EE-606/EEE-606 OPTIMAL CONTROL

(w. e. f. Session 2018-19)

L	T	P	C
4	0	0	4

Pre-requisites: None **Co-requisites:** None

Unit-1 Basic mathematical concepts and Dynamic programming

Finite dimensional optimization, Conditions for optimality, Optimal control law, Principle of optimality, Dynamic programming concept, Recurrence relation, Hamilton-Jacobi-Bellman equations, Performance measures for optimal control problems (8)

Unit-2 Calculus of variations

Basic calculus of variations problem, Weak and strong extrema, Variable end point problems, Hamiltonian formalism and mechanics: Hamilton's canonical equations, Necessary conditions for strong extrema, Calculus of variations versus optimal control, Optimal control problem formulation and assumptions, Variational approach to the fixed time, Free end point problem. (8)

UNIT-3 The Pontryagin's Minimum principle

Statement of Minimum principle for basic fixed end point and variable end point control problems, Proof of the minimum principle and state inequality constraints, Properties of the Hamiltonian, Time optimal control problems. (8)

UNIT-4 The Linear Quadratic Regulator

Finite horizon LQR problem - Candidate optimal feedback law, Ricatti differential equations (RDE), Global existence of solution for the RDE; Infinite horizon LQR problem - Existence and properties of the limit, Solution, Closed loop stability. (8)

UNIT-5 Minimum Time problems

Minimum control–effort problems, Singular intervals in optimal control problems, Numerical determination of optimal trajectories – Two point boundary – valve problems, Methods of steepest decent, Variation of extremals. (8)

References:

1. D.E. Kirk, "Optimal Control Theory- An Introduction", Dover Publications, New York, 2004.
2. Alok Sinha, "Linear Systems- Optimal and Robust Controls", CRC Press, 2007.
3. Jason L. Speyer, David H. Jacobson, "Primer on Optimal Control Theory", SIAM, 2010.
4. Ben-Asher, Joseph Z, "Optimal Control Theory with Aerospace Applications", American Institute of Aeronautics and Astronautics, 2010
5. Daniel Liberzone, "Calculus of variations and Optimal control theory", Princiton University press, 2012.

EEE-607/EE-607 COMPUTATIONAL TECHNIQUES IN CONTROL ENGINEERING

(w.e.f. session 2018-19)

L	**T**	**P**	**C**
3	**0**	**0**	**3**

Pre requisites: None **Co requisites**: None

UNIT -1 Introduction to Automatic control

Optimal Control, Discrete control, Embedded Control, Robust control Graph and matroid decompositions, Applications of control theory (8)

UNIT-2 The activities of Control and Computing

Computational methods for systems theory, Cryptography and coding theory, Dynamic programming, Dynamical systems, Grobner basis methods (8)

UNIT-3 Intelligent techniques

An overview of intelligent techniques, Fuzzy logic and Neural Networks Fundamentals, Back propagation model, Fuzzy Control Applications, Numerical Techniques. (8)

UNIT-4 Robot control and linear methods

Feed forward control, State feedback, Nonlinear Control methods, Computed Torque Control, Feedback linearization, Linear quadratic control, Application of energy storage system control.

(8)

References:

1. Gupta S.K., "Numerical Methods for Engineers", New Age International, 1995
2. Mariesa L. Crow, "Computational Methods for Electric Power Systems", CRC Press, 2015.
3. Cornelius Leondes, "Digital Control Systems Implementation and Computational Techniques", Volume 79, 25th June 1996, Academic Press, 1996.
4. Robert E King, "Computational intelligence in control engineering", Marcel Dekker, New York, 1999.

EE-608/ EEE-608 ADVANCE PROCESS CONTROL

(w. e. f. 2018-19)

LT PC

3 0 0 3

Pre-requisite: Process Instrumentation and control (EE 507/EEE 507) **Co-requisite:** None

Unit-1 Development of Control Relevant Linear Perturbation Models

Linearization of Mechanistic Models, Introduction to z-transforms and Development of White-box models, Grey-box models, Black-box models, Models for computer control, Digital control, State Realizations of Transfer Function Models (8)

Unit-2 Stability Analysis of discrete time system and Multi-loop Control

Discrete Time Models, Stability of Unforced System, Stability of Autonomous Systems, BIBO Stability, Stability of Non-autonomous System, Loop Interactions, Multi-loop Control, Internal Model Control (8)

Unit-3 System State Estimation

Model Based Soft Sensing, Soft Sensing Approaches, State Estimation, Development of Luenberger Observer, Single Output System (SOS) Luenberger Observer, Prediction Estimation, Optimal State Estimation, Introduction to Kalman Filtering. (8)

Unit-4 Linear Quadratic Optimal Control and Model Predictive Control

Pole Placement State Feedback Control Design and Introduction to Linear Quadratic Gaussian (LQG) Control, Linear Quadratic Gaussian (LQG) Regulator Design, Linear Quadratic Gaussian (LQG) Controller Design, Model Predictive Control (MPC). (8)

References:

1. Gelb, A., "Applied Optimal Estimation", MIT Press, 1974.
2. Franklin, G. F., Powell, J. D., and M. L. Workman, "Digital Control Systems", Addison Wesley, 1990.
3. Astrom, K.J. and B. Wittenmark, "Computer Controlled Systems", Prentice Hall, 1994.
4. Ljung. L., Glad. T., "Modeling of Dynamic Systems", Prentice Hall, N. J., 1994.
5. Cecil L. Smith, "Advanced Process Control: Beyond Single Loop Control", 1st Edition, Wiley-AIChE Publication, 2010.

EE-609/ EEE-609 COMPUTER CONTROL OF PROCESSES

(w.e.f. 2018-19)

L T P C

3 0 0 3

Pre-requisite: None **Co-requisite: None**

Unit-1 Computer control

Introduction of Computer control, Review of Z Transform, Modified Z Transform and Delta Transform, Relation between Discrete and Continuous Transfer function, Poles and Zeros of Sampled Data System (SDS), Stability Analysis in Z domain (8)

Unit-2 Pulse Transfer function

Introduction to Pulse Transfer function; Open loop and closed loop response of Sampled Data System (SDS); Design and implementation of different digital control algorithm: Dead beat, Smith predictor and Internal Model Control algorithm (8)

Unit-3 Discrete System

Different Models of Discrete System; Linear time-invariant systems (LTI systems); Family of Discrete Transfer function Models: State Space models, Distributed Parameter Model, Models for Time varying and Non-linear System, Linear Time varying models, Non-linear State space models (8)

Unit-4 Adaptive Control

Introduction to Adaptive Control; Deterministic Self Tuning Regulator: Indirect and Direct self tuning regulator, Continuous time self tuners, Disturbances with known characteristics. (8)

References:

1. Lennart Ljung, "System Identification Theory for the user", PTR Prentice Hall Information and system sciences Series, NJ, 1999.
2. P. Deshponde and Ash, "Computer Controlled System", ISA Press, USA, 1988.
3. Richard H. Middleton and Graham C. Goodwin, "Digital Control and Estimation A Unified Approach", Printice Hall NJ, 1990.
4. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, "Process Dynamics and Control", Willey India, 2006.
5. Astrom. K. J., Bjorn Wittenmark, "Adaptive Control", Second Edition, Prentice Hall of India, New Delhi, 1994.