



NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRICAL ENGINEERING PROGRAM

EE363 – ELECTRICAL MEASUREMENTS I

I. GENERAL INFORMATION

CODE	: EE363 – Electrical Measurements I
SEMESTER	: 6
CREDITS	: 02
HOURS PER WEEK	: 02 (Practice)
PREREQUISITES	: EE112 – Analysis of Electrical Circuits II
CONDITION	: Mandatory

II. COURSE DESCRIPTION

The course provides students with the necessary knowledge in the areas related to measurements, errors and uncertainties but focused on electrical engineering. Analyzes the various analogue measuring equipment classified by their operating principle and especially the most common measurements currently taken in the field supported by their technical standard.

III. COURSE OUTCOMES

At the end of the course the student will:

- Recognize the characteristics, disadvantages and virtues of the various ways of measuring in the field of electricity
- Meet the main standards related to electric field and laboratory measurements
- Learn the methodology to interpret and analyze measurements made in the field and laboratory
- Define equipment requirements and the influence of external factors when making a measurement
- Values the information obtained from technical catalogs and technical standards differentiating reliable sources of information from others.
- Apply concepts of electrical circuit courses in problems with a real character, mainly within the functionality of analog equipment.

IV. LEARNING UNITS

1. Measurement and error theory

Definition of terms Accuracy versus precision. Error concept Classification of errors. Statistics.

2. Analog equipment

Differences between analog and digital equipment and measurements. Symbology in analog equipment. Mobile coil equipment and permanent magnet. Galvanometers, formation of

ammeters and voltmeters. Mobile iron equipment. Electrodinamic equipment Analog energy meter.

3. Insulation measurement

Insulation measurement phenomenon, megohmmeter description. Leakage currents within the insulation measurement. Indexes of insulation quality. Interpretation of data. IEEE 400.2 Standard

4. Tangent delta and partial discharges

Polarization phenomenon in the tangent delta measurement, description of the equipment. Partial discharge phenomenon, description of the arrangement of equipment involved. Interpretation of data. Comparison between the use of the megohmmeter, the delta tangent method and the measurement of partial discharges.

5. Instrument transformers

Importance and scope of application of instrument transformers. Difference between measurement transformer and protection. Accuracy class measurement test and burden concept. Differences between MT and BT equipment. IEC 60044 Standard

6. Power and distribution transformer

IEC 60076 Standard. General of the standard. IEC 60076 standard. Insulation levels. IEC 60076 standard. Heating. IEC 60076 standard. Short circuit

7. Dielectric fluid and dry transformers

Differences between mineral oil and organic dielectric fluid. Field tests to the conventional transformer: Physicochemical and gas chromatography. Dielectric oil rigidity, differences between ASTM D1816, ASTM D 877 and IEC 60156. Dry transformers: features, and design considerations

V. METHODOLOGY

Classes are developed through teacher presentations, with active participation of students, encouraged through real situations.

VI. EVALUATION FORMULA

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

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

$$FA = \frac{PE + FE + P}{3}$$

VII. BIBLIOGRAPHY

- William D, Cooper. Modern electronic instrumentation and measurement techniques. Publisher: Pearson Prentice hall, 1991.
- Juan Antonio Suarez. Electrical measurements Editorial: Unknown, computer resource (<https://docplayer.es/26899456-Medidas-electricas-juan-antonio-suarez.html>) seen on 07/07/2019.
- Chauvin Arnoux Group. Insulation measurement guide. Publisher: Chauvin Arnoux Group, 2010.

- IEEE Power & Energy Society. IEEE 400: Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above. Editorial: IEEE Power & Energy Society, 2011.
- Robert Capella PT-069 Measurement of the level of partial discharges. Publisher: Schneider Electric España S.A., 2000.
- IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION. Instrument transformers - Part 1, Part 2, Part 3. Editorial: IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION, 2003.
- IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION. Power Transformers: Part 1, 3, 4 and 7. Editorial: IEC INTERNATIONAL ELECTROTECHNICAL COMMISSION, 2000.
- Megger. The Megger guide to insulating oil dielectric breakdown testing. Editorial: Megger, 2013.