GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Applied Instrumentation

Subject Code : ME02067011

Subject Name : Digital Control

WEF Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Core Course

Prerequisite :	Control Engineering, Advance control techniques
Rationale :	This course provides an overview and fundamentals of design of Digital control for differenttypesofcontrolsystems.Alsocoversdifferenttypesofcontrollerstructuresandit'sdesign for special applications in digital domain.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understand the structure of various types of Digital Structures	UN
02	Design of different types of Digital PID Controllers	AP
03	Design of different types of Pole Placement Controllers	AP
04	Design of Model Predictive Controller	AP
05	Design of digital controllers with transfer function and state space approach	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

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Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
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 InternalStabilityandRealizability,ForbidUnstablePole–ZeroCancellation ,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 Aryabhatta's Identity, Euclid's Algorithm for GCD of Two Polynomials, Aryabhatta's Identity, Algorithm to Solve Aryabhatta's Identity	**10**	**22**
2	**Proportional, Integral, Derivative Controllers** Sampling Revisited, Discretization Techniques , Area Based Approximation, Step Response Equivalence Approximation, Discretizationof PID Controllers, Basic Design , Ziegler–Nichols Method of Tuning , 2-DOF Controller with Integral Actionat Steady State ,Bumpless PID Controller with Tc=Sc,PID Controller with Filtering and $Tc = Sc$,2-DOF PID Controller with $Tc = Sc(1)$, 2-DOF PID Controller with $Tc(1) = Sc(1)$.	**06**	**13**
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,Comparing1-DOFand2-DOFControllers,AntiWindup Controller, PID Tuning Through Pole Placement Control	**05**	**11**
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	**04**	**10**
5	**Minimum Variance Control**	**08**	**18**

	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 PhaseSystems,MinimumVarianceControllerforARIMAXSystems,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 (GPC), Model Derivation,OptimizationofObjectiveFunction,PredictivePID,Tunedwith - GPC,Dynamic Matrix Control	**06**	**13**
7	**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	**06**	**13**
	Total	**45**	**100**

Reference Book:

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. Digital Control Systems, Second Revised Edition by RolfIsermann, Springer-Verlag.
6. Published Research Papers on Digital controller design

Suggested Course Practical List:

Student has to prepare computer programs and simulations for various Digital Controller Design techniques covered in this course with any computing tools (MatLab, Scilab, etc...).

Prepare research paper and submit report of various Digital Controller Design covered in this course with presentation.

List of Laboratory/Learning Resources Required:

- Matlab, Scilab
- NPTEL

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