

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Semester: 2

Instrumentation and Control Engineering
(Applied Instrumentation)

Subject Name: DIGITAL CONTROL

Sr.No	Course content
1.	Transfer Function Approach to Controller Design Structures and Specifications Control Structures , Feed Forward Controller, One Degree of Freedom Feedback Controller, Two Degrees of Freedom Feedback Controller ,Proportional Control , Nyquist Plot for Control Design, Stability Margins Internal Stability and Realizability , Forbid Unstable Pole–Zero Cancellation ,Internal Stability ,Internal Stability Ensures Controller Realizability ,Closed Loop Delay Specification and Realizability, Internal Model Principle and System Type , Internal Model Principle , System Type , Introduction to Limits of Performance , Time Domain Limits , Sensitivity Functions , Frequency Domain Limits, Well Behaved Signals, Small Rise Time in Response , Small Overshoot in Response , Large Decay Ratio , Solving Aryabhata's Identity, Euclid's Algorithm for GCD of Two Polynomials , Aryabhata's Identity , Algorithm to Solve Aryabhata's Identity
2.	Proportional, Integral, Derivative Controllers Sampling Revisited, Discretization Techniques , Area Based Approximation, Step Response Equivalence Approximation, Discretization of PID Controllers , Basic Design , Ziegler–Nichols Method of Tuning , 2-DOF Controller with Integral Action at Steady State , Bumpless PID Controller with $T_c = S_c$, PID Controller with Filtering and $T_c = S_c$,2-DOF PID Controller with $T_c = S_c(1)$, 2-DOF PID Controller with $T_c(1) = S_c(1)$.
3.	Pole Placement Controllers Dead-Beat and Dahlin Control , Pole Placement Controller with Performance Specifications, Implementation of Unstable Controllers , Internal Model Principle for Robustness, Redefining Good and Bad Polynomials, Comparing 1-DOF and 2-DOF Controllers , Anti Windup Controller , PID Tuning Through Pole Placement Control .
4.	Special Cases of Pole Placement Control Smith Predictor, Internal Model Control , IMC Design for Stable Plants , IMC in Conventional Form for Stable Plants , PID Tuning Through IMC
5.	Minimum Variance Control j -Step Ahead Prediction Error Model , Control Objective for ARMAX Systems , Prediction Error Model Through Noise Splitting , Interpretation of the Prediction Error Model , Splitting Noise into Past and Future Terms , ARIX Prediction Error Model , ARIMAX Prediction Error Model , Minimum Variance Controller , Minimum Variance Controller for ARMAX Systems ,

	Expression for Sum of Squares , Control Law for Nonminimum Phase Systems , Minimum Variance Controller for ARIMAX Systems, Generalized Minimum Variance Controller , GMVC for ARMAX Model , GMVC for ARIMAX Model, PID Tuning Through GMVC
6.	Model Predictive Control Generalized Predictive Control, GPC for ARIX Model, ARIMAX Model, Steady State Weighted Generalized Predictive Control (γ -GPC), Model Derivation, Optimization of Objective Function, Predictive PID, Tuned with γ -GPC, Dynamic Matrix Control
7.	Linear Quadratic Gaussian Control Spectral Factorization , Controller Design , Simplified LQG Control Design , Introduction to Performance Analysis of Controllers
8.	State Space Techniques in Controller Design Pole Placement , Ackermann's Formula, Control Law when System is not in Canonical Form , Controllability , Estimators , Prediction Estimators, Observability , Current Estimators , Regulator Design – Combined Control Law and Estimator , Linear Quadratic Regulator , Formulation of Optimal Control Problem , Solution to Optimal Control Problem , Infinite Horizon Solution to LQR Design, Kalman Filter

Reference Books:

1. Digital Control by Kannan M. Moudgalya , Wiley Interscience
2. Computer Controlled Systems. Theory and Practice by K. J. Astrom and B. Wittenmark, Prentice-Hall
3. Digital Control of Dynamic Systems G. F. Franklin, J. D. Powell and M. Workman, , Addison Wesley Longman, Menlo Park, CA, 3rd edition, 1998.
4. Digital Control Systems, Second Edition, Benjamin C. Kuo , Oxford University Press
5. Published Research Papers on Digital controller design