Devi Ahilya University, Indore, India **Institute of Engineering & Technology**				**III Year B.E. (Electronics and Instrumentation)**			
Subject Code & Name	**Instructions Hours per Week**			**Credits**			
6EIRC3	**L**	**T**	**P**	**L**	**T**	**P**	**Total**
CONTROL SYSTEM	**3**	**1**	**1**	**3**	**1**	**1**	**5**
Duration of Theory Paper: 3 Hours							

Course Objectives:

1. To develop the mathematical model of the physical systems.
2. To analyze the response of the closed and open loop systems and identify the need of Controllers
3. To analyze the stability of the closed and open loop systems.
4. To design the various kinds of compensator and Compensators.
5. To represent and analyze the system response in z- 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.

UNIT-III: Stability and Frequency domain analysis of CS
The Root locus concept, Guidelines for sketching Root-locus, Root contour.
Frequency domain analysis- Concept of complex frequency, performance specification of frequency domain, Co-relation between time & frequency domain, Polar plot, Bode plot.

UNIT-IV: Design of Feedback CS & State Space Analysis of CS
Stability analysis in frequency domain- Nyquist Criterion, Stability margins-Gain and Phase margin, MATLAB Based Problems. 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.

UNIT-V Digital Control Systems
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.
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.

Course Outcomes:

CO.No.	CO	PO
CO1	After the completion of this course student will be able to developed the mathematical modelling of different physical system and identify open loop and close loop system.	PO-1,PO-2,PO-3
CO2	After the completion of this course student will be able to Analyze the response of the closed and open loop systems and identify the needs of different types of controllers to ascertain the required dynamic response from the system	PO-1, PO-2,PO-3
CO3	After the completion of this course student will be able to draw different plots and analyze the stability in time domain and frequency domain.	PO-1, PO-2, PO-3, PO-4
CO4	After the completion of this course student will be able to design different types of compensators and represent and analyze the system in state space form	PO-1, PO-2, PO-3, PO-4 ,PO-5
CO5	After the completion of this course student will be able to represent and analyze the system response in z- domain.	PO-1, PO-2, PO-3, PO-4, PO-5

CO-PO Relationship

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	2	2	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	-	-	-	-	-	-	-	-

CO4	3	2	3	1	2	-	-	-	-	-	-	-
CO5	3	2	2	1	2	-	-	-	-	-	-	-

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.