NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHANICAL ENGINEERING PROGRAM

MN423 – INSTRUMENTATION, MEASUREMENT AND CONTROL

I. GENERAL INFORMATION

CODE	:	MN423 Instrumentation, Measurement and Control
SEMESTER	:	8-10
CREDITS	:	3
HOURS PER WEEK	:	4 (Theory–Practice)
CONDITION	:	Elective
DEPARTMENT	:	Applied Engineering

II. COURSE DESCRIPTION

The course will provide to the students the knowledge and understanding of the instruments operation (sensors and actuators) and the role within the process control in an industrial plant, making a sizing and proper selection by using software based on international regulations. Also, it will release control techniques most widely used in industry, conventional and unconventional industrial processes. Finally, the student will provide skills in PLC, DCS, SCADA programming and data management systems as well as an overview of the of instrumentation engineering deliverables of Control and Automation for industrial processes.

III. COURSE OUTCOMES

1. Understand the operation of industrial sensors and actuators, selection and sizing using software and international standards.
2. Know and proposes the solution to controllers for industrial processes using conventional and unconventional control techniques.
3. Design and program the PLC, DCS and SCADA of common applications for the industry.
4. Meet the international standards related to instrumentation and control in industrial processes.
5. Meet and produces instrumentation deliverables in industrial processes.

IV. LEARNING UNITS

1. INSTRUMENTATION AND PROCESS CONTROL

Definitions of control. Classes of instruments. Electronic and pneumatic transmitters.

2. INDUSTRIAL SENSORS

Pressure measurement. Flow measurement. Level measurement. Temperature measurement. Analysis and other variables: weight, density, humidity and dew point, pH meters and additional variables.

3. FINAL CONTROL ELEMENTS - ACTUATORS

Control valves, sizing and selection. Valve actuators, sizing and selection. Final electronic components (starting systems of electromechanical and electronic motors, variable speed drives), sizing and selection. Other final control elements.

4. INTRODUCTION TO CONTROL OF PROCESSES

Continuous processes vs. Batch processes. Control for command and regulation. Disturbance and regimes. Earnings. Response time and downtime. Documentation of Engineering in Instrumentation and Control. Summary of International Standards.

5. TYPES OF AUTOMATIC CONTROL

Conventional controllers (cascade control, ratio control, anticipatory control, PID control and tuning). Unconventional controllers (uncoupled multivariable control industrial processes, predictive and robust). Applications of complete processing plants for mineral processing, metal processing,

chemical processing, water treatment plants, natural gas, etc.

6. **PROGRAMMABLE LOGIC CONTROLLER - PLC**
   Characteristics, PLC types and languages programming based on rules. Typical blocks for PLC programming. Basic instructions, latch and unlatch. Instructions timed and accountants. Instructions for words, comparison and movement of words. Instructions for continuous monitoring, scaling analog inputs and outputs. PID instruction. Jumps and subroutine instructions.

7. **SCADA AND HMI PROGRAMMING SYSTEMS**
   Definitions. Industrial Networking Protocols. Approach and Interplay between SCADA and PLC / DCS.

8. **DOCUMENTATION OF INSTRUMENTATION FOR PROCESS CONTROL ENGINEERING**
   P and ID diagrams. Drawings and documentation according to ISA. Control philosophy. Control architecture.

9. **PLC AND SCADA PROGRAMMING APPLICATIONS**
   Application of PLC and SCADA programming in Natural Gas Plant. Introduction to Safety Instrumented Systems and Intrinsic Safety.

V. METHODOLOGY

The course takes place in theory, practice and computer lab sessions. In the theory sessions, the instructor presents the concepts, theorems and applications. In the laboratory sessions, simulation software for each stage of the course (MATLAB, manufactured software under international regulations, Step7 and SCADA software) is used to solve problems and analyze their solution. At the end of the course, the student must submit an integration project. In all sessions, the active participation of students are encouraged.

VI. LABORATORY AND PRACTICAL EXPERIENCES

Practice 1: Preparation of data sheets
Practice 2: Selection of flow and pressure instruments
Practice 3: Selection of temperature and level instruments
Practice 4: Evaluated practice
Practice 5: Selection of control valves
Practice 6: Selection of control valve actuators
Practice 7: Evaluated practice
Practice 8: Simulation of conventional controls by MATLAB
Practice 9: Simulation of unconventional controls by MATLAB
Practice 10: Programming PLC programming
Practice 11: PLC programming
Practice 12: Programming of industrial networking
Practice 13: SCADA and HMI programming
Practice 14: Exhibition of works

VII. EVALUATION FORMULA

The Average Grade PF is calculated as follow: **PF = (EP + 2EF + PP) /4**

PP = (PC1 + PC2 + PC3+ PC4) / 4

EP: Mid-Term Exam **EF**: Final Exam
PP: Average of practices or monographs (not eliminate any evaluation)

VIII. BIBLIOGRAPHY

1. **CREUS SOLÉ, ANTONIO**
   Industrial Instrumentation, Alfa Omega, Eighth Edition, 2010.
2. **DESHPANDE, PRADEEP B. AND TANTALEAN, ROBERTO Z.**
   Process Control and Optimization, Six Sigma and Advanced Controls, 2006.
3. **MURILL, P.W.**
   Fundamentals of Process Control Theory, Third Edition.
4. **WHITT, MICHAEL D.**
   Successful Instrumentation and Control Systems Design, Second Edition (with CD-ROM).