NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHATRONICS ENGINEERING PROGRAM

MT247 – SENSORS AND SIGNAL CONDITIONING

I. GENERAL INFORMATION

CODE	**:**	MT247 Sensors and Signal Conditioning
SEMESTER	**:**	6
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory – Practice – Labs)
PREREQUISITES	**:**	ML831 Analysis and Design of Electronic Circuits MT127 Analysis and Design of Digital Circuits
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

Students will be able to design a complete data acquisition system, where they will select the best sensor according to the application; they will also be able to design the signal conditioning circuit and the software for data acquisition, storage and visualization. This course encompasses: sensors, signal conditioning, signal acquisition and processing.

III. COURSE OUTCOMES

1. Learn main characteristics, properties, limitations and applications of sensors.
2. Study of several signal conditioning circuits using operational amplifiers.
3. Analyze and design conditioning circuits for a certain sensor in a required application.
4. Study of several A/D and D/A converters applied to the design of (industrial, medical, aeronautic, maritime, robotic, etc.) signal acquisition systems.
5. Design of Hardware/PC and PC/Hardware interface specifications through computer ports, with the aim of mounting an acquisition system for a certain application.
6. Basic knowledge of digital signal processing for the processing of the acquired data.

IV. LEARNING UNITS

1. SENSORS / 20 HOURS

General concepts and terminology / Classification of sensors / general input and output configuration / Dynamic and static characteristics of measurement systems / Other characteristics / Basic sensors / Resistive sensors / Electromagnetic and variable reactance sensors / Self-generating sensors / Digital sensors / Other sensing methods.

2. SIGNAL CONDITIONING / 15 HOURS

Signal conditioning for a resistive sensor / Signal conditioning for a variable reactance sensor / Signal conditioning for a self-generating sensor / Signal conditioning for other sensing methods / Operational amplifiers and commercial instrumentation amplifiers.

3. A/D AND D/A CONVERTERS / 10 HOURS

Types of A/D and D/A converters. Characteristics of A/D and D/A converters.

4. INTERFACE SPECIFICATIONS DESIGN / 10 HOURS

Sensor selection (range, precision and sensibility) for a certain application, according to measurement parameters / selection of op-amps, A/D or D/A converters and communication medium with the PC / Noise and interference sources.

5. SIGNAL ACQUISITION, PROCESSING AND STORAGE / 15 HOURS

GUI programming tools for the data acquisition and storage / Use of Matlab for the visualization of stored data / Signal processing using Matlab, study of DEP (Data Execution Prevention), Filtering of signals stored in a digital file.

V. LABORATORY EXPERIENCES

Lab 1: Temperature sensors – J and K thermocouples.
Lab 2: Characteristics and comparisons among RTDs and thermistor.
Lab 3: Proximity sensors and level transmitter.
Lab 4: Pressure sensors.
Lab 5: Design of a measurement system – Phase 1: Sensor selection and conditioning circuit design.
Lab 6: Design of a measurement system – Phase 2: Design of the circuit PCB and design tests.
Lab 7: Design of a measurement system – Phase 3: use of microcontrollers and internal A/D converter for data visualization (LCDs, leds and others) and communication with the computer.
Lab 8: Design of a measurement system – Phase 4: Design of programs on the computer with Virtual Basic to store and visualize data transmitter from the conditioning system.

VI. METHODOLOGY

The course is carried out in computing lab, theory and practice sessions. In theory sessions, Student active participation is encouraged in every session through questions, problem-solving, discussion of cases, bibliographic information search on the internet. In practice sessions, the instructor proposes exercises and cases to be solved using the knowledge acquired during theory sessions. Lab sessions are carried out using the proper software which help the student visualize the most important aspects of the analysis of a continuous-time control system. Cases to be solved will be given in advance so that the reports can include research, updating and an in-depth knowledge of it. Hardware such as computers and multimedia projectors, and aids such as texts, offprints, software and virtual campus will allow a better understanding of the studied topics.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = (EP+EF+((P1+P2+P3+P4)/3+(L1+L2+L3+L4+L5+L6+L7+L8)/8)/2)/3

EP: Mid-Term Exam	EF: Final Exam
P#: Quizzes	L#: Labs

VIII. BIBLIOGRAPHY

1. **PALLAS ARENY, R.; WEBSTER, J.G.**
   Sensors and digital conditioning. 2nd ed. John Wiley and Sons, 2001
   2nd ed. John Wiley and Sons, 2001

2. **WEBSTER, J.G.**
   The measurement, instrumentation and sensors handbook
   CRC; iEEE, 1999

3. **KIRLANAKI, N. V. [et al.]**
   Data Acquisition and Signal Processing For Smart Sensors
   John Wiley and Sons, 2002