Course Title: Nonlinear Dynamics and Chaos

Course Code: EE702

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II. **Tools for Detecting Chaos:** Saddle-node, transcritical, pitchfork bifurcations, hopf bifurcation, global bifurcations, Center manifold theory and Poincare maps, Lyapunov Exponents, Power spectrum, phase plane, Stable and Unstable Manifolds, Frequency Spectra of Orbits, Dynamics on a Torus, analysis of Chaotic Time Series.

III. **Discrete Time Dynamical Systems:** Poincare section, Logistics map, Henon map, strange attractors

IV. **Theory of Bifurcations:** Saddle-node, transcritical, pitchfork bifurcations, Hopf bifurcation, global bifurcations, Stable and Unstable Manifolds, Center manifold theory.

Examples of chaotic systems: Lorenz Equation, Rossler Equation, Forced Pendulum and Duffing oscillator, Chua's Circuit

V. **Analysis, Control, and Application of Chaos:** Need for chaos control, the OGY method, PC method, optimal control, Adaptive control, Non-feedback control, Feedback control, Physics (Laser, Plasma), Electrical and Electronic Systems (Electrical drive/power system), Communication Systems.

VI. **Chaos Synchronization and its Applications:** Types and method of synchronization, synchronization in complex systems, synchronization technique using (PID, Adaptive, Active, Sliding Mode, Optimal) control, chaos-synchronization-based secure communications.
Text/References

10. M W Hirsch, S Smale, R L Devaney, Differential Equations, Dynamical Systems, and an Introduction to Chaos
Course Title: Fractional Order Control System

Course Code: EE703

L T P CR CH: 2 1 1 4 5

I. **Introduction to Fractional Calculus:** Brief history of fractional calculus, Different methods to calculate fractional order derivative and integration (Definition given by Riemann-Liouville, Grunwald-Letnikov, Caputo, Euler etc.), fractional derivative without singular kernel, special functions used in fractional calculus. Laplace transform of fractional derivative and integrals. Solution of fractional order differential equations.

II. **Fractional-order System Analysis:** Relevance of fractional order in control systems. Fractional order transfer function, Stability of fractional order systems. Transient and steady state behavior of fractional order systems. Frequency domain analysis of fractional order transfer function, Outstaloup’s approximation of fractional order transfer function.

III. **State Space Analysis of Fractional-order System:** State space representation of fractional order system, solution of state equation, controllability, observability, discrete time state space analysis.

IV. **Fractional-order System Identification and Modeling:** Fractional order modelling of physical system using time domain and frequency domain analysis, System Identification in fractional order using FOMCON, NINTEGER MATLAB toolboxes.

V. **Fractional-order Controller Design and Implementation:** Fractional order PID controller, fractional order lead and lag compensator, fractional order sliding mode control, fractional order H infinity control, Crone’s controller, realization of fractional order controllers and implementation issues.

Reference books:

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<tr>
<th>Sl. No.</th>
<th>Book</th>
<th>Author</th>
<th>Publisher</th>
<th>Year of publication</th>
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<tr>
<td>1.</td>
<td>Fractional Order Systems and Control</td>
<td>Concepcion <em>et al</em></td>
<td>Springer</td>
<td>2010</td>
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<td>3.</td>
<td>Functional Fractional Calculus</td>
<td>Santanu Das</td>
<td>Springer</td>
<td>2011</td>
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<td>4.</td>
<td>Design, Control, Synchronisation and Applications of Fractional-order Chaotic Systems</td>
<td>Manashita Borah</td>
<td>NIT Silchar</td>
<td>2018</td>
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<tr>
<td></td>
<td>Title</td>
<td>Authors</td>
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<td>Year</td>
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<td>5.</td>
<td>Fractional Order Dynamics and Control</td>
<td>Dumitru Baleanuet al</td>
<td>Springer</td>
<td>2012</td>
</tr>
<tr>
<td>6.</td>
<td>Fractional Order Differentiation and Robust Control Design</td>
<td>Sabatier et al</td>
<td>Springer</td>
<td>2015</td>
</tr>
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</table>

**Reference papers:**


3. Special issue of Chaos Solitons and Fractals, Papers appeared in volumes 113 to 117 (1918).
Course Title: Transducers & Sensor Technology

Course Code: EE704

L  T  P  CR  CH: 2 1 1 4 5

Unit- I Transducer Characteristics: General concepts and terminology of measurement systems: Transfer Function, Span (Full-Scale Input), Full-Scale Output, Accuracy, Calibration, Calibration Error, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Resolution, Special Properties, Output Impedance, Excitation, Dynamic Characteristics, Environmental Factors, Reliability. Modeling and analysis of the measuring system, standards and calibration of the measuring instrument.

Unit-II Transducers: Classifications, working principle, construction and design of various active and passive transducers. Voltage and current transducers, Tap position transducers. Hall effect transducers, optical transducers. Semiconductor traducers for physical and chemical parameters measurement.

Unit-III Signal Conditioning Circuit: Design of detection electronics and signal conditioning circuits for various resistive, capacitive, inductive transducers. Active filters, Impedance matching, loading effect. Introduction to electromagnetic coupling (EMC), inference coupling mechanism, shielding.

Unit-IV Industrial Application: Applications of Industrial transducers: Thermal sensors, Fluid flow measurement, Level measurement, Strain measurement, Load cell, measurement of industrial parameters using non invasive techniques (Ultrasonic and infrared sensing) Application of sensors in pollution monitoring. Transducers activated RFID tags.

Unit-V Intelligent Sensor and Interfacing: Introduction to Intelligent sensor, Description, Architecture of Intelligent sensor, Concepts of interfacing with digital device like computer, microcontroller microprocessor. Data Acquisition, application ADC/DAC for interfacing. Application of Artificial Neural Network and Fuzzy logic technique in intelligent sensing.

Text/Reference Books:

Course Title: Embedded System & IoT

Course Code: EE705

L T P CR CH: 2 1 1 4 5

UNIT I – Introduction

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems.

UNIT II – Overview of PIC, ARM and CORTEX

Background of PIC, ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development. Cortex- Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode,. Implementation Overview and programming on PIC, ARM and Cortex.

UNIT III – IoT-An Architectural Overview

Internet of Things Promises–Definition– Scope–Sensors for IoT Applications – Structure of IoT– IoT Map Device. Building an architecture, Main design principles and needed capabilities, M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT IV –IoT: Application Area, Recent Development & Project

Application of IoT in Health, Wearable Devices, Smart Home, Smart Grid, Smart retail etc. Creating the sensor project - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data - Creating the actuator project Hardware - Interfacing the hardware - Creating a controller - Representing sensor values - Parsing sensor data - Calculating control states - Creating a camera - Hardware – Recent Development and changes. (Referencing to recent research paper).

UNIT V – Iot Data Link Layer & Network Layer Protocols

PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP.
References: