NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHATRONICS ENGINEERING PROGRAM

MT228 – DIGITAL CONTROL

I. GENERAL INFORMATION

CODE	: MT228 Digital Control
SEMESTER	: 9
CREDITS	: 3
HOURS PER WEEK	: 4 (Theory – Practice - Laboratories)
PREREQUISITES	: MT227-MT417
CONDITION	: Mandatory

II. COURSE SUMMARY

The course prepares the student in the theoretical-practical applications in topics related to data acquisition in which physical phenomena are analyzed, discrete time modeling from the mathematical and experimental perspective, analysis of the transitory response of a control system in the discrete time domain, analysis and test of the stability of a control system, the design of control techniques that will be implemented in real time tasks, thus validating the theoretical aspects taught in class.

III. COMPETENCES

The student:

1. Analyzes acquired data of analog input and output on an experimental basis and interprets the results based on technical manuals of physical devices.

2. Constructs and interprets methodologies for discrete time modeling of linear and time invariant systems.

3. Explains and determines computational algorithms to obtain dynamic models by identifying models in experimental form.

4. Solves control algorithms based on digital control strategies using the tools provided by the MATLAB and LabVIEW simulation software.

5. Implements and builds control strategies by redesign and direct digital control to perform the experiments in real time.

IV. LEARNING UNITS

1. FUNDAMENTALS OF THE DIGITAL CONTROL SYSTEM / 6 HOURS

Digital Control Systems / Discrete Time Signals / Sampling Phenomena / Equations in Differences / Models with Equations in Differences / Calculation of Dynamic and Static Responses / Block Diagram of Equation Models in Differences / The Z-Transform / Definition / Properties of the Z-Transform / Inverse Transform / Solving of Z-Transform / Initial Value Theorem / Final Value Theorem / The modified Z-transform / Analysis of discrete first-order systems.

2. DISCRETE TIME MODELING / 4 HOURS

Modeling of systems in discrete time / Models of finite difference / Exact discretization for linear systems / Analysis of higher order systems / Adjustment of discrete time equations to process data / Calculation of discrete time response of models with Z transfer functions.

3. SAMPLING AND RECONSTRUCTION / 12 HOURS

Sampling and Reconstruction / Data Sampling of a System / Sampling System Components / Reconstructing a Signal from its Samples / Systems Analysis with Delay Time / Pulse Transfer Function / Procedure to Find the Pulse Transfer Function / Pulse Transfer Function of a system with zero order retainer / pulse transfer function of a system with cascade elements / open loop systems with digital filters included / pulse transfer function for a closed loop system.

4. ANALYSIS OF THE TRANSITIONAL RESPONSE / 6 HOURS

Dynamic Response of Discrete Systems / Transient Response Analysis in Stationary State / Effects of Sampling in Discrete Systems / Mapping in S-Plane to Z-Plane / Mathematical Relations of Mapping / analysis of damping lines and natural frequency lines.

5. STABILITY ANALYSIS / 8 HOURS

Stability in discrete systems / Properties of stability / Analysis of stability in transfer function models and state space models / Analysis of stability in feedback system / Jury stability criterion / Analysis of stability by Hurwitz / Analysis of the Frequency stability.

6. IDENTIFICATION OF LINEAR SYSTEMS / 8 HOURS

Identification of systems / Types of models / Procedures for identification / Identification techniques / Parametric identification / Identification by non-recursive least squares method / Identification by recursive least squares method.

7. TECHNIQUES AND DIGITAL CONTROL DESIGN / 12 HOURS

Digital Emulation / Matched Digital Approximation (MPZ) / Digital Bilinear (V-trapezoidal) Approxiomation / Digital Prewarp Approximation / Classical Continuous Time Control Systems / Phase Forward and PID Controller Design /

Controller Design Discrete Direct / Controller Design P / PI / PD / PID / Deadbeat controller design.

V. LABORATORIES AND PRACTICAL EXPERIENCES

Laboratory 1: Data Acquisition
Laboratory 2: Discrete time modeling
Laboratory 3: Identification of parametric models
Laboratory 4: DC motor speed control

VI. METHODOLOGY

The course is developed in sessions of theory, practice and computer lab. In theory sessions, the teacher presents concepts, theorems and applications. In practical sessions, various problems are solved and their solution is analyzed. In the laboratory sessions there are two aspects: first, the use of MATLAB and LabVIEW simulation software to solve problems and analyze their solution, secondl, the implementation of real-time tasks using interface that communicate with the PC through the USB port. In the course of the academic semester the student must present 4 laboratory reports. In all the sessions the active participation of the student is promoted.

VII. EVALUATION FORMULA

Evaluation System F

VIII. BIBLIOGRAPHY

1. C. Phillips, H. Nagle. “Control System Analysis and Design”. Prentice Hall, 1984.
2. Gene Franklin, J. Powell, A. Emami-Naeini. “Feedback Control of Dynamics System”. Addison Wesley, 3era Ed, 1994.
3. Karl. J. Astrom & Bjorn Wittenmark. “Computer Controller System”. Prentice Hall, 1997.