NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

METALLURGICAL ENGINEERING PROGRAM

ME527 – NON-DESTRUCTIVE TESTING

I. GENERAL INFORMATION

CODE	**:**	ME527 Non-Destructive Testing
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	5 (Theory–Practice–Laboratory)
PREREQUISITES	**:**	ME429 Physical Metallurgy
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Metallurgical Engineering

II. COURSE DESCRIPTION

The course prepares students in the application of the different non-destructive testing methods for the detection of defects and discontinuities in a piece owed to problems during the formation process, fabrication process or along the piece use and operation. Non-destructives tests are based on the application of physical principles mostly electric, magnetic, electromagnetic, ultrasound, optical, among others. Students select the most appropriate method depending on the type of material or piece (characteristics and properties), and type of expected fault. The course also aims to motivate students in non-destructive tests and transformation metallurgy research.

III. COURSE OUTCOMES

At the end of the course, students:

1. Design the most appropriate non-destructive testing method for the detection of specific defects in a given piece of machinery, equipment, vehicle or industrial installation.
2. Explain the physical principles underlying the selected non-destructive testing.
3. Select proper equipment and instruments, as well as the required processes to implement the selected non-destructive testing method.
4. Interpret specific technical norms and standards setting the processes of non-destructive testing.
5. Complete technical reports with the results of non-destructive tests fulfilling norms and standards.

IV. LEARNING UNITS

1. INTRODUCTION

Non-destructive testing fundamentals / Quality levels of metallurgic products / Useful life time of metallurgic products / Reliability of metallurgic products.

2. CHARACTERISTICS AND PROPERTIES OF FORMED MATERIALS

Characteristics and properties of formed products by foundry, lamination, stamping, extrusion, forge, EDM, powder metallurgy, electroerosion, electron beam, laser beam.

3. CHARACTERISTICS AND PROPERTIES OF WELDED JOINTS AND RECOVERIES. DEFECTS AND FAILURES OF FORMED MATERIALS

Characteristics, properties and defects of welded pieces: oxigas, electric arc, laser beam, electron beam, brazing and electric resistance. / Defects and failures of formed materials / Acceptability of defects / Defects by location: internal, surface, subsurface / Defects by origin: inherent to process and service.

4. **DAMAGES AND FAILURES IN FORMED MATERIALS. NON-DESTRUCTIVE TESTS AND DIAGNOSIS BY VISUAL INSPECTION AND PENETRANT LIQUIDS**
   Damage and failure by distortion / Damage and failure by wear / Damage and failure by erosion / Damage and failure by chemical corrosion / Damage and failure by electrochemical corrosion / Damage and failure by thermal fatigue / Damage and failure by thermal creep / Damage and failure by weakening by hydrogen / Damage and failure by thermal impact / Damage and failure by aging / Non-destructive testing and diagnosis by visual inspection: Physical principles / Non-destructive testing and diagnosis by penetrant liquids: physical principles, processes, modeling.

5. **NON-DESTRUCTIVE TESTS AND DIAGNOSIS BY INDUCED CURRENTS. NON-DESTRUCTIVE TESTS AND DIAGNOSIS BY RADIOGRAPHY: R-X, R, R-N:**
   Non-destructive testing and diagnosis by induced currents: physical principles / Mathematical modeling of primary and secondary inductors / Testing technics processes / Required equipment / Non-destructive testing and diagnosis by X rays: physical principle / Non-destructive testing and diagnosis by gamma rays: physical principle / Non-destructive testing and diagnosis by N rays: physical principle. / Mathematical modeling of radiations / Testing technical processes / Required equipment for permanent and transitory records.

6. **NON-DESTRUCTIVE TESTS AND DIAGNOSIS BY ULTRASOUND. NON-DESTRUCTIVE TESTS AND DIAGNOSIS BY THERMOGRAPHY AND METALLOGRAPHY BY REPETITION:**
   Non-destructive testing and diagnosis by ultrasound: physical principle / Waves and ultrasound wave decomposition: mathematical modeling / Sonic field and ultrasound efficiency / Testing technical processes / Required equipment for different kinds of scanning / Non-destructive testing and diagnosis by thermography by infrared radiations: physical principle. / Non-destructive testing and diagnosis by metallography by repetition: physical principle / Testing technical processes / Required equipment.

V. LABORATORY

Session 1: Non-destructive test by penetrant liquids.
Session 2: Non-destructive test by magnetic particles.
Session 3: Non-destructive test by radiography X Ras.
Session 4: Non-destructive test by ultrasound.

VI. METHODOLOGY

The course takes place in theory, practice and laboratory sessions. In theory, faculty presents and analyze concepts and methods. In practice sessions problems related to different non-destructive testing methods are solved and analyzed. In laboratory sessions, students perform experimental tests and verify expected outcomes and results. After each laboratory experience, students submit a report describing procedures and summarizing results and conclusions. At the end of the course, students complete an actual project applying non-destructive testing methods to a given piece.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + EF + PL) / 3

EP: Mid-term Exam EF: Final Exam
PL: Average of Practical and Laboratory Works.

VIII. BIBLIOGRAPHY

1. AMERICAN SOCIETY FOR METALS.
   Metal Hand Book. Volume 1 to 21. Ed. 2010.