

Centre of Excellence in

“Complex & Nonlinear Dynamical Systems”

VJTI, Matunga, Mumbai

The study of complex and nonlinear dynamical systems is one of the most exciting and fastest growing fundamental research areas. Its intrinsic interdisciplinary nature has attracted scientists and engineers across many different streams to develop innovative ideas and methods to study complex behaviour exhibited by many natural and man-made systems. It is having an imperative impact on variety of applied engineering branches ranging from the study of turbulence and the behaviour of the weather, through the investigation of electrical and mechanical oscillations, robotics, cryptography, nonlinear transient stability in electrical power systems, fluidization process, plasma, to the analysis of biological and economical phenomena. It has also fired the public’s imagination under the popular name of “chaos”.

A common theme among these and many other examples is the underlying universal laws of nonlinear science that govern the behaviour, in space and time, of a given system. These laws are universal in the sense that they transcend the model-specific features of a system and so they can be readily applied to explain and predict the behaviour of a wide ranging phenomenon. VJTI is having a long history of expertise in the advanced and nonlinear dynamics working in various branches of engineering. The proposed Centre of Excellence (CoE) shall bring their synergies together and act as a focal point for the interdisciplinary research into the theory of complex and nonlinear dynamics and its applications across science and engineering. We have identified four theoretical areas (TA) and five application domains (AD) which are listed below:

Theoretical Area (TA)

- **TA1**-Mathematical Modeling (Geometric mechanics, ode, pde, multi-scale, Graph Theoretic)
- **TA2**-Analysis (Stability, Controllability, Observability, Bifurcation analysis)
- **TA3**-Numerical Simulations& Tool integration
- **TA4**-Situational Awareness & Control

Application Domain (AD)

- **AD1**-Pulse Power & Plasma Dynamics
- **AD2**-Mechanisms & Machinery (Robotics, Aerospace)
- **AD3**- Energy (Renewable Energy & High Voltage Engineering, Partial Discharge)
- **AD4**-Fluidics & Fluid dynamics
- **AD5**-Structural Dynamics

Specific Thematic Areas of TEQIP Covered:

- Fundamental research areas- Advanced mechanics, dynamics, flow control, fluidics
- Renewable Energy integration to power grid
- Robotics

Key Objectives of the CoE:

The proposed CoE is aimed at developing a rigorous and unified framework for both theoretical and applied research in the area of complex and nonlinear dynamical systems by interconnecting scattered groups to create critical mass and complementarity. Following are the key objectives:

- To foster in both ways fundamental studies and applications by collaborative research
- To develop a basis for a unified framework harnessing complex and nonlinear systems
- To motivate and integrate multi-disciplinary approaches to complex problems
- To contribute in nation's growth- technologically & socially by synthesising the obtained results and methodologies into unified strategies, criteria and procedures for design of new devices and processes.
- Facilitate the interchange of scientific results and ideas between various institutes, industries and research organizations within and outside India
- Promote use of open-source softwares in fundamental research areas

Structure of the CoE:

- Participating Faculty- 7 (6 PhD with 2 having Post-Doctoral research experience)
- Participating Departments- 5 (Electrical, Electronics, Mechanical, Structural, Physics)
- Research Assistants- 14 (2 each for the 7 participating faculties)
- Collaborative Arrangements:
 - Academic/Research Institutes (Within India): IIT Bombay, IIT Madras, BARC, ISRO
 - Academic/Research Institutes (Outside India): MIT (USA), IOWA State University (USA), CNRS France, University of Western Australia (UWA), University of Groningen- The Netherlands, Queensland University of Technology.
 - Industry Partners: KUKA Robotics, Emerson, Larsen & Toubro, Siemens
 - Policy Makers/PSUs: PGCIL, MERC

Team Members

1. Prof. Faruk S. Kazi (Electrical Department)
2. Prof. N. M. Singh (Electrical Department)
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