MODEL PREDICTIVE CONTROL: THEORY AND APPLICATIONS

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TYPE OF COURSE : New | Elective | PG
COURSE DURATION : 12 Weeks (18 Jan' 21 - 09 Apr' 21)
EXAM DATE : 24 Apr 2021

PRE-REQUISITES : UG Math (covering linear algebra) and
Any of the following courses: Process Control; Control Engineering / Systems; Digital Control

INTENDED AUDIENCE : Post-Graduate students; final year UG; industry / research professionals

INDUSTRIES APPLICABLE TO : Automation companies, such as: ABB, Honeywell, Yokogawa, Aspen Tech, Siemens, Emerson, Rockwell, Schnieder and GE.
Chemical Process Companies, such as: Shell, IOCL, HPCL, BPCL, Reliance, ONGC, Exxon Mobil, Praxair, etc.

COURSE OUTLINE :

Model Predictive Control (MPC) is one of the predominant advanced control techniques. MPC originated in the chemical process industry and is now applicable to a wide range of application areas. MPC is an optimization-based technique, which uses predictions from a model over a future control horizon to determine control inputs. This course will provide an overview of MPC, and will cover both theory and practical applications. The course will involve MATLAB-based hands-on learning modules for understanding and solving advanced control problems. The course will cover multiple aspects of MPC implementation, including dynamical system models, state estimation, unconstrained and constrained optimal control, and model identification.

ABOUT INSTRUCTOR :

Dr. Kaisare received his PhD in Chemical Engineering at Georgia Tech, working on "Modeling, Analysis and Control of Nonlinear Switching Systems." Thereafter, he did a post-doc at University of Delaware working on modeling of microchemical systems for portable power generation. He then spent four years as Assistant Professor in IIT-Madras. He then switched to industrial R&D for three years, working at General Motors and ABB Corporate Research. He joined back in November 2014 as Associate Professor in Chemical Engineering at IIT-Madras

COURSE PLAN :

Week 1: Models for MPC: Step-Response Models Finite impulse and step response models; Model prediction; Parameter estimation

Week 2: Models for MPC: Linear Time Invariant (LTI) models State-space models; Transfer function models; Model transformation

Week 3: Model analysis and Disturbance Modeling Model stability; Observability and controllability Representing uncertainty; White, colored and integrating noise

Week 4: Dynamic Matrix Control Step-response based MPC

Week 5: Linear State Estimation State observer; Pole placement; Stability

Week 6: Optimal Linear State Estimation Kalman Filter; Stochastic filtering theory

Week 7: Linear Control Systems Linear control; pole placement; stability

Week 8: Unconstrained linear quadratic control LQ control theory

Week 9: Constrained LQ control Constrained LQ control theory

Week 10: State-Space MPC State-space MPC; deterministic formulation; state feedback control

Week 11: State-Space Output-Feedback MPC Separation principle; Implementation of output feedback MPC

Week 12: Practical Implementation Nonlinear systems; Multi-rate system; Inferential control