NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ELECTRICAL AND ELECTRONICS ENGINEERING
ELECTRONICS ENGINEERING PROGRAM

SYLLABUS - EE615 CONTROL I

I. GENERAL INFORMATION

CODE : EE615
SEMESTER : 7
CREDITS : 4
HOURS PER WEEK : 5 (Theory – Practice)
PREREQUISITES : MA185 Mathematics V, EE421 Electronic Circuits I
CONDITION : Compulsory
INSTRUCTOR : Daniel Carbonel, Ruben Aquize

II. COURSE DESCRIPTION

The course trains the student to elaborate a mathematical model of a plant or process to be controlled followed by stability analysis and by its temporal response to a particular reference signal. Root locus graphic techniques and the frequency response are introduced and applied to the control system analysis. Engineering application problems are solved, and specialized software is used.

III. COURSE OUTCOMES

1. Learn basic concepts of feedback control systems, and the foundation of its analysis and design, understanding it is the necessary basis for the course.
2. Formulate mathematical models for components and physical systems based on the transfer function concept, understanding it is the first step for the control system analysis.
3. Analyze and simulate the transient and steady response, as well as to establish conditions for control systems stability, assessing results according to the solved physical problem.
4. Apply root locus and frequency response graphic techniques, assessing the importance of these tools in the simplification of solution to automatic control problems.

IV. LEARNING UNITS

1. INTRODUCTION TO CONTROL SYSTEMS / 5 HOURS

Definitions / open and closed loop control system / Types of control system / Control system components / Examples / Mathematical basis / Use of MATLAB in control systems.

2. SYSTEMS MODELING / 15 HOURS

Differential equations for physical systems / Linearization / Laplace transform application. Transfer function / Block diagram / Mechanical, electrical, hydraulic, pneumatic and thermal systems models / Multivariable systems and transfer matrix / Signal flow graphs.

3. TIME-DOMAIN ANALYSIS OF CONTROL SYSTEMS / 15 HOURS

Stationary and transitory response / Linear systems stability / Routh – Hurwitz criterion / First-order systems / Second-order systems / Higher-order systems / Dominant roots / Performance specifications / Effects of addition of zeros to the transfer function / Steady-state error / Sensitivity to parameter variation / Effects of external disruption.

4. ROOT LOCUS METHOD/ 15 HOURS

Root locus basic conditions (RL) / Rules for construction of RL / Examples of RL drawing / Effects of addition of poles and zeros to the loop gain GH / RL for Typical transfer functions / RL Application to control system analysis.

5. FREQUENCY RESPONSE METHOD / 20 HOURS

Frequency response graphs / Bode plot / Minimum-phase and non-minimum phase systems / Transport delay / Complex plane projections / Nyquist stability criterion / High and low frequency tendencies in Bode and Nyquist plots / Relative stability / Gain and phase margins / Steady error and frequency response / Bode and Nyquist plots for typical transfer functions.

V. LABORATORY EXPERIENCES

Lab 1: Use of MATLAB Symbolic math Toolbox.
Lab 2: Use of MATLAB Control System Toolbox.
Lab 3: Use of MATLAB simulkit.
Lab 4: Graphic interface application of MATLAB's GUI LTI Viewer.
Lab 5: Root locus using MATLAB.
Lab 6: Bode plots using MATLAB.
Lab 7: Nyquist plot using MATLAB.
Lab 8: Analysis, design and simulation of a particular case using MATLAB.

VI. METHODOLOGY

The course is carried out in computing lab, theory and practice sessions. In theory sessions, the instructor introduces concepts, theorems and applications. In practice sessions, several problems are solved, and their solutions are analyzed. In lab sessions, Matlab simulation software is used to solve problems and analyze their solutions. At the end of the course the student must hand in and expose an integrating paper or project. In all sessions student's active participation is encouraged.

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. **DORF, R. and BISHOP, R.**
   Modern Control Systems
   Pearson Publishing – Prentice Hall, 2005.

2. **OGATA, K.**
   Modern Engineering of Control (Spanish)
   Pearson Publishing – Prentice Hall, 2005