EE4040 Power System Protection and Control I

1. Course title: Power System Protection and Control I

2. Course ID: EE4040

3. Credits: 3(3-1-0-6)

Theory: 45hours
Exercise/Assignment: 15hours

4. Intended attendee:4th year electrical engineeringstudents

5. Requirement:

Pre-requisites: Electrical network (EE4010)
Preparatory: Short-circuit Calculation (EE4020)
Co-requisites: null

6. Expected Learning Outcomes

The main objective of the course is to provide an overview of the principles and schemes for protecting power lines, transformers, buses and generator. It also provides basic guidelines for relay setting calculation.

Upon successful completion of this course, students will be able to:

Comprehending basic protection principles in power system
Applying and analyzing protection schemes for main equipment in power system
Perform setting calculations for protection relays.

The student will also have increased his/hers abilities to:

Work independently and in groups,
Use effectively presentation tools and perform basic teamwork skill.

Contribution to program outcomes:

Outcomes	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	4.1	4.2	4.3	4.4	4.5
Level	U	T	T	U	T	I	U	U	T	U	U	I	I	T	T	T	T

7. Course topics:

Main component of protection systems.Protective voltage and current instruments.Protection principles. Protection schemes for main equipment in power system: distribution and transmission lines; power transformers, generators; motors, busbars; capacitor and reactor banks.

8. Textbooks and references:

Textbooks:

- Power System Protection, Tran Dinh Long, Science and Technics Publishing House, 2000
- Power System Automation, Tran Dinh Long, Hanoi University of Science and Technology Publishing House, 2004

References:

- Power System Protection, Paul M. Anderson, Wiley-IEEE Press, 1999.
- Protective Relaying Theory and Applications, Walter A. Elmore, CRC Press, 2003.
- Power System Relaying, Stanley H. Horowitz, Arun G. Phadke, John Wiley & Sons, 2008.

9. Learning methods and activities:

Course attendance: in compliance with general regulation

Exercise/Assignment: complete all assigned homework.

10. Grading plan: Progress (0.3)-Final Exam(TL: 0.7)

Coursework will be weighted as follows:

Progress evaluation: weighting factor of 0.3

- At least 6 homework (topic may vary yearly).

Final written exam: weighting factor of 0.7

11. Tentative Schedule

Week	Topic/Activity	Chapter	Note
1	General phylosophy Requirements for power system protection system Main components of power system protection Needed information for power system protection design	Introduction chapter	
2	Fault and abnormal operating condtions of power system	Chapter1	
3	Specification of main components of power system protection ● Current transformer ● Voltage transformer ● Sequence component filter ● Auxiliary power supply ● Relay ● Communication chanels	Chapter2	Homework
4	Protection principle utilized in power system: ● General introduction to protection principle ● Overcurent protection	Chapter3 3.1, 3.2	
5	● Overcurent protection& Under voltage protection	Chapter3 3.3,3.4	Homework

	● Differential protection		
6	● Phase comparison protection ● Under impedance protection	Chapter3 3.5, 3.6	
7	● Directional overcurent protection ● Sequence conmponents of voltage and current ● Frequency protection ● Other protection principles	Chapter3 3.7, 3.8, 3.9, 3.10	Homework
8	Protection of main equipment in power system: ● Transmission and distribution lines protection ○ General introduction ○ Application of overcurrent protection ○ Application of differential protection	Chapter4 4.1, 4.2, 4.3	
9	○ Application of distance (under-impedance) protection ○ Directional comparison protection ○ Earth fault protection in un-earthed system	Chapter 4 4.4, 4.5, 4.6	Homework
10	○ Auto reclose	Chapter 4 4.7	
11	○ Load shedding	Chapter 4 4.8	
12	● Power transformer protection	Chapter 4 4.9	Homework
13	● Busbar protection ● Capacitor bank and reactor bank protections	Chapter 4 4.10, 4.11	
14	● Generator protection	Chapter 4 4.12	Homework
15	● Motor protection	Chapter 4 4.13	

EE3420 Power Supply System

1. Course title: Power Delivery System

2. Course ID: EE3420/EE3420E

3. Credits: 3(3-1-0-6)

Theory: 45hours
Exercise/Assignment: 15hours

4. Intended attendee: 3th year electrical engineering students

5. Requirement:

Pre-requisites: Circuit Theory (EE2020)
Preparatory: Electric Machines (EE3140)
Co-requisites: null

6. Expected Learning Outcomes

Provide learners with general introduction about electrical system configuration, basic techno-economic calculations in the design and operation of power supply systems, electrical calculations in medium voltage and low voltage power systems.

Upon successful completion of this course, students will be able to calculate, design and operate the power supply system to ensure the load requirements. The student will also have improved his/hers abilities to Work independently and in groups.

Contribution to program outcomes:

Out-comes	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	4.1	4.2	4.3	4.4	4.5
Level	U	T	T	U	T	I	U	U	T	U	U	I	I	T	T	T	T

7. Course topics:

Power System Introduction, Power delivery system. Electric Loads, Econimical Evaluation, Distribution system topologies, distribution system modeling and steady-state analysis, fault calculations, Selection of Electric Equipment, Voltage Consideration, Capacitor Application, Distribution System Protection, Lighting system calculation.

8. Textbooks and references:

Textbooks:

- Cung cấp điện cho xí nghiệp công nghiệp. A.A. Fedorov, NXB Năng lượng Maxcơva, 1981 (bản tiếng Nga).
- Thiết kế cấp điện, Ngô Hồng Quang, Vũ Văn Tẩm, NXB KHKT 2010.

References:

- Turan Gonen, Electric power distribution system engineering, McGraw Hill, Inc., 1986
- T. A. Short, Electric power distribution equipment and systems, CRC Press, 2006.
- Schneider Electric, Electric Installation Guide according to IEC international standards, 2016.
- ABB Switchgear Manual, ABB Calor Emag Mittelspannung GmbH, Ratingen, 2004.

9. Learning methods and activities:

Course attendance: in compliance with general regulation
Exercise/Assignment: 1.

10. Grading plan: Progress (0.3)-Final Exam (TL: 0.7)

Coursework will be weighted as follows:
Progress evaluation: weighting factor of 0.3
- One Assignment

Final written exam: weighting factor of 0.7

11. Tentative Schedule

Week	Topic/Activity	Chapter	Note
1	Introduction to Power System ● Power Generation (Hydro-power, thermal, atomic, wind, Solar, Centralized vs Distributed) ● Power Transmission and Distribution (Voltage, mission and functions) ● Fundamental Requirement (Designs, operation) Introduction to Power Delivery ● Power Delivery vs Power Distribution ● Distribution Configurations (Primary and Secondary, Three-phase and single phase, Industrial-Urban-Rural distribution system configuration) ● Power Distribution Planning (General procedures)	Chapter 1	
2	Load conception (Demands, conductor heating by load current, load types) Load Characteristics (Load Curve, Power ratings, Factors)	Chapter2	
3	Methods of Load Estimation ● Individual Customer Load (Demand, Max demand, Average demand, load factor) ● Groupe of Loads (Diversified demand, Max diversified demand, max coincident demand,	Chapter2	Homework

	density factor, demand factor, utilization factor, load density) ● Feeder load (density factor, load survey, feeder max demand) ● System load Demand Forecasting ● Trending methods ● Simulation methods		
4	Economic analysis ● Introduction to costs: Capital cost, O&M cost ● Methods for economic analysis: Annual cost function, Life-cycle cost	Chapter 3	
5	Distribution System Configuration Introduction (Mission and goals, System Layout and its interaction with reliability) ● System Sources: Source sizing, Source location ● Feeder Arrangement: Radial feeder (big trunk, multi-branch, mixed), Loop feeders, Feeder networks, Dual-voltage feeder (radial, loop) ● Bus Arrangement in Substations: Single Busbar without Separation, Single Busbar with Sectionalizer, Double Busbar Arrangement	Chapter 4	
6	Steady-state calculations of power delivery system ● Equivalent Circuits: Line equivalent circuits and application, Transformer equivalent circuits and application ● Techno-economic indices: Voltage drops, Power and Energy Losses ● Calculation of Techno-economic indices	Chapter 5	Homework
7	● Calculation of Techno-economic indices	Chapter 5	
8	Fault Calculations ● Introduction (phenomena, types, characteristics,applications, Per-unit Calculation) ● 3 phase fault calculation for Primary System (Medium voltage) ● 3 phase fault calculation for Secondary System (Low voltage)	Chapter 6	Homework
9	Electric equipment Sizing Introduction (Requirement)	Chapter 7	

	Conductor Sizing ● Allowable Ampacity (Derating due to number of conductors, ambient temperature) ● Allowable voltage drop ● Conductor sizing economics (Economical loading ranges) Transformer sizing ● Number of transformers per substation ● Transformer rating ● Optimal loading for substation transformers		
10	Selection of Electric Equipment ● Circuit breaker (ratings) ● Switch (ratings) ● Fuse and Fuse-Switch combined Power delivery system protection ● Introduction (fundamental requirement, general configuration of a protection system, protection classification)	Chapter 7 & Chapter 8	
11	● Overcurrent protection principles ● Overcurrent protection applications	Chapter 8	
12	Reactive power issues ● Load‘s power factor ● Soultions for load’s power factor improvement ● Compensated reactive power distribution in power delivery system ● Capacitors sizing and operation	Chapter 9	Homework
13	Electric safety ● Generality (Electric shock concept, safety requirement and standards) ● Direct contact analysis ● Indirect contact analysis ● Protection solutions	Chapter 10	
14	Protection solutions for electric safety Lighting calculation ● Illuminance Categories ● Lighting fundamental	Chapter 10 & Chapter 11	

	• Lamps • Area indoor lighting calculations		
15	Revision and reservation		