



# NATIONAL UNIVERSITY OF ENGINEERING

## COLLEGE OF MECHANICAL ENGINEERING

### MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

---

#### MC654 – MAINTENANCE ENGINEERING

##### I. GENERAL INFORMATION

<b>CODE</b>	: MC654 Maintenance Engineering
<b>SEMESTER</b>	: 10
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 6 (Theory–Practice)
<b>PREREQUISITES</b>	: MS213 Engineering Economics and Finance
<b>CONDITION</b>	: Elective

##### II. COURSE DESCRIPTION

The course prepares students for the analysis and application of maintenance engineering for assuring the correct operability of equipment, machinery and industrial plant as a whole. Students identify the maintenance requirements of a plant, formulate maintenance plans and policies, determine maintenance costs, implement preventive and corrective maintenance operations, and apply total productive maintenance.

##### III. COURSE OUTCOMES

At the end of the course, students:

1. Understand the basic concepts of maintenance management for assuring equipment and plant operability.
2. Understand the responsibilities of maintenance engineers and know how to work to fulfill them.
3. Apply modern techniques of control, organization and costs reduction.
4. Know how to manage the Maintenance Department in a company to assure the highest levels of effectiveness.

##### IV. LEARNING UNITS

###### 1. INTRODUCTION

Introduction to maintenance engineering / The maintenance in the company / Evolution of maintenance engineering / Position of the Department of Maintenance in the company / Differences between Production and Maintenance Departments. Objectives of both departments / Types of maintenance: classification of maintenance operations / Scheduled and unplanned maintenance / Preventive and corrective maintenance / Advantages and disadvantages of the different types of maintenance / Maintenance policies / Choice of the type of maintenance according to production and nature of the plant / Procurement of services of maintenance: advantages and disadvantages.

###### 2. MAINTENANCE DEPARTMENT

Organization of the Maintenance Department / Hierarchies and coordination of maintenance operations / Criteria for the organization of maintenance operations / Structural organization of maintenance processes / Maintenance policies / Maintenance personnel / Interdepartmental relations / Organization charts / Reports of reliability or failure / Design of work orders / Hierarchy / Operative conduction of maintenance.

###### 3. MAINTENANCE PLANNING

Strategic planning of maintenance / Maintenance budgets / Budget planning / Costs center / Planning of preventive maintenance / Gantt diagrams / Applications of PERT CPM /

Information systems applied to of maintenance / Structure / Documentation of maintenance operations / Orders of work / Files / Processing of data / Machine registry or life sheet.

#### **4. COSTS AND BUDGETS**

Study of cost reduction / Maintainability and maintenance / Differences / Control of maintenance / Assessment of maintenance results and effectiveness / Graphics of control / Control of maintenance rates / Effectiveness of systems / Evaluation of those systems / Systems in series / Systems in parallel / Parameters and factors associated with the effectiveness of systems. / Reliability. / Optimal design. / Operation. / Availability. / Definition of failure / Curve of reliability / Random failures / Exponential distribution / Attrition and normal distribution / Reliability of machines / Average time between failures / Optimization of the effectiveness of systems / Effectiveness of the cost / Cost of use / The life cycle of costs / Cost of direct service / Cost of penalty.

#### **5. TOTAL PRODUCTIVE MAINTENANCE**

Predictive maintenance / Fundamentals / Structure / Flow diagram / Industrial predictive cycle / Techniques of predictive maintenance / Total Productive Maintenance TPM / Features of TPM / Evolution and development of TPM / Activities and implementation of TPM.

#### **V. PRACTICAL EXPERIENCE**

**Session 1:** Planning and control.

**Session 2:** Costs and budgets.

**Session 3:** Final work: First revision.

**Session 4:** Statistical tools and TPM.

**Session 5:** Final work: Final presentation.

#### **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 maintenance engineering, maintenance management, preventive maintenance, Total Productive Maintenance. 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:

$$PF = (EP + EF + 2*TM) / 4$$

EP: Mid-term Exam      EF: Final Exam

TM: Final Work

#### **VIII. BIBLIOGRAPHY**

1. MORROW  
Maintenance Engineering Handbook, Mc. Graw–Hill Ed.
2. SALVATORE CALABRO  
Maintenance Reliability, Mc. Graw–Hill Ed.
3. HAVILLAND  
Engineering Reliability in Long Life Design, Van Nostrand Ed.