"Self control is the Strength
Systems and Control is the Mastery"
The Systems and Control group formed in 1977, is a unique interdisciplinary program in the country that offers post-graduate education (M. Tech./Ph. D.) in the broad area of Systems and Control.

The group has 10 core faculty members and about 11 associated faculty members from other academic units of the institute. The average doctoral strength is around 20 and the M. Tech. intake every year is around 16.

The research focus of the core group is in the areas of nonlinear control, robotics, pathplanning, automation and feedback control, coordination of autonomous vehicles, multi-agent systems, game theory, information theory, combinatorics, sliding mode control and applications, fractional-order modelling and control, optimization and optimization-based control, deep learning, NMR spectroscopy and stochastic processes. In addition, research in the areas of process control, identification, behavioural theory, matrix computation, adaptive control, automotive control are being pursued by the associate faculty members.

Many of the alumni of the group hold senior positions in the control and automation industry and research laboratories in the country.

Disclaimer

Though the ISCP (Institute Student Companion Program) has taken care while compiling the handbook, neither the council nor the Institute can be held responsible for errors/inadequacies that may inadvertently creep in. This handbook cannot be used as a basis for making a claim on facilities/concessions/interpretation of rules/statues or the like. If there is some critical information to which the reader of this handbook refers, it is with his or her own responsibility that it is put to use, with cross verification if need be.
Welcome Note from the Convener

Dear new entrants to SysCon,

At the outset I welcome you all on behalf of the faculty, staff and students at the Indian Institute of Technology, Bombay and in particular to Systems and Control group.

As you know that Systems and Control group is a unique group in India where we offer Ph.D, M.Tech and minor programmes in System and Control Engineering, I congratulate you all to get selected in such prestigious group. SysCon M.Tech program has a very good balance of theory and applied courses in control system.

Recent days are very exciting times for control engineers as this discipline is now widely recognized as an essential source of tools and technologies for advancement in nearly all spheres of human endeavour.

I hope you all will enjoy fully in going through several courses and project work during your stay here and also wish your stay becomes very enjoyable, fruitful and academically productive. I also wish you unparalleled success, unique accomplishments in your careers and professional pursuits in the coming years.

Once again wish you all a wonderful stay at IIT campus.
With my best wishes,

Prof. Bijnan Bandyopadhyay
Convener
Systems and Control Engineering &
Institute Chair Professor
About ISCP

Hello, Friends!

We hope you are just excited to be a part of IIT Bombay as we are. Hearty congratulations on this incredible feat! **Institute Students Companion Program (ISCP)** welcomes you to one of the most resourceful campuses in India. The next two or three years are going to be the most memorable, impactful, insightful and life changing years which will fly past. We hope you imbibe as much as you can and more from your peers, seniors, faculty and staff. Here’s to your first glimpse of ISCP, the backbone of your journey through the mecca of learning.

ISCP is a program within IIT Bombay Post Graduate (PG) student community. Its primary objective is to develop an atmosphere of cordial interaction amongst the PG entrants and the PG seniors. It will encourage the flow of information, knowledge, and sharing of experiences among the students.

Life in IIT Bombay can appear a little daunting at times, balancing between the academic workload and the plethora of extra-curricular activities. And that is where ISCP can help you blend in and make the most of it. ISCP strives to provide a senior student companion as a mentor to all newly admitted students. New entrants can contact their assigned companion to discuss their academic and non-academic issues or concerns. Student Companions enable the smooth and gentle transition from the graduation days to post-graduation days. New entrants also feel assured that there is somebody on campus to help them and listen to their concerns. Many a times they find a caring friend in companions.

**What to expect from a Student Companion:**

- Initial information about the campus, courses, academics and extracurricular activities.
- Support in case of any problem or difficulty.
- Organization of various academic and non-academic activities for student's development.
- Continuous interaction and feedback from students on their needs and requirements.

In short, this is a program by the students of IIT Bombay, for the new students to ensure their overall development through utilization of all the available resources at IIT Bombay.

Let the learning begin. Feel free to contact us anytime!

**Email:** iscp@iitb.ac.in

**Overall Coordinators, ISCP 2018-19**

Anwesha Lahiri  |  Sumedh Dey  |  Basudev Behera

+91-9007766390  |  +91-9432152174  |  +91-7008955255
Welcome note from IMR

Dear Freshmen,

On behalf of all the Master's students at IIT Bombay, it is my honour to welcome you all here. Congratulations on having made it to one of the premier technical institutes of the country.

You are now a part of the IITB PG community and there are an exhaustive number of services and facilities available to ensure a fruitful educative experience. As post graduate students, you have already been exposed to university level education. While you will delve deeper into understanding your area of interest better, I urge you to explore more. There are several student led bodies on campus focusing on development of skills, sports and extracurricular activities such as dance, drama, music, etc. Your experience will be what you make of it, and your opportunities will be limited only by the limits you place on yourself. Utilize the opportunities to the best of your ability. Along with academics, do explore and make the most of the excellent facilities the institute has to offer.

As the Institute Masters Representative, my team and I, aim to address your grievances and help you to the best of our abilities. Supporting you in your academic endeavours is our foremost priority and we will strive to improve the IITB experience in all the ways we can. On this note, I, once again, welcome you to IIT Bombay and wish you every success in your future endeavours.

Jasmeen Kaur
Institute Masters Representative
PG Academic Council
imr@iitb.ac.in

Welcome note from DC

Hello all,

Congratulations for making it to IIT Bombay and a warm welcome to the Syscon family.

Feel free to contact me to get your doubts clarified. Be prepared for rigorous academic curriculum and loads of fun at the same time.

Harivardhan Geddada
Dept. Coordinator
The Department Faculty and their Research Interests

Modelling of dynamical systems, Large size nuclear reactor modelling and control, Variable structure systems and Discrete Time Sliding Mode Control, Higher Order Sliding Mode Control, Large Scale Nuclear Reactors Modelling and Control and Event Triggered based sliding mode control

Deep Learning, Modeling, Simulation, and Control of Gas turbines, Modeling, Simulation and Control of Boilers, Nonlinear System Analysis and Control, Reliable Computing using interval analysis techniques, Robust Stability and Control especially using quantitative feedback theory (QFT) techniques, SCADA and PLCs

Optimal control, Geometric mechanics and nonlinear control Lagrangian and Hamiltonian mechanics. Application areas - Mechanical (robotics), aerospace (launch vehicles, spacecrafts) and electrical power system networks

Control theory
NMR spectroscopy
Nonlinear and geometric control
Quantum information and control

Cooperative control of Multi-agent systems
Resource Allocation
Team theory and its application
Game theory
The Department Faculty and their Research Interests

Leena Vachhani

- Embedded control systems, Vision based autonomous motion planning, Multi agent map building, Open source hardware/software for robotic applications, Autonomous underwater robotic applications.

Debasish Chatterjee

- Constrained and optimization based control, in particular, stochastic model-predictive/receding-horizon control, switched and hybrid systems, control under communication and computation constraints, stochastic control, applications of stochastic process in engineering systems

Sukumar Srikant

- Nonlinear and adaptive control, non-autonomous controller and state observer design, decentralized control, cooperative and network control, hybrid systems, mathematical control theory. Application areas: Spacecraft attitude control, bio-mechanical systems, dynamics and control, power systems, autonomous vehicles and robotics, formation flying and consensus theory.

Ankur Kulkarni

- Game theory, stochastic control, optimization, economics, information theory, combinatorics and systems biology

Vivek Natarajan

- Distributed parameter systems, output regulation, adaptive control, power system stability, nonlinear Schrödinger equation, multiagent networks, repetitive control, periodic systems, vibration control
PoRs of SysCon

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9923458770

Joydoot Ghatak
joydoot@sc.iitb.ac.in
7030962256
## M. Tech. Projects Of 2016-18 Batch

<table>
<thead>
<tr>
<th>Name</th>
<th>Project Title</th>
<th>Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarekukka Rufus</td>
<td>Mapping in 3D Overhead crane using Vision sensor</td>
<td>Prof L. Vachhani</td>
</tr>
<tr>
<td>Emmey Teja</td>
<td>Development of Algorithm for Adaptive Control based Dual MPC</td>
<td>Prof S. C. Patwardhan</td>
</tr>
<tr>
<td>Meet Doshi</td>
<td>Low Reynolds number robotics: Micro and Nano scale robots</td>
<td>Prof R. N. Banavar</td>
</tr>
<tr>
<td>Bhagyashri Somani</td>
<td>Deep Learning Based Dynamic Modelling and Fault Diagnosis of SP-30 Gas Turbine Engine</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>P Hari Krishna</td>
<td>Visual Homing-Robotics Computer Vision</td>
<td>Prof L. Vachhani</td>
</tr>
<tr>
<td>S Deepak Mallya</td>
<td>Path Planning and Patrolling for a car-like robot in Urban Campus Environment</td>
<td>Prof A. Sinha</td>
</tr>
<tr>
<td>P Shekar</td>
<td>Embedded Control of Solar PV system</td>
<td>Prof S. C. Patwardhan</td>
</tr>
<tr>
<td>Kishan Kumar</td>
<td>Embedded and PLC based control of DC motor</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>Anurag Kashyap</td>
<td>System Identification and Controller Design Studies for Single Board Multi Heater System (SBMHS)</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>Sambit Senapati</td>
<td>Application of Discrete Maximum Principle to Wheeled Mobile Robotics</td>
<td>Prof R. N. Banavar</td>
</tr>
<tr>
<td>Rohit Kawde</td>
<td>Development of Embedded and Data Driven Model based controller design for DC-DC boost converter</td>
<td>Prof S. C. Patwardhan Prof Vivek Agarwal</td>
</tr>
<tr>
<td>Myat Toe</td>
<td>Tracking control for non-minimum phase system-A Sliding Mode Approach</td>
<td>Prof B Bandyopadhyay</td>
</tr>
<tr>
<td>Khairul Fahim</td>
<td>Design and analysis of DC-DC power convertors with Sliding Mode Controller</td>
<td>Prof B Bandyopadhyay</td>
</tr>
<tr>
<td>Bharat Joshi</td>
<td>Steering Control of off-highway vehicles</td>
<td>Prof Sukumar Srikant</td>
</tr>
<tr>
<td>Devender Sharma</td>
<td>Mathematical Modelling, Robust Controller Design and Simulation of SR-30 Gas Turbine Engine</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>Abhay Raju</td>
<td>Design and Implementation of Coefficient Diagram Controller for boiler Drum Level to Feed Water Flow Loop of a Laboratory Boiler</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>Anurag Tiwari</td>
<td>Robust control of Laboratory Boiler</td>
<td>Prof PSV Nataraj</td>
</tr>
<tr>
<td>Manas R Das</td>
<td>Developing a Generic IoT platform</td>
<td>Prof K. Moudgalya</td>
</tr>
<tr>
<td>Anjali R</td>
<td>Implementation of auto tunning PID controller on Hybrid Two Tank sytem</td>
<td>Prof PSV Nataraj</td>
</tr>
</tbody>
</table>
# M. Tech. Projects Of 2017-19 Batch

<table>
<thead>
<tr>
<th>Name</th>
<th>Project Title</th>
<th>Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shreyas Kulkarni</td>
<td>Sensor less control of BLDC motor</td>
<td>Prof. Vivek Agarwal</td>
</tr>
<tr>
<td>Joydoot Ghatak</td>
<td>Predictive health maintenance of electrical instruments using deep learning</td>
<td>Prof. PSV Nataraj</td>
</tr>
<tr>
<td>Tejdeep Reddy Hunabad</td>
<td>Online motion planning of self driving cars</td>
<td>Prof. Arpita Sinha</td>
</tr>
<tr>
<td>Pratik Patil</td>
<td>On road decision making and reactive path planning of autonomous vehicles</td>
<td>Prof. Arpita Sinha</td>
</tr>
<tr>
<td>Harivardhan Geddada</td>
<td>Simulation of fleet of electric vehicles</td>
<td>Prof. Ankur Kulkarni</td>
</tr>
<tr>
<td>Nitesh Kumar Devangan</td>
<td>Application of sliding mode control in biomedical system</td>
<td>Prof. B. Bandopadhyay</td>
</tr>
<tr>
<td>Varad Patil</td>
<td>Simulation of fleet of electric vehicles</td>
<td>Prof. Ankur Kulkarni</td>
</tr>
<tr>
<td>Aniket Vaze</td>
<td>DSP Implementation of Sensor less Control of BLDC Motor</td>
<td>Prof. Vivek Agarwal</td>
</tr>
<tr>
<td>Kshitij Kadam</td>
<td>Visual odometry for jerky motion using ROS</td>
<td>Prof. Leena Vachhani</td>
</tr>
<tr>
<td>Arijit Sarkar</td>
<td>Servo control of 6-DOF mechanical system</td>
<td>Prof. Debasish Chatterjee</td>
</tr>
<tr>
<td>Omkar D Sangar</td>
<td>Embedded Image processing of 3D overhead crane</td>
<td>Prof. Leena Vachhani</td>
</tr>
<tr>
<td>Sidharth Singh</td>
<td>Predictive health maintenance of electrical instruments using deep learning</td>
<td>Prof. PSV Nataraj</td>
</tr>
</tbody>
</table>
Important Websites:

Application Software Centre (asc) – Administration
http://asc.iitb.ac.in/
This website is the main interactive website for a student for all of his/ her’s administrative requirements. From paying your fees to checking your grades, all can be done on this website. The website also has links to all other websites of the institute. Some of the most important facilities offered by this website are given under:

> Payment of fees
> Registration and de-registration from courses
> Checking previous years’ grades awarded in any subject
> Brief contents of any subject being offered
> Own personalised timetable
> Checking of own academic performance (grades)

Moodle – Academics
http://moodle.iitb.ac.in
This website provides academic interaction between students and faculty for all courses enrolled by a student. You can download study material/ books/ notes uploaded by a professor/ TA and also submit projects etc here. The website also offers a platform where you can interact with the Professor/ TAs/ other students on any subject related matter.

GPO – e-mail
https://gpo.iitb.ac.in/src/login.php?secure_login=yes
This is your personalised e-mail in IIT. Every student gets one when you enrol. Along with normal mail, here you also get alerts for registration/ de-registration of courses, fees payment and any broadcast on moodle among others. You may create alias for your LDAP ID once. Your LDAP ID is your roll no.

Central Library
http://www.library.iitb.ac.in/
The website for the central library offers a search engine for books available in the library. You can also check the number of books issued at any given time, renew them and “queue” up for any book already drawn by some other individual.

Systems and Control
http://sc.iitb.ac.in/
Our department’s website, it has the contact details of all faculty members, staff and students of our department. It also displays the academic research areas of the Syscon department and has a link for the intra department e-mail.
How to choose subjects:

One of the biggest dilemmas facing a new student is “how do I choose which subject to take”. While interest of a student and aptitude are the most important, the following information would help you to decide on your courses as well.

1. **Types:** Subjects for M Tech can broadly be grouped into 4 types i.e.
   a. **Compulsory Graded Courses** – These subjects are to be compulsorily taken during the course.

   b. **Compulsory Non Graded Courses** – This is the Communication Skills course being offered. Though compulsory, it is non graded. It consists of two parts – one being taken by the department and one by the institute.

   c. **Electives** – Apart from the compulsory courses you will have to register for electives which can be chosen from other departments. You will have to choose electives from the list approved by the Department.

   d. **Institute Elective** – These are non engineering courses offered by various departments. These are graded and will be reflected in your final Grade sheet. You will have to choose electives from the list approved by the Institute.

2. **Content:** Course content / syllabus for every subject is available online at asc.iitb.ac.in (ASC website) along with the name of the professor offering it.

3. **Grading:** If you want to know the previous years grading statistics you can check on ASC website. The number of students also indicates the popularity of the course.

4. **Audit:** A student wanting just an exposure to a course, without the riggors of obtaining a good grade, then he/she may audit a course. The minimum requirement is 80% attendances, with any additional requirements as set by the instructor such as submission of assignments and minimum performance in some of the in-sem evaluations.

5. **Project:** If you have selected your Guide early enough and/ or have decided on your Project, it is advisable to take the advice of your Guide for choosing your electives in line with your future Project.
## M.Tech course work Details

As mentioned at SysCon website, sc.iitb.ac.in -> Academics -> M.Tech Course Work and the letter from the department

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
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<tbody>
<tr>
<td>SC 601</td>
<td>Modeling and Identification of Dynamical Systems</td>
<td>3</td>
<td></td>
<td>6</td>
<td></td>
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<tr>
<td>SC 629</td>
<td>Introduction to Probability and Random Processes</td>
<td>3</td>
<td></td>
<td>6</td>
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</tr>
<tr>
<td>SC 620</td>
<td>Automation and Feedback Control</td>
<td>3</td>
<td></td>
<td>6</td>
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<tr>
<td>SC 625</td>
<td>Systems Theory</td>
<td>3</td>
<td></td>
<td>6</td>
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<tr>
<td>SC 694</td>
<td>Course Seminar</td>
<td>0</td>
<td></td>
<td>4</td>
<td></td>
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<tr>
<td>HS 791</td>
<td>Communication Skills (Institute side)</td>
<td>2</td>
<td></td>
<td>4</td>
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<tr>
<td>SC 792</td>
<td>Communication Skills (Department side)</td>
<td>2</td>
<td></td>
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<tr>
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<tbody>
<tr>
<td>SC 602</td>
<td>Control of Nonlinear Dynamical Systems</td>
<td>3</td>
<td></td>
<td>0</td>
<td>6</td>
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<tr>
<td>SC 607</td>
<td>Optimization</td>
<td>3</td>
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<td>0</td>
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<tr>
<td>SC 626</td>
<td>Systems and Control Engineering Lab</td>
<td>0</td>
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<td>Elective I / Institute Elective</td>
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<tr>
<td>Elective II</td>
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<tr>
<td>Elective I / Institute Elective</td>
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<tr>
<td>Elective III / Institute Elective</td>
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<tr>
<td>SC 697</td>
<td>I Stage Project</td>
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<td>54</td>
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<tr>
<td>II Stage Project</td>
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<thead>
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<th>P</th>
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<tbody>
<tr>
<td>II Stage Project</td>
<td></td>
<td></td>
<td></td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
About TA (Teaching Assistantship) Work, Attendance and Stipend

> TA work will be allotted by the office if available.

> Attendance is compulsory and every M.Tech student (TA category) is expected to mark her / his daily attendance in the biometric machine outside SysCon office.

> To avail leave students need to fill the leave application form (found in office) and get it signed by their respective Faculty Advisor/Guide and submit it in the office.

> Stipend: Rs. 12,400/-

> Procedure to avail stipend: At the end of each month, students need to get the TA attendance form signed by the Faculty Advisor/Guide and submit it in office. Only if this procedure is completed by the deadline (generally 5th of every month), will the student get the stipend.

> Please refer to FAQs on www.sc.iitb.ac.in for further questions.
Facilities in the department

Lab facilities in SysCon

<table>
<thead>
<tr>
<th>Room No</th>
<th>Name / Lab-Incharge</th>
<th>Description (Equipments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>Computational Lab A</td>
<td>SysCon project staff work here. Projects from MHRD (magnetic levitation and dc motor analysis), DRDO (gas turbine engine), CUDA, MDWS (water meter) are currently being worked on.</td>
</tr>
<tr>
<td>109</td>
<td>Embedded Control Lab Prof Leena Vachhani</td>
<td>Embedded control using various embedded boards such as FPGA, ARM, etc. Currently sensing and control techniques on 3-D crane and spherical robot are being developed in this lab.</td>
</tr>
<tr>
<td>204</td>
<td>Experimental Lab B Prof PSV Nataraj</td>
<td>This lab houses hybrid tank, pneumatic actuator, 2 dof, quadcopter, 3D crane, plant Emulator, gyroscope, inverted pendulum for experiments and projects</td>
</tr>
<tr>
<td>214</td>
<td>Experimental Lab A Prof S Srikant</td>
<td>Primarily dedicated to robotics, this lab houses set ups of different kind of mobile and aerial robots.</td>
</tr>
<tr>
<td>301</td>
<td>Autonomous Robots &amp; Multi-robot Systems (ARMS) Lab Prof Arpita Sinha</td>
<td>Laboratory is installed with motion capture facility for collecting real time 3-D position and orientation feedback. High level robotic applications such as path planning algorithms, Co-operative control, multi agent systems are tested here.</td>
</tr>
</tbody>
</table>

Department Library

The SysCon dept. library is next to the office room. Entry to the library is biometric. It contains course books and M.Tech/Phd thesis of the previous years students. A TA will be allotted in charge of the library. For issuing/returning of or browsing through the books, one is expected to contact the TA in charge.

SysCon Email and Server

Upon filing the appropriate forms at the office, an email account and some space is allocated to you on the syscon server. The email ID and password will be separate from the IITB email id and will be from the domain sc.iitb.ac.in

Note:
All the labs and library rooms are biometric access controlled. Separate permission has to be taken from the department office to enable access to each room.
Welcome to the SysCon family

Systems and Control Engineering

Near Central Library
Indian Institute of Technology, Bombay
Powai, Mumbai - 400 076
Maharashtra, INDIA

email: syscon_office@sc.iitb.ac.in

Phone: +91 22 2576 7884