Motilal Nehru National Institute of Technology
Allahabad

One-Week GIAN Course on
(Face-to-Face mode)

![GIAN](GLOBAL INITIATIVE OF ACADEMIC NETWORKS)

Resilient Control of Cyber-physical Systems
February 3-7, 2025

Under the
Global Initiative for Academic Networks (GIAN)
Ministry of Education (MoE), Government of India.

Organized by
Department of Electrical Engineering
Motilal Nehru National Institute of Technology Allahabad, Prayagraj, India.

Organizing Committee

Patron	**Prof. Rama Shanker Verma** Director, MNNITA.
Chairperson	**Prof. Richa Negi** Head, EED, MNNITA.
Foreign Expert	**Prof. Hamid-Reza Karimi** Department of Mechanical Engineering Politecnico di Milano, 20156 Milan, Italy.
Course Coordinator(s)	**1. Dr. Dipayan Guha** Department of Electrical Engineering, MNNITA. **2. Dr. Souradip De** Department of Electrical Engineering, MNNITA.
Local Coordinator	**Prof. G. P. Sahu** School of Management Studies, MNNITA.

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About the Course

In the Industry 4.0 and beyond to Industry 6.0 revolution, the exponential growth of Information Communication Technologies (ICT) and Network-based Control Systems (NCSs) has reshaped modern industrial systems, seamlessly integrating physical and cyber sub-systems/components. Interaction among the physical, cyber, and communication layers gives rise to network-based cyber-physical systems (CPSs). *This course will introduce systematic approaches to designing resilient cyber-tolerant control frameworks for industrial CPSs.*
The course content will cover topics related to: *(i) robustness assessment and guaranteeing high degrees of resiliency through artificial intelligence-based control approaches, (ii) model predictive control design, (iii) rigorous stability analysis, and applications.* The course content starts with an introduction to the resiliency of uncertain affine systems with malicious cyber-attacks basics.
The fundamentals and advanced concepts of robust control algorithms will be discussed in detail, including Sliding mode, fixed-time control, and H$_\infty$ control, as well as neural-network-based observer/controller design and applications to delayed-CPS. Active disturbance rejection control (ADRC) approaches housing states/detectable attack estimation techniques will be discussed; these include linear/nonlinear observers, AI-based observers, etc. Kalman's theory will be addressed with tutorial examples for state estimation with malicious cyber-attacks. Subsequently, the course will address recent advances in resilient model predictive control of CPS with challenging system nonlinearities. A rigorous study on the formation of stability conditions for time-delayed CPS will be addressed considering sensors/actuators faults/attacks.
The lectures will also illustrate dynamic MPC methodologies through several practical examples. Finally, case studies on industrial applications of resilient control CPS will be presented; these include Flight control, Autonomous Vehicles, Robotics, and Smart Grid. *Course participants will learn these topics through lectures and hands-on experiments/tutorials. Also case studies and assignments will be shared to stimulate research motivation of participants.*
After the successful completion of this course, participants will be able to:
[i] demonstrate the resiliency of uncertain affine systems with malicious cyber-attacks.
[ii] discuss the design methodologies for affirming resiliency of CPS.
[iii] understand resilient control frameworks for industrial CPSs.
[iv] study/derive the stability approaches of delayed-CPS.
[v] familiarize and develop artificial intelligence (AI)-based attack's detection/mitigation methodologies.
[vi] discuss model predictive control (MPC) frameworks for resilient CPS.

The entire course has been organized into three modules as elaborated below.
    Module A: Robust control of CPS [5hrs (L) + 2hrs (T)].
    Module B: CPS Modelling and Control framework [6hrs (L) + 2hrs (T)].
    Module C: Model predictive control of CPS [3hrs (L) + 2hrs (T)].

Participants will be evaluated through Assignments/Quiz. After successful completion of the course, all participants will get participation certificates.

About Foreign Expert

Prof. Hamid-Reza Karimi is currently a Professor of Applied Mechanics with the Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy. Karimi's original research and development achievements span a broad spectrum within the topic of automation/control systems, and intelligence systems with applications to complex systems such as wind turbines, vehicles, robotics and mechatronics. Prof. Karimi is an ordinary Member of *Academia Europa (MAE)*, Honorary Academic Member of *National Academy of Sciences of Bolivia*, Distinguished Fellow of *the International Institute of Acoustics and Vibration (IIAV),*Fellow of The *International Society for Condition Monitoring* (ISCM), Fellow of the Asia-Pacific Artificial Intelligence Association (AAIA), Member of Agder Academy of Science and Letters and also a member of the IFAC Technical Committee on Mechatronic Systems, the IFAC Technical Committee on Robust Control, the IFAC Technical Committee on Automotive Control as well as member of the board of Directors of The International Institute of Acoustics and Vibration (IIAV). Prof. Karimi is currently the Editor-in-Chief of the Journal of Cyber-Physical Systems. He has also participated as a distinguished speaker or program chair for several international conferences in the areas of Control Systems, Robotics and Mechatronics.

About MNNIT Allahabad

Motilal Nehru National Institute of Technology Allahabad, Prayagraj is an Institute with total commitment to quality and excellence in academic pursuits. It was established as the 17th Regional Engineering Colleges in India in the year 1961 as a joint enterprise of Government of India and Government of Uttar Pradesh, and was an associated college of University of Allahabad, which is the third oldest university in India. On June 26, 2002, MNREC was transformed into NIT and Deemed University fully funded by Government of India. With the enactment of NIT Act-2007 (29 to 2007), the Institute has been granted the status of institution of national importance *w.e.f.* 15.08.2007. The first Master's Programme of the Institute was introduced by the Mechanical Engineering Department in the year 1966 and in all other Engineering Departments, were introduced in the 1970-71. To add a new dimension to itself the Institute established School of Management studies in 1996, which offers a two year/four semester post graduate degree Programme in Management (MBA). The Institute has been recognized by the Government of India as one of the centers for the Quality Improvement Programme for M.Tech and Ph.D. The Institute has a very progressive policy towards extending all possible facilities to its faculty members to acquire higher degrees and receive advanced training. The Institute was selected as a lead institution in the Design theme under Indo-UK REC Project (1994-99). The Institute has been selected as a Lead Institution under World Bank funded Government of India Project on Technical Education Quality Improvement Programme (TEQIP) (2002-2007). It stands 60th place for its 'Engineering' category in the NIRF 2024 announced by MoE, GoI, and in top 15 NITs in the country.

Department of Electrical Engineering

The graduate course in Electrical Engineering was started in 1961. Subsequently post graduate programmes in Electrical Machine/Power System/Control System were introduced in the year 1970-71. The Department has well qualified and experienced faculty members in all the related fields of Electrical Engineering and well equipped laboratories. There is a widespread interaction between the Electrical Engineering Department and various other departments like Electronics and Communication Engineering, and Computer Science and Engineering, etc., in the field of teaching and research. Ph.D. started in the year 1971, and established a Ph.D. program under QIP in 2002.

Registration details: [GST No.: 09AAAJM1116B2ZR]

Participants Category	Registration Fees (in INR)	18% GST (in INR)	Total (in INR)
Students (UG/PG/Research scholars)	800/-	144/-	**944/-**
Faculty/Academicians	1,500/-	270/-	**1,770/-**
Industry personals	3,000/-	540/-	**3,540/-**

Account Name	**SNFCE MNNIT Allahabad**
Account Number	**10424975574**
IFSC Code	**SBIN0002580**
Bank and Branch	**SBI, MNNIT Allahabad**
Swift code	**SBININBB828**

Who can apply/attend the course?

❖ Executives, engineers and researchers from industries, service and government organizations including R&D laboratories.
❖ Students at all levels (B.Tech/B.Engg/M.Tech/PhD).
❖ Faculty from reputed academic institutions and technical institutions.
❖ **The registration fee is Non-refundable. Number of participants for the course will be limited to FIFTY.** The course will be organized in-physical/face-to-face mode.
❖ **The accommodation to participants may be provided in the Institute Guest House/Students' Hostels (based on the availability) on payment basis, as per the institute rules.**
❖ Mention *"09/GIAN-2025/EED/2024-25/SNFCE"*, as a remark while paying the registration fee.
❖ **Last date of Registration: January 28, 2025.**
❖ The registration fees include all instructional materials, registration kit, computer usage for tutorials and assignments, and free internet facility.
❖ **Complete the Registration by filling the Google Form Link:** https://forms.gle/WcotE11TPQv1Ykpc9