

SYLLABUS OF MASTER IN CONTROL SYSTEM ENGINEERING

First Semester

Category - Departmental / Specialization Basket

Paper- I

PG /CNSE/T / 111A Modelling and Simulation of Dynamic Systems

State variable Modelling of Continuous Dynamic Systems. Solution methods for Nonlinear Differential equations. Bond Graph Techniques. Simulation Software. Skeletal Structure of Simulation software. Packages and Scripting Techniques. Real-time simulation systems. Case studies. Qualitative Modelling.

Paper- II

PG /CNSE/T/ 112A Control System Engineering

Review of classical control theory: Stability margins, correlation of frequency domain and time domain parameters, design specifications, compensation of continuous systems, actuator selection and design.

State variable modelling of linear continuous systems, controllability and observability.

Concepts of linear sampled data systems: Discrete equivalents of continuous data systems, reconstruction of sampled signals, sample and 0 order holds, stability of linear sampled data systems.

State variable modelling of linear discrete data systems, controllability and observability.

Paper- III

PG /CNSE/T/ 113A Digital Control Theory

Structure of a computer controlled system. Review of Z-transform. Computation of time response of Discrete Data system. Bilinear Transformation. W-plane, prewarping, inverse transformation. Design of discrete controllers. Z-domain compensation, w-plane compensation, state variable feed back, deadbeat controller sampled data version of PID controllers. Effect of Data Digitization. Effect of finite word size, limit cycle determination.

Paper- V

PG /CNSE/T/ 115A Rockets and Missiles

Introductory concepts:

Classification of Rockets & Missiles, components, subsystems and layout, launching techniques, variation of air density with altitude, Indian Standard atmosphere.

Motion of Rockets – external ballistics and powered motion:

Equations of motion in point mass mode, static stability, motion about the CG, special case like exo-atmospheric, vertical ascent motion, tip-off, reentry.

Elementary Missile Guidance Principles:

Guidance schemes, command guidance, proportional navigation, inertial sensors and auxiliaries, concept of quaternion, strapped down inertial navigation.

Aerodynamics of Subsonic and supersonic vehicles:

Drag coefficients, lift coefficients, wake and down wash effects, design consideration.

The airframe – structural, functional and aerodynamic aspects:

Control schemes: Aerodynamic, thrust vectoring, actuation systems.

Propulsion systems:

General considerations, thrust-time characteristics, ISP, solid propulsion systems (construction and subsystems, propellant types, composition and characteristics), liquid propulsion system (Construction and subsystems, propellant types, composition and characteristics, cryogenic propulsion systems), RamJet concepts, Nozzle design consideration.

Category – Sessional Courses

Sessional – I

PG /CNSE/ S / 111 Laboratory

Sessional – II

PG /CNSE/S / 112 Seminar

Second Semester

Category - Departmental / Specialization Basket

Paper – VII

PG /CNSE/T/ 127A Computer Control of Industrial Processes

Introduction to computer Control: Brief History, Advantages, different types and application areas, Direct Digital Control and Supervisory Control, SCADA, Embedded Controller.

Example Processes: Standard SISO process, first order with delay Standard sensors and actuators. Simple MIMO process. Batch process, which require sequential control.

Architecture of a Computer Control System: Generic architecture. Use of Context diagram and DFD for architectural description. Specific Examples

Interfacing : Digital data transfer from peripherals, polling, interrupt, DMA. Interfacing considerations for field Input-output.

Programmable Logic Controllers: Features functionalities and Architecture, Examples of programming and applications

DDC controllers: Features functionalities and Architecture, Examples. DDC algorithms. Digital Implementation of Two term (PI, PD) and three term (PID) controller. Implementation of digital compensators. Model Based Control and their digital implementations.

Distributed Control: Architecture, advantages. Communication for distributed control. Field Bus. Application Examples.

PG /CNSE/T/ 127B Optimal and Robust Control

Optimal Control Systems and Performance Indices. Optimal Control of linear systems with Quadratic Performance Index. Optimal State Regulator Design through Matrix Riccati equation. Properties and Application of the Optimal Regulator. Linear Quadratic Gaussian (LQG) Control. State Estimator Design. System Design using State Estimators. Loop Transfer Recovery (LTR). Frequency Shaping. Robust Control Systems and System sensitivity. Uncertainty and Robustness. Structured and Unstructured uncertainty. Internal Stability. Kharitnov's methodology. Stability robustness and Performance robustness of Control Systems. Mu-Synthesis. Robust Tracking. H₂ and H-infinity Control. H-Infinity Loop Shaping. Gap Metric. Linear Matrix Inequalities (LMI). Quantitative Feedback Theory (QFT).

PAPER VIII

PG /CNSE/T/ 128A Nonlinear and Adaptive Control

A: Nonlinear Control

State-space representation of non-linear systems, Common nonlinearities and their origin, Examples of phase plane analysis for relay based control, Popov's stability criterion, Local linearization, Jacobian and Lyapunov's first theorem, Stability analysis by Lyapunov theory, Describing function method and Limit cycle, Feedback linearization, Sliding Mode Control, Concepts of observability for non-linear systems

B: Adaptive Control

Linear parametric model, Adaptive laws, Model reference adaptive control, Robustness in adaptive control, Adaptive control of nonlinear systems, Gain scheduling control

PG /CNSE/T/ 128B Real Time Systems

Overview of Real time systems.

Definition, evolution, typology, structure and applications.

Temporal Modelling and specification of real time systems.

State diagram, finite automata model, petri-net, state chart and mode chart, Q-model, formal methods.

Sequential and logic control.

Ladder diagram, PLC programming, case studies in interlocking and sequence control.

Hardware Components and Configuration of real time system.

Interfacing systems for analog and digital I/O, programmable logic control system architecture, computer control system architecture, flight control systems, hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy.

Real time Operating systems.

Features, primary components.

Structured design of real time systems.

Data flow oriented method of analysis and design. Mode chart oriented methods.

Development, integration and validation of real time systems.

Special consideration for safety critical systems.

PAPER IX

PG /CNSE/T/ 129A Control and Guidance

Handling Criteria of Piloted Aircraft.

Motion of a Missile in 6 DOF.

Euler angle and quaternion. Six DOF equation of motion, structure of 6 DOF simulation.

Roll autopilot for missiles

Equation of motion, transfer function, objective and structure.

Lateral stabilisation of missiles.

Equation of motion, transfer functions, structure and design of lateral missile autopilots.

Pitch plane control of aircraft.

Objectives, structure of stability augmentation systems, pitch demand, q-demand, n-demand and alpha demand FCS control systems.

Lateral control of bank to turn vehicles.

Goals and structure of lateral FCS, coordinated turn, roll lateral coupling, cross feed.

Command guidance.

Scheme, optical and microwave beam riding on board and components, block diagram, transfer function.

Homing guidance.

Proportional navigation, modified proportional navigation, engagement kinematics, effect of seeker dynamics, seeker and homing heads-tracking, stabilisation and filtering.

Inertial navigation.

Basic concepts, stabilised platform, strapped down INS, error analysis.

Special control problems.

Inertial coupling (TWD), high alpha coupling, canard control, moving wing control, structure control interaction.

Category – Sessional Courses

Sessional – I

PG /CNSE/ S / 121 Term Paper Leading to Thesis

Sessional – II

PG /CNSE/S / 122 Seminar

Third and Fourth Semester

Sessional 1

PG /CNSE/ TH / 21 Thesis Work

Sessional 2

PG /CNSE/ VV/ 22 Viva – Voce