Modelling and control of Dynamic Electro-Mechanical System - Web course

COURSE OUTLINE

This course is based on the identification, modeling and control of dynamic mechanical systems. It begins with the modeling of different mechanical systems and their representation in time and frequency domain. Transfer function and State-space models will be discussed along with graphic representations like signal flow graph and block diagram. Next, the response of different systems will be classified and discussed into three groups ¸ first order systems, second order system and higher order systems. The specifications corresponding to transient response, steady state response and stability will be defined. Design of controllers based on these specifications will be carried out for various mechanical systems. The course will then deal with state-space representation of the system and design of controller based on eigen-value and eigen structure assignment. In case of partial state feedback, the design of observers will be discussed, along with conditions of observability and controllability of the dynamic system. Finally, the system will be described in discrete time domain and the corresponding stability conditions will be developed.

Course Contents:

Physical System Modelling, Modelling of Mechanical, Electrical and Electro-mechanical Systems, Transfer Function and State Space Approach. Response of Dynamic Systems, First order, Second Order and Higher Order System Response, Transient and Steady-state system specifications, Stability of the Dynamic Systems. Frequency Domain Control of Systems, Techniques of Proportional, Lead, Lad and Lead-Lag Control, Design of Controller. State-space Control of Systems, Full state and output feedback control, Observer Design, Optimal Control, Liapunov Stability Criteria, Matrix and Algebraic Ricatti Equations. Discrete Control of Dynamic Systems, Zero-order hold, Transformation from Continuous to Discrete time, Sampling and Aliasing, System Eigen Values, Sensor Modellling and Model Order Reduction.

COURSE DETAIL

Lectures	Course Titles
1	Introduction to System Modelling
2	Information Organization through Block Diagram
3	Information Organization through Signal Flow Graph
4	State Space Approach in Modelling
5	Dynamic Modelling of Mechanical Systems
6	Dynamic Modelling: Energy Approach
7	Modeling of Electrical Elements

NPTEL

http://nptel.iitm.ac.in

Mechanical Engineering

Pre-requisites:

Some background of Ordinary Differential Equation, Signal Transformation and Linear Algebra will be required.

Coordinators:

Prof. Bishakh Bhattacharya
Department of Mechanical EngineeringIIT Kanpur

8	A Brief Review of Laplace Transforms
9	Dynamic Response of First Order Systems
10	Dynamic Response of Second Order Systems
11	Steady State error of a System
12	Stability of a Dynamic System
13	Stability of a Time-Variant Dynamic System
14	Nyquist Stability Criteria
15	Frequency Response study using Nyquist Criteria
16	Root Locus Method – Part 1
17	Root Locus Method Part 2
18	Effect of Different Parameters on Root Locus
19	Design of Controller using Root Locus Method
20	Design of a Lead Compensator
21	Lead-Lag Compensator and Notch Filter
22	Time Delay and Use of MATLAB in Controller Design
23	PID Controller Design
24	PID Controller Design – Part B
25	Introduction to Bode Plot
26	Bode Plot for Controller Design
27	State Space Design

28	Controllability & Observability of Dynamic Systems
29	Full State Feedback Control
30	Full State Feedback Control (non-canonical)
31	Observer Design
32	Reduced Order Observer Design
33	Optimal Controller Design Using Linear Quadratic Regulator
34	Direct Output Feedback Control
35	Independent Modal Space Control for Flexible Dynamic Systems
36	Introduction to Actuators
37	High Precision and Advanced Actuators
38	Actuator Governing Equation
39	Introduction to Photo Sensors
40	Introduction to Position Sensing

References:

1. Identification and Control of Mechanical Systems, Juang and Phan, Cambridge University Press
2. Feedback Control of Dynamic Systems, Franklin, Powell and Naeini, Pearson Education
3. Dynamic Systems Control, Skelton, John Wiley and Sons
4. Control System Design, Friedland, Dover Publication
5. Control Systems Engineering, Nise, John Wiley
6. Dynamic Systems and Response, Kelly, Cengage Publication

NOTE: Some additional material to cover non additive processes is not in books. I will try to prepare a handout for the same.