NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRICAL ENGINEERING PROGRAM

EE376 – PROTECTION OF POWER SYSTEMS

I. GENERAL INFORMATION

CODE	**:**	EE376 – Protection of Power Systems
SEMESTER	**:**	9
CREDITS	**:**	03
HOURS PER WEEK	**:**	06 (Theory – Practice)
PREREQUISITES	**:**	EE354 – Analysis of Power Systems II
CONDITION	**:**	Elective

II. COURSE DESCRIPTION

It is a subject of a practical nature and belongs to the area of elective training. Its purpose is to consolidate the theoretical knowledge, by practicing experimental verification of the protection of power systems using also the knowledge acquired in previous courses. The practical sessions of this course validate the characteristics of a power system and the different protection methods.

III. COURSE OUTCOMES

At the end of the course the student will:

- Identify and understand the basic concepts in power electrical systems.
- Identify and understand the function of the protection elements.
- Correctly select the protection components of a power system.
- Know the protection standards required internationally.

IV. LEARNING UNITS

1. **GENERAL CONCEPTS**
   Introduction. Role of protection systems. Classification of relays. Basic terms used in protection. Evaluation of protection systems.

2. **VOLTAGE AND CURRENT TRANSFORMERS**
   Voltage transformers. Current transformers.

3. **ELECTROMAGNETIC RELAYS**
   Types of measure. Comparators. Relays of one magnitude. Directional relays of attraction. Induction relays of a single magnitude. Directional induction relays. Universal relay equation. Differential relays. Other types of relays. Contact behavior. Nominal coil power (rating).

4. **STATIC AND NUMERICAL RELAYS**
   Development of static protection. Indicators for relays. Layout of static relays. Stripes and interference effects. Philosophy and design of numerical relays.

5. COMMUNICATION SYSTEMS FOR PROTECTION

Applications and performance. Means of transmission. Transmission methods. Schemes of communication systems.

6. OVERCURRENT AND EARTH FAILURE PROTECTION

Protection Coordination. Principles of time / current calibration. Margins of graduation. Reverse time overcurrent relays, very inverse and extremely inverse. Defined time relays. Characteristic curves. Overcurrent protection of D / Y transformers. Overcurrent relay calibration. Earth failure protection. Fuse coordination. Directional overcurrent relays. Feeders in parallel. Ring systems Directional earth fault relays.

7. UNIT FEEDER PROTECTION

Address Convention Directional comparison. Pilot thread. Directional protection schemes. Carrier protection systems.

8. PROTECTION OF TRANSFORMERS AND GENERATORS

Nature and effects of transformer failure. Transformer protection Differential protection. Compensation for differential protection. Differential protection settings. Sensitivity of differential protection. High impedance differential protection. Protection of feeder transformers. Protection of transformer generator units. Complete scheme of protection.

9. DISTANCE PROTECTION

Parameters to be measured. Impedance of positive, negative and zero sequence. The distance relay of the impedance type. The distance relay of the modified impedance type. The distance relay of the reactance type. The Ohm type distance relay. The distance relay of the admittance or Mho type. Relay Performance Relation between the relay voltage and the Zs / Z1 ratio. Close faults. Mho Relay Offset. Mho relay with cross polarization. Protection zones Impedance seen by the healthy phase relays. Impedance presented to the relay. Distance protection schemes. Protection of parallel lines. Protection of multiterminal feeders. Self-reclose.

10. BAR PROTECTION

Protection Requirements. Types of protection systems. Stability of a differential protection system. Use of polarization in differential protection. Supervision. Location of current transformers.

V. METHODOLOGY

The course is developed in theory and practice sessions. In the theory sessions the teacher presents the concepts, principles for power systems protection and their applications in engineering. In the practical sessions different problems and their various applications are presented and solved. In all classes the active participation of the student is promoted both in the analysis and in the solution of problems.

VI. EVALUATION FORMULA

The learning will be evaluated through the "F" system.

- Partial Exam (PE): Weight 1
- Final Exam (FE): Weight 2
- Average of Practices (P): Weight 1.

$$FA = \frac{PE + 2 * FE + P}{4}$$

VII. BIBLIOGRAPHY

- “Fundamentals of Power System Protection”, Y. G. Paithankar, S. R. Bhide. PHI Learning Pvt. Ltd. 2011.

- “Power System Stability and Control”, Leonard L. Grigsby. CRC Press, 2007.

- “Practical Power System Protection”, Leslie Hewitson, Mark Brown. Newnes, 2005.