

Controller Design: Evolution from Classical to Machine Learning Framework

Overview

Applications of automatic control principles and control methods appear practically everywhere which range from consumer electronics, homes devices, communications systems, modern vehicles, mechatronics, bank sectors, to health services and so on. Automatic control methods with integration of information and communication systems are today pervasive in all fields of people's activities.

One of the major objectives of this course is to introduce the participants to the exciting area of control engineering where they will learn how the control theory has evolved over the years from classical control to adaptive, robust, predictive and machine learning based controllers. The first part of the course will acquaint the participants with fundamentals of conventional control strategies including physical significance of many commonly used control system terminologies such as poles, zeros, eigenvalues etc., which are the basis on which the course will proceed. Since most of the control strategies are model based, the availability and accuracy of a model are key to the successful controller design. The next part of the course will focus on identifying discrete parametric models from input/output measurements borrowing techniques from data driven modelling. In the third part, the participants will know the design of adaptive self-tuning controllers of various types such as minimum variance, generalised minimum variance for linear systems followed by design of predictive controller such as model predictive controller and generalised predictive controller.

At the last, focus will shift to controller design for nonlinear systems especially the classical feedback linearizing control to machine learning based intelligent controllers borrowing theory from bio-inspired computing such as genetic algorithms, particle swarm optimization and deep networks.

The course will consist of both lectures and hands-on tutorials/practical's wherein the concepts illustrated during the lectures will be exemplified by applying them to practical problems.

<p>Modules</p>	<p>July 7, 2025: Introduction to linear systems, Controller design for linear systems, data driven modeling followed by tutorial/practical session</p> <p>July 8, 2025: Least square algorithms for linear model fitting, design of minimum variance controller and generalized minimum variance controller, generalized predictive controller for linear systems-I and design of sliding mode controller followed by tutorial/practical session.</p> <p>July 9, 2025 : Generalized predictive controller for linear systems-II, Model predictive controller for linear systems, characteristics of non-linear systems followed by tutorial/practical session</p> <p>July 10, 2025: Feedback linearizing controller for nonlinear systems, Zero dynamics for nonlinear systems, Back-stepping controller design, Stability of nonlinear systems, Lyapunov based controller design</p> <p>July 11, 2025: Machine learning in the Design of Controller, GA based controller design: Tuning of PID gains, PSO based controller design, Introduction to Reinforcement Learning and Deep Learning Based Controller followed by tutorial/practical.</p> <p style="text-align: center;">Course Exam will be conducted on July 12, 2025 Number of participants for the course will be limited to fifty. All modules are compulsory to attend</p>
<p>You Should Attend If...</p>	<ul style="list-style-type: none"> ▪ You are an executive, engineer and researcher from industry and government organizations, including R&D laboratories interested in learning/working in control system. ▪ You are a student at levels M.Tech /Ph.D or Faculty from the reputed academic institutions interested in pursuing research in Control system with emphasis on design of linear and non-linear controllers.
<p>Fees</p>	<p>The participation fees for taking the course is as follows:</p> <p>Participants from abroad : US \$200 Industry/ Research Organizations: INR 6000 Academic Institutions: Rs. 3500/- (Faculty) & Rs. 1,000/- (Student) *An additional 18% GST is applicable for each participation fee as per institute norms.</p> <p>The above fee includes all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hrs free internet facility. The participants will be provided with accommodation on payment basis.</p> <p>Note: There is no central registration on the GIAN portal (gian.iith.ac.in); registration will be managed directly by the hosting institute.</p>

The Faculty



Prof. Akshya Swain is an internationally recognized expert in nonlinear system identification and control and lead the Applied Control and System Identification research group at the University of Auckland. He received Ph.D. degree from the Department of Automatic Control and Systems Engineering, The University of Sheffield, Sheffield, U.K. Currently he is with the Department of Electrical, Computer & Software Engineering in The University of Auckland, New Zealand. He has supervised 3 Post-Doctoral Researchers, 25 PhD students, 30 Master's Thesis to completion and currently supervising 10 PhD students. Akshya has authored/co-authored over 250 papers in different international journals and conferences including over 105 journal papers. The impact of his publications are obvious from citation figures: over 4000 Google Scholar Citations with an h-index=33; Over 3000 SCOPUS citations with an h-index=29. Dr. Swain is an Associate Editor of *IEEE Sensors Journal*, *Electronics*, *International Journal of Innovative Computing Information and Control (IJICIC)*, and Member of the Editorial Board of *International Journal of Automation and Control* and *International Journal of Sensors, Wireless Communications and Control*. He is a Series Editor of Book Series on : *Studies in Infrastructure and Control (Springer)*.



Dr. Amol D. Rahulkar is an Associate Professor in the Department of Electrical and Electronics Engineering at National Institute of Technology Goa. He is currently guiding research scholars in the field of Digital Signal/Image Processing, Control Systems, Wavelets, FPGA accelerators, Deep neural Networks. He has published many papers in the reputed journals and international conference proceedings. He is IEEE Senior Member and has more than 20 years of experience in teaching and research and is associated with sponsored projects funded by DST, MeitY etc.



Dr. T. Veerakumar is an Associate Professor in the Department Electronics and Communication Engineering at National Institute of Technology Goa. He has more than 15 years of experience in teaching & research and has been associated with sponsored projects funded by DST. He is currently guiding research scholars in the field of acoustic signal processing, hyperspectral imaging, and deep learning. He has published around 70 papers in international/national journals and conferences. His area of interests includes Image Denoising, Image Compression, Video Compression, Medical Image Analysis and Moving Object Detection and Tracking.

Venue:



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Registration Details:

Last date for registration: 30 /05/2025

Link for registration fee payment:

<https://forms.gle/PAYUWkQdM7UgCSuFol>

After paying the registration fee plus 18% GST, participants are requested to complete online registration process by filling details at below link.

<https://forms.gle/SDDHtckupSwr8YnX8>

Please note that the Registration fee is Nonrefundable.

Students have to attach **Bonafide certificate** or **photocopy of their valid identity card** along with registration form.

Selected participants will be informed through Email.

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For more information about GIAN, Please refer:

<https://gian.iith.ac.in/>