Devi Ahilya University, Indore, India Institute of Engineering & Technology				ME I Year Electronics (Sp. Digital Instrumentation) Semester- A			
Subject Code & Name	**Instructions Hours per Week**			**Credits**			
DIR1C3: Modern Control Systems	**L**	**T**	**P**	**L**	**T**	**P**	**Total**
Duration of Theory Paper: 3Hours	**3**	**1**	**2**	**3**	**1**	**1**	**5**

Course Objective: The objective is to give students a clear understanding on characteristics of digital control systems from both frequency and time domain viewpoints. Also to give students the basic knowledge of nonlinear, optimal and adaptive control systems.

Prerequisite: Knowledge of classical control methods, Z-tansform, mapping of s-plane to z-plane, & MATLAB control system toolbox

COURSE CONTENTS

Unit I

Data conversion & quantization, Sampling process, mathematical analysis of sampling process, Reconstruction of sampled signal, zero order, first order hold pulse transfer function, Block diagram reduction for systems interconnected through samplers, Sampled Signal flow graphs, Stability definition, Jury's test of stability, extension of Routh-Hurwitz criterion to discrete time systems, steady state error analysis.

Unit II

Root Loci, Frequency domain analysis, Bode plots, Nyquist plots, Gain margin & phase margin, Digital implementation of analog controllers: Digital controller Design: Classical methods, digital PID's, digital lead-lags, dead-beat controller.

Unit III

State space representation of discrete time systems, Solution of state equation, Pulse transfer function from state equation, Response between sampling instant using state model, observability, controllability, useful transformation in state space, pole placement methods, controller implementations, State observers.

Unit IV

Non Linear Control Design: Introduction, General properties of linear and nonlinear systems, describing function analysis: Definition, limitations, use of describing function for stability analysis, describing function of ideal relay, relay with hystersis, dead zone, saturation, coulomb friction and backlash, Phase Plane Analysis, phase portrait of second order nonlinear systems, limit cycle, Equilibrium finding, Stability of Nonlinear Systems: Liapunov Theorems, An Overview of Kalman Filter Theory.

Unit V

Adaptive control: Model reference control. Identification, convergence and stability. Adaptive control of linear systems via state feedback and via output feedback. Adaptive control of nonlinear systems.

Optimal Control Design : Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State Quadratic Optimal Control, Calculus of Variations: An Overview, Optimal Control forrmulation using Calculus of Variations, Classical Numerical Methods for Optimal Control, Linear Quadratic Regulator (LQR) Design – I, Linear Quadratic Regulator (LQR) Design – II

Text and Reference Books:

[1] Kuo, Digital Control System, 2/e Oxford Press, 1992.
[2] Ogata, Discrete – Time Control System, 2/e PHI, 1995.
[3] M Gopal, Digital Control System, TMH, 1997.
[4] H. K. Khalil, Nonlinear Systems, 3/e, Prentice Hall, 2002.
[5] Jasbir Arrora, Introduction to Optimum Design, third edition, Elsevier. 2003
[6] N Andreasson , A Evgrafov , M Patriksson , An Introduction to Continuous Optimization, Overseas Press, India Pvt. Ltd. 2006
[7] D. S. Naidu, Optimal Control System, CRC Press, 2003
[8] Arturo Locatelli, Optimal control: An introduction ,Birkhauser Verlag, 2001.
[9] K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989.
[10] P. A. Ioannou and J. Sun, Robust Adaptive Control, Prentice-Hall, 1995 (available now at http://www.rcf.usc.edu/~ioannou/RobustAdaptiveBook95pdf/Robust_Adaptive_Control.pdf)