University Course

Power System Protection

at Graz University of Technology

§ 1 Description of the qualification

1. Goals of the university course

Electrical power and energy are not only an essential production factor in industrial and commercial processes, but are also critical for maintaining the quality of our civilization. The process of delivering electrical power and energy has to meet the imperative to be as safe as possible, as well as highly reliable. Reliability of power distribution, in the sense of continuity and security of supply, also has to be balanced with economic considerations.

In addition, digitalization has given rise to new topics in protection engineering; it has influenced the technology of power system devices and the associated parameterization and testing methods so that we now have new approaches to supplying electricity at local and higher levels, improved network calculation methods, digital protection processes, and more.

In electrical installations and networks faults can develop under the influence of external disruptive factors or internal problems (e.g. due to ageing), and faults can, unless the affected systems are rapidly and selectively isolated, lead to severe and long-lasting power outages or even blackouts.

In order to prevent such events, high-quality protection systems are needed. These must be designed in accordance with proven and innovative protection strategies, and they must be installed and operated correctly. These tasks make up the profession of the protection engineer.

To carry out these complex tasks competently, protection engineers need a thorough knowledge of electrical fundamentals such as fault calculations, and also a profound understanding of the operation of electrical systems under both normal and faulty operating conditions.

The main goal of the course is for the participants to know how to use state-of-the art technology for operating and testing protection equipment; this is an essential part of the competence of highly-qualified protection engineers.

The course topics include an introduction to the essential requirements for a protection system, fault calculation for single- and multi-pole fault cases, a presentation of the different protection strategies, such as timed cascades of protective devices, and typical combinations of the different device types. The course concludes with a section on system protection.

2. Who the course is for

The university course is designed primarily for people who have a basic qualification in electrical power engineering and are looking for specialized training in electrical power system and protection engineering.

Participants who successfully complete the course will have a sound knowledge of protection engineering which they can draw on in their further professional development towards working as protection engineers for distribution networks and power systems.

What makes this course unique is that it is designed as a specialized, practically oriented training for professionals already working in a relevant field.

3. Career opportunities

People who complete this course successfully will take up positions of responsibility in companies in the electrical power industry (grid operators, suppliers, engineering firms, etc.) in which they are responsible for the design and operation of electrical power systems, since the broad approach of the course will enable them not only to plan and implement protection concepts, but also to carry out critical assessments of diverse aspects of protection engineering.

4. Learning goals

The graduates of the university course are competent to develop and implement a suitable protection concept for a particular power system, taking account of the relevant optimization parameters.

They are able to correctly identify known and potential fault cases in the operation of power networks and can make recommendations on quality assurance of electricity power supplies in the event of fault conditions.

They are able to simulate the effects of individual protective devices in the context of a complete protection system and to apply the results correctly in practice.

5. Teaching and learning concept

The university course is provided in the form of e-learning. The participants will watch short videos, supported by notes that summarize the content and a catalogue of focus questions.
Self-tests on the individual videos give the participants instant feedback.
Building on the basic principles, the practical knowledge will be presented in five 2-hour webinar units.
The acquired knowledge will be applied in individual work on realistic examples. After these are submitted, there will be two 2-hour online question-and-answer sessions which will serve as preparation for the written examination.

6. Assessment concept

Before the course participants take the examination, they have successfully answered the feedback questions to all the e-learning videos.
In the personalized examination, the participants are asked to give handwritten answers to around five questions chosen at random from the abovementioned catalogue of focus questions. The participants send these to TU Graz in electronic form immediately after they have answered them. Following that, there is an individual, oral online

examination lasting around 15 minutes. The final grade is based on both the written and oral parts of the examination.

§ 2 Duration, structure and workload (in ECTS credits)

The course has a workload of 125 real hours (corresponding to 5 ECTS). It takes place over a period of approximately 3 months and is divided into 4 phases, consisting of online contact periods and self-study, as described in detail in § 4.

§ 3 Admission criteria and selection process

The language of instruction is English. German upon request.
The requirement for admission to the university course is a basic professional qualification in the subject, for example graduation from a Higher Technical Education Institute (HTL) in the subjects of electrical power engineering, telecommunications engineering, measuring and control engineering, or a relevant qualification from a University of Applied Sciences (Fachhochschule).
The decision on admission to the course is taken by the course director based on the applicants' qualifications.

Maximum number of participants: 20

§ 4 Course plan

The course is organized in 4 phases, each of which builds on the previous one:

Phase	Workload in hours	ECTS
Phase 1 Learning the contents of 25 short videos ("nuggets") of 6 minutes each, with the possibility to repeat each video and carry out further reading, and answering the feedback questions on each video.	**37,5**	**1,5**
Phase 2 Consolidation of the previous content using the course notes, as preparation for the webinar. Participation in the webinar in 5 units of 120 minutes each, with a further phase of self-study to reach a deeper understanding of the content and practice applying the concepts.	**25**	**1,0**
Phase 3 Completion of case exercises and submission of the answers by the participants, followed by a submission/feedback interview with the instructor.	**25**	**1,0**
Phase 4 Revision of the course contents in self-study. Participation in 2 Q&A sessions of 120 minutes each as examination preparation and to deal with any unanswered questions. Preparation for the examination in self-study.	**37,5**	**1,5**

The contents of the course are divided into six sections:

1. System aspects

- Systems and security of power supply
- Short-circuit calculations
- Faults and grid availability
- Risk management
- Probability of coincidence
- Network fault dynamics, reliability indicators for protection and the grid

2. Overcurrent protection

- Overcurrent protection and fault dynamics
- Fundamentals of overcurrent protection
- time grading of protective devices
- Overcurrent protection in ring structures
- time grading for transformers
- Zone interlocking
- Selectivity of the overcurrent protection, fault localization
- Overcurrent back up protection

3. Differential protection

- Fundamentals of differential protection

4. Ground fault protection

- Ground fault protection and neutral point treatment
- Ground fault dynamics and stationary behaviour
- Ground fault calculation
- Ground fault relays - wattmetric relays
- earth path return factor (k0 factor)

5. Distance protection

- Fundamentals of distance protection
- Fundamental selectivity and cascading
- Signal comparison

6. Fault behaviour

- Fault types and fault analysis
- Vector groups in transformers
- Faults behind different transformer vector groups
- Current transformers

§ 5 Examination regulations

The decision on passing or failing the examination rests with the instructor.
The overall grade is composed of the following components by percent:

- Self-tests as described in § 1 no. 5 20%
- Working-out of the application cases 20%
- Written answers to the examination questions 30%
- Oral examination 30%

In the event of a negative examination result (fail), it is possible to repeat the written and oral examination. The repeat examination must take place within one year after the end of the course, at the latest.

§ 6 Certificate

On successful completion of the university course, a certificate is issued by TU Graz.

§ 7 University course fee

The fee for the university course covers only the costs of the university course as specified in § 8 for the course teaching and related activities. The applicable course fee is shown in the current information on the website of TU Graz Life Long Learning.

§ 8 Costs of the university course

The costs of the university course are composed of the costs of the instructors and the other expenses for the management and organization of the course, etc. The university course can only be held when the necessary budget corresponding to these costs is available.

§ 9 Performance of the university course

Organizationally, the university course is conducted by the Institute of Electrical Power Systems of TU Graz in cooperation with TU Graz Life Long Learning.

§ 10 Entry into force

The curriculum enters into force on the day after it is published in the Gazette of TU Graz.

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Vice Rector for Academic Affairs

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