RĪGAS TEHNISKĀ UNIVERSITĀTE

RTU Course "Principles of Protective Relaying of Electric Power Systems"

33000 Faculty of Computer Science, Information Technology and Energy

General data

Code	DE0633
Course title	Principles of Protective Relaying of Electric Power Systems
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Aleksandrs Dolgicers
Academic staff	Tatjana Lomane Jevgeņijs Kozadajevs Ivars Zālītis
Volume of the course: parts and credits points	1 part, 6.0 credits
Language of instruction	LV, EN
Annotation	The study course provides professional knowledge on the basic issues of protective automation of modern electric power systems. During the study course, students will receive the knowledge, necessary to design and implement basic types of protection, such as overcurrent, differential (pilot-wire), and distance protection. The design aspects of relay protection for lines, transformers, generators, motors, buses are considered. The study course also concerns problems of protection optimisation and coordination.
Goals and objectives of the course in terms of competences and skills	The goal is to introduce students to the principles of fault protection of power systems, it's settings and operation. Task: to develop basic skills of students in the selection of anti-accident automation equipment, estimation and coordination of settings.
Structure and tasks of independent studies	Practical tasks on fault modelling, settings selection for protection devices. Preparation of laboratory work, processing and evaluation of results.
Recommended literature	Obligātā/Obligatory: 1. J. Putniņš. Elektroapgādes sistēmas relejaizsardzība un automātika. -Rīga: Zvaigzne, 1993. -416 lpp. 2. Anderson, P.M Power System Protection, Piscataway: Willey-IEEE Press, 1998. 3. J. Lewis Blackburn, Thomas J.Domin Protective Relaying. Principles and application. CRC press, 2007 4. Ziegler Gerhard Numerical Distance Protection. Principles and application. Siemens AG, 2005 5. Donald Reimert Protective relaying for power generation systems. CRC Press, 2006. 6. Christophe Prévé Protection of electrical networks ISTE Ltd, 2006 7. Network Protection & Automation Guide(2011) Alstom Grid France May 2011 ed. 8. ABB Distribution Automation Handbook (2010) ABB Oy, Distribution Automation Finland 1MRS757284 9. ABB Transformer protection RET670 Technical reference manual Document ID: 1MRK 504 113-UEN 2010 10. Line distance protection REL650 ANSI application manual (2011) IEEE Transactions on Applied Superconductivity ABB 11. Zalitis, I., Dolgicers, A., Kozadajevs, J.A. Distance protection based on the estimation of system model parameters 2017 IEEE Manchester PowerTech, Powertech 2017, art. no. 7981277 Papildu/Additional: 1. X. Luo, C. Huang, Y. Jiang and S. Guo. An adaptive three-phase reclosure scheme for shunt reactor-compensated transmission lines based on the change of current spectrum. Elsevier Electric Power Systems Research, vol. 158, May 2018, pp. 184–194. ISSN: 0378-7796. Available from: https://doi.org/10.1016/j.epsr.2018.01.011 203 2. B. Papkovs, I. Zicmane, Elektromagnētiskie pārejas procesi elektriskās sistēmās. Rīga: RTU Izdevniecība, 2007, 306 lpp. ISBN 978-9984-32-3. 3. G. I. Atabekov. The Relay Protection of High Voltage Networks, London: Pergamon Press, 1960, p. 576. 4. A. Dolgicers and I. Zalitis. Numerical calculation method for symmetrical component analysis of multiple simultaneous asymmetrical faults. In: Proceedings 2017 IEEE 58th International Scientific Conference on Power and Electrical Engineering of Riga Technical University.
Course prerequisites	Electrical networks and systems

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Study course tasks and basic concepts: power system faults. Tasks and methods of protection. The concept of a relay. Criteria for the assessment of the protection.	2	0	0	0
Basics of calculus the parameters of the fault regime. Fortesque transformation, application conditions.	8	6	0	0
Faults in the network with effectively grounded neutral. Analysis of the impact of the transient resistance.	2	2	0	0
Faults in the network with isolated and compensated to neutral. Fault on the customers side of transformer.	4	4	0	0

Current sensors, measurement errors.	2	0	0	0
Voltage sensors.	2	0	0	0
Overcurrent protections.	6	6	0	0
Combined protections.	2	4	0	0
Directed overcurrent protection.	2	12	0	0
Earth fault protection.	4	8	0	0
Distance protection.	8	12	0	0
Pilot wire protection.	4	2	0	0
Special protections for generators.	2	2	0	0
Special protections for synchronous motors.	2	2	0	0
Special protections for asynchronous motors.	2	4	0	0
Transformers protection.	2	8	0	0
Minimal voltage protection.	2	4	0	0
Out-of-step condition and prevention automation.	2	6	0	0
Autoreclosing and automated reserve connection.	2	6	0	0
Fault location.	2	8	0	0
Basics of protective exploitation and development trends.	2	0	0	0
Total:	64	96	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Is able to formulate the tasks of the protective equipment, operate with quality criteria such as sensitivity, selectivity, reliability.	Test, defense of course project, examination.
Is able to calculate currents and voltages at the point of fault and at the place of installation of protection in case of a single fault.	Check tasks, defense of course project, at the exam – test task.
Is able to formulate operating principles and identify the application area for overcurrent protection with and without power direction, zero sequence maximal current protection with and without polarisation.	Practical tasks (includes defense of laboratory works), defense of course project, at the exam – test task.
Is able to formulate operating principles and identify the application area for distance and differential (pilot wire) protection.	Test task, exam.
Is able to formulate operating principles and identify the application area for the protection of generators, synchronous and asynchronous motors.	Test task.
Is able to identify protected zones, select protection settings and assess their sensitivity.	Test task, exam.
Is able to analyse time-current, time-resistance characteristics, is able to synthesize them by coordination of protections.	Defense of course project, practical tasks (includes defense of laboratory works), test task, at the exam – test task.
Is able to analyse characteristic curves in the complex resistance, plane to understand the basics of their synthesis.	Practical work (includes defense of laboratory works), defense of course project.
Is able to evaluate the joint operation of several protections as a united system.	Practical tasks.
Is able to analyse out of step condition's parameters and select prevention automation settings.	Practical tasks, test.
Is able to analyse parameters and select reclosing automation settings.	Practical task (includes defense of laboratory works), exam.

Evaluation criteria of study results

Criterion	%
Laboratory works	20
Exam	30
Practical tasks and tests	20
Course project	30
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	6.0	32.0	16.0	16.0		*	