NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

ML633 – ELECTRIC PROTECTION SYSTEMS

I. GENERAL INFORMATION

CODE	**:**	ML633 Electric Protection Systems
SEMESTER	**:**	10
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory–Practice)
PREREQUISITES	**:**	ML511 Power Systems
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Mechanical - Electrical Engineering

II. COURSE DESCRIPTION

The course prepares students in the analysis of electric failures, their types and features, as well as in the design of electric protection systems. Students analyze and calculates the parameters of short-circuits, equipment associated to protection, characteristics and applications of relays, protection of power generators, protection devices, automatic re-closing equipment, coordination of protection and fundamental stages in protection systems. Norms and regulations on electrical protection and safety are analyzed and applied.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand standard regulations and legal prescriptions in power protection systems.
2. Apply concepts of electrical machines and power systems to solve problems.
3. Design protection systems for electrical installation projects.
4. Calculate the electrical parameters of failures for sizing and selecting the protection equipment, specifying the proper technical characteristics.

IV. LEARNING UNITS

1. BASIC CONCEPTS

Quality and reliability in electrical systems / Failures in electrical systems: Nature, causes, consequences and statistics / Quality of a protection system / Planning of a protection system / Protection system components.

2. SHORT CIRCUIT CALCULATION

Symbols and quantities / Representation of an electrical system: synchronous generator, transformer, transmission lines and loads (characteristic values) / Values per unit / Types of failures / Symmetrical components / Calculation of different types of ground failures (tri-polar, bipolar, unipolar).

3. EQUIPMENT ASSOCIATED TO PROTECTION

Current transformers / Potential transformers / Relay switches and fuses / Auxiliary power supplies / Teams of signs / Automation and communication related to protection.

4. APPLICATION AND CHARACTERIZATION OF RELAYS

Principle of protection relays (operational policy) / Overcurrent relays / Instantaneous overcurrent relays / Time-current relays / Directional relays / Distance relays / Differential relays / Over-voltage, under-voltage and frequency relays.

5. **POWER GENERATORS PROTECTION**
   Introduction / Overcurrent protection / Distance protection / Protection devices and teleprocessing / Protection of ground failures with neutral isolated system / Crash resistant protection.
6. **ELECTRICAL EQUIPMENT PROTECTION**
   Introduction / Protection of transformers / Protection of generators / Protection of motors / Protection of bars / Protection of bank of capacitors / Protection in low-voltage installations.
7. **AUTOMATIC RE-CLOSING PROTECTION EQUIPMENT**
   Definitions and characteristics / Three-phase and single-phase automatic re-closing.
8. **COORDINATION OF PROTECTION SYSTEMS**
   Coordination principles / Current vs time curves / Fixing limit values.
9. **FUNDAMENTAL STAGES IN PROTECTION SYSTEMS**
   Basic requirements / Scheme, project / Installation and operation starting.

V. PRACTICAL EXPERIENCE

Practice 1: Ground failures calculation.
Practice 2: Relays application and power generators protection.
Practice 3: Electrical equipment protection and automatic re-closing equipment.
Practice 4: Protection systems coordination and electrical protection project applications.

VI. METHODOLOGY

The course takes place in theory and practice sessions. In theory sessions faculty presents the theory, concepts and methods. In practice sessions, students apply theory to solve diverse problems related to electric failures and safety, and design an electric protection system satisfying given requirements and constraints. At the end of the course, students submit and defend a final report. Student active participation is promoted throughout the course.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = PP

PP: Average of 4 Practice Works.

VIII. BIBLIOGRAPHY

1. MICHAEL A. ANTHONY
   Electric Power System Protection and Coordination, Mc Graw – Hill Ed.
2. KIMBARK.
   Power Systems Stability, Volume 3.