E	D	C	B	A
Number of points	less than 50 points	greater than or equal to 50 points and less than 60 points	greater than or equal to 60 points and less than 70 points	greater than or equal to 70 points and less than 80 points	greater than or equal to 80 points and less than 90 points	greater than or equal to 90 points