Devi Ahilya University, Indore, India Institute of Engineering & Technology				**III Year B.E. (Electronics and Telecommunication)**			
Subject Code & Name	**Instructions Hours per Week**			**Credits**			
ETR6C3	**L**	**T**	**P**	**L**	**T**	**P**	**Total**
CONTROL SYSTEM	**3**	**1**	**2**	**3**	**1**	**1**	**5**
Duration of Theory Paper: 3 Hours							

Learning Objectives: To provide the fundamental knowledge of control system engineering and the concept of mathematical modeling of the physical system. The subject gives various classical analysis tools for design and stability of system in time and frequency domain.

Prerequisites: Knowledge of Laplace transforms, Z-transform, Basics of MATLAB & Simulink.

COURSE CONTENTS

UNIT-I: Introduction to the control system & Physical modeling

Basic component of control system (CS), open-loop CS (non-feedback system), close-loop CS (feedback CS), Types of feedback CS- linear and non-linear CS, time-invariant and time variant CS, single variable and multivariable control system.
Effect of feedback on-overall gain, stability, sensitivity, external disturbance or noise, Block diagram representation of CS, Block diagram reduction rules, Transfer function (TF), Poles-zero concept, Signal flow graph (SFG), Mason's gain formula.
Modeling of CS- electrical networks, mechanical systems-translational and rotational mechanical system, analogy concept- force to voltage (F-V) and force to current (F-I) analogy.

UNIT-II: Time domain analysis & Stability

Time response of continuous-data system, Standard test signals, Time response of prototype first and second order CS, Performance specifications of prototype I & II order systems, Steady-state errors and error constants (positional, velocity, acceleration), Effect of adding Poles and Zeroes to open-loop and close-loop transfer function (TF), Concept of Dominant poles of TF.
Types of controllers and their control action-proportional (P), integral (I), derivative (D), PID control, and derivative feedback control, MATLAB based problems.
Stability-Concept of stability, Necessary conditions for stability, Absolute and relative stability, Algebraic Criterion of stability- Routh Hurwitze Criterion. The Root locus concept, Guidelines for sketching Root-locus, Root contour.

UNIT-III: Stability and Frequency domain analysis of CS

Frequency domain analysis- Concept of complex frequency, performance specification of frequency domain, Co-relation between time & frequency domain, Polar plot, Bode plot, Stability analysis in frequency domain- Nyquist Criterion, Stability margins-Gain and Phase margin, MATLAB Based Problems.

UNIT-IV: Design of Feedback CS & State Space Analysis of CS

Approach to system design, Preliminary considerations classical design, Realization of basic Compensators-Lead, Lag, and Lag-lead compensator, Design of compensators in Time and Frequency domain.
Concept of State, State Variable, and State Model, State model representation of an LTI system, co-relation between State Model and TF, Solution of State Equations, Transfer Matrix, Concept of Controllability & Observability, MATLAB based problems.

UNIT-V Digital Control Systems

Block diagram representation of Digital Control System, Sampling process, Mathematical analysis of sampling process, Reconstruction of sampled signal, Pulse Transfer Function, Zero-order and first order hold circuit, Mapping of s-plane to z-plane.

Learning Outcomes:

Upon Completing the Course, Student will able to:

- Understand the concept of LTI control systems, Importance of feedback in CS and stability concept.
- Able to Design a Stable Control System
- Understand the difference between Linear and Digital Control Systems.

BOOKS RECOMMENDED:

[1] B.C. Kuo, Automatic Control System, 7/E, PHI, 2006.
[2] I. J. Nagrath and M. Gopal, Control Systems Engineering, 5/E, New Age International Publishers, 2007.
[3] M. Gopal, Control Systems (Principles & Design), 5/E, Tata McGraw Hill, 2007.
[4] Bishop & Dorf, *Modern Control System*, Addision Welseley.
[5] Ogata, Discrete-Time Control System, 2/e, PHI, 1995.

List of Practical Assignments:

1. Find the transfer function of various LTI control systems (open loop and close loop) using MATLAB command.
2. Write a program to plot the poles and zeroes for the different sets of transfer function using MATLAB.
3. Write a program to plot the time response of first and second order control system on impulse, unit-step, ramp and parabolic input signals using MATLAB. Also find the value of various transient response parameters.
4. To determine the position, velocity and acceleration error coefficient of given transfer functions using MATLAB.
5. Plot the root locus for various transfer functions using MATLAB command.
6. Plot the Nyquist plot for the given transfer function using MATLAB. Also comment on the systems stability.
7. Plot the Bode plot for the transfer function given below by using MATLAB.

$$G(s)H(s) = \frac{2(s+0.25)}{s^2\,(s+1)\,(s+0.5)}$$

Also find (a) Phase cross over frequency (b) Gain cross over frequency
(c) Gain margin (d) Phase margin.