Department Handbook
2020 - 2021

IIT Bombay

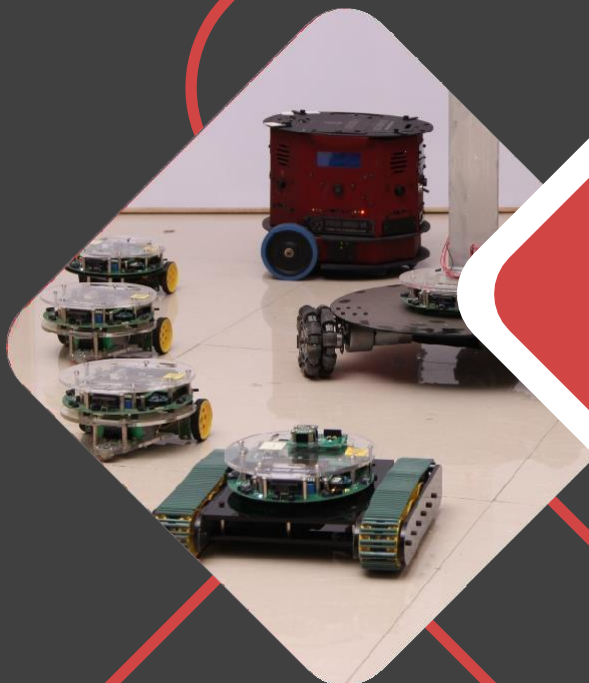Systems and Control

" Self-control is the
Strength Systems and Control
is the Mastery "

SysCon iitb
Systems & Control

SCP

IIT BOMBAY

IIT Bombay was founded in 1958 and In the year 1961 became the Institute of National Importance. It is located at Powai, in East Mumbai, between the Vihar and Powai lakes with a lush green campus spanning over 550 acres.

In 2018, IIT Bombay was one of the first six institutes to be awarded the Institute of Eminence status. IIT BOMBAY as an institute offers an all-round development opportunity to its students in the form of rich academic programmes and rich non-academic culture. The institute is a budding ground for many talents that are nurtured by different clubs and societies functioning at IITB.

IIT BOMBAY have been serving the nation and society by producing some of the brilliant minds over the past many years and continues to do so.

The list of feats achieved by IITB is long, some recent additions to that list are (1) IIT BOMBAY secured fourth position in 'Overall' category, third position in 'Engineering' category and eleventh position in 'Management' category of the National Institutional Ranking Framework (NIRF), (2) IIT Bombay has secured the first position in India and 172nd rank this year in the Quacquarelli Symonds (QS) World University Rankings (2021), (3) Became the pioneer in developing and adopting a new academic structure in these challenging times.

IIT BOMBAY Main Building

THE DEPARTMENT

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 M. Tech. intake every year may vary but it would be roughly around 18.

The research focus of the core group is in the areas of nonlinear control, robotics, path-planning, 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. Besides, 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, Analytics, automation industries and research laboratories in and outside the country.

Batch of 18-20 & 19-21

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 PhD, M.Tech and minor program 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 for courses in the 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

MESSAGE FROM ISCP TEAM

Dear New Entrants,

These are tough times, but you are not alone.

We welcome you to one of the most prestigious institutes in the nation. Congratulations on having achieved this incredible feat. You are about to become part of a culture that will leave its traces within you for a long, long time, even if it begins 'untraditionally.' You will be the ones witnessing the first term to happen entirely online in the history of IIT-Bombay. It might feel overwhelming, and for all the right reasons, we must say. There will be several things you might be worried about, from coping up with the academics in online mode to missing out on things; however, as we said, "You are not alone."

Institute Student Companion Programme (ISCP) is a student body with the primary objective of building a relationship of trust and comfort between the final year students and the incoming students of the PG programmes. We are here to help you in getting familiar with the ways of IIT-B, which is even more critical in these times. You will become a part of a culture where people want to perfect their craft and thus work day in and day out at it. The scope of these is not limited just to academics. Various online events are and will be organized by the cultural, technical, and sports clubs in IITB, like Code in Quarantine, Fitness challenges, Dance Challenges, etc. Managing these along with online lectures might seem daunting at first, and hence, to help you with a world of problems including these, we assign you a Student Companion.

The Student Companions are self-motivated volunteers who will genuinely help you in low and high tides as an act of giving back what they received from the programme. You can look up to the team for any form of support, any information before venturing out into an unknown domain, be it academics or extracurricular activities. You can reach out to us for any issue regarding the curriculum, facilities provided, your physical, social or mental health, and last but certainly not the least, reach out to have a chat with us because that is what we are for, for you.

The COVID -19 pandemic has affected all of us. For now, Health concerns prevent your arrival in our beautiful lush-green IIT-B campus, it also prevents your participation in hostel activities, sports, cultural activities. There are many things here at IIT-B waiting for you, but the most important thing is the campus, and the buildings do not define IIT-B. It's you. You set the culture, the activities, you represent IIT-B to the world, and you make IIT-B what IIT-B is. So, knowing that time flies at IITB, we strongly suggest participating in things that happen online other than attending lectures, make memories, reach out to us for any queries, and relax with the comfort of your home. At least till we get an opportunity to welcome you into the campus, let's be safe, let's be optimistic and let's keep our learning spirits high.

Looking forward to getting to know you. Giving out some motivation for these difficult times, we end with a quote by Albus Dumbledore: "Happiness can be found, even in the darkest of times, if one only remembers to turn on the light."

Stay Safe!

Overall Coordinators,

Institute Student Companion Programme (2020-21)

IIT Bombay

OVERALL COORDINATORS ISCP 2020-2021

Aakrit Anshuman

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aakritanshuman@gmail.com

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MESSAGE FROM DEPARTMENT COORDINATOR

Dear New Entrants,

Congratulations on making it to IIT BOMBAY.

We at ISCP are always engaged in a quest to serve the freshers coming to IIT. As the department coordinator, I will be responsible for extending those benefits to you and to take up your issues for timely mitigation.

As the upcoming session will be conducted in online mode, many of you must be wondering how you will cope with it all be it academics or getting along with IIT culture. Worry not we got your back. I can bet on the fact, that your tenure at IIT will be worth remembering for a lifetime.

Difficult situations are testimony of one's character, you all did the hard work to get here and from now onwards we will work together to steer you through the current situation that has prevailed due to the coronavirus pandemic.

It's a suggestion to all, please go through this handbook content and follow the guide book that is provided with it. If there is anything that u couldn't get over with, feel free to contact me or student companion.

We are always there to help you.

Stay safe and All the Best for all your future endeavour.

Regards

Ravindra Kumar Panda

Department Coordinator

Institute Student Companion Programme (2020-21)

IIT BOMBAY

SYSCON ISCP TEAM

Ravindra Kumar Panda
Department Coordinator
9178955042
ravinra.panda@gmail.com

Komal Agnihotri
Student Companion
8318868279
komalagnihotri18@gmail.com

Welcome Note From PG Academic Council

Dear Freshmen,

Congratulations to all freshmen for making it to one of the premier institutes of the country. Despite the stiff competition, you all managed to come out with flying colours. So on behalf of the PG students of IIT Bombay, it is my honour to welcome you all here.

So now all of you are a part of IIT Bombay PG community or "PG JUNTA" as we call them. The institute has a wide range of facilities and services to offer to all its students. This will not only ensure a fruitful educational experience but also promote overall skill development. In the institute, there are several student-run bodies, that focus on the development of skills, sports and extracurricular activities such as music, dance, drama etc. Along with academics, we urge you all to explore and make the most of the excellent facilities that the institute has to offer.

As the Institute Master's Representative, my entire team and I aim to address your grievances and help you to the best of our abilities. This time since the first semester for you all is going to be online, you might have a lot of queries in your mind. Please feel free to contact us at any time. Our council PGAC is one that is for the PG students, of the PG students and most importantly by the PG students. So whenever you face a problem, we are always there to help you out. Supporting the students in their academic endeavour is also our foremost priority and we will try to improve the IITB experience in all the ways we can. On this note, I once again welcome you all to IIT Bombay, hoping to welcome you all back in the campus as soon as the situation gets better, and wishing you every success in your future endeavours.

Institute Masters Representative(2020-2021)
Post Graduate Academic Council
Sohini Dasgupta
imr@iitb.ac.in

The Department Core Faculty and their Research Interests

B. Bandyopadhyay

Multi-rate Output feedback Discrete-Time Sliding Mode Control, Continuous and Discrete-Time Sliding Mode Control, Higher-Order Sliding Mode Control, Large Scale Nuclear Reactors Modelling and Control, Systems Reduction and Large Scale Systems, Event-Triggered Control.

P. S. V. Nataraj

Deep Learning, Modelling, Simulation, and Control of Gas turbines, Modelling, 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.

R. N. Banavar

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

Navin Khaneja

Control theory NMR
spectroscopy
Nonlinear and geometric control
Quantuminformationandcontrol.

Arpita Sinha

Cooperative control of Multi-agent systems
Resource Allocation
Team theory and its application
Game theory.

The Department Core Faculty and their Research Interests

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

Leena Vachhani

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.

Debasish Chatterjee

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.

Sukumar Srikant

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

Ankur Kulkarni

Distributed parameter systems, output regulation, adaptive control, power system stability, nonlinear Schrödinger equation, multiagent networks, repetitive control, periodic systems, vibration control.

Vivek Natarajan

Position of Responsibility of SysCon

M Y V Krishna Teja   General secretary   Krishna.teja@sc.iitb.ac.in
                                                                          Contact: 9912227213

Shubham Sharad Bhise   Sports secretary   shubham@sc.iitb.ac.in
                                                                          Contact: 8446893049

Girish Prakash Maske   Cultural secretary   girish@sc.iitb.ac.in
                                                                          Contact:8 4 2 1 3 1 5 4 9 0

Placement team:

Ekansh Saraf   Dept.Placement Coordinator   ekansh@sc.iitb.ac.in
                                                                          Contact: 9038544529

M.Tech Projects Of 2019-21 Batch

Name	Project Title	Guide
Komal Agnihotri	Agent-Based Modelling.	Prof. Ankur A. Kulkarni
S Bhargav Pawan Kumar	State Estimation and Observer Design on partial differential equations.	Prof. Vivek Natarajan
Rajopaadhye Abhishek Atul		Prof. Ankur A. Kulkarni
Ekansh Saraf	Data Analytics for Banking Problems.	Prof. Ankur A. Kulkarni
Ravindra Kumar Panda	ML methods for Depth Estimation for robotic application.	Prof. Leena Vachhani
M Y V Krishna Teja	Development of Embedded Adaptive predictive controller using Raspberry Pi.	Prof. P S V Natraj Prof. Sachin C Patwardan
Akamal Khan	Trajectory Planning for Autonomous Vehicles.	Prof. Arpita Sinha
Himadri Haldar	Adversarial Attacks and Defences in Deep Learning.	Prof. P S V Natraj Prof. Biplab Banarjee
Shubham Sharad Bhise	Compliant Mechanism inspired Leech Robot – Modelling and Control.	Prof. Bijan Bandyopadhyay Prof. Prasanna Gandhi
Girish Prakash Maske	Ml methods for Identifying Unique Location.	Prof. Leena Vachhani
Neelam Patwardhan	Work State Estimation based on time series data of off-road Vehicle using ML.	Prof. Leena Vachhani
Pooja Satelkar	Fault-Tolerant Control System using Kalman Filter.	Prof. Leena Vachaani

M.Tech. Projects Of 2018-20 Batch

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Name	Project Title	Guide
Aniket Mukherjee	A variational approach for path estimation	Prof. Debasish Chatterjee
Ashwin Aravind	The computational approach of control in power system networks	Prof. Debasish Chatterjee
Shishir Kumud	Localization, Mapping and navigation using Android Applications	Prof. Leena Vachhani
Anurag Gupta	Linear programming based converses for finite blocklength joint source-channel coding with feedback	Prof. Ankur Kulkarni
Ponala Venkata Eswara Srisai	Simultaneous Localization and Mapping using Android Application	Prof. Leena Vachhani
Piyush Tripathi	Feedback stabilization of Operational Amplifier	Prof. Navin Khaneja
Neeraj Adwani	Navigation of Autonomous Vehicles using Deep Learning	Prof. Arpita Sinha
Saiprasad Pampatwar	Comparative analysis of different control strategies of Rotary inverted Pendulum	Prof. Bijnan Bandhopadhyay
Saurabh Dhamne	Control of compliant motion stages	Prof.Leena Vachhani Prof. P.S. Gandhi
Kishan Chauhan	Comparative analysis of different control strategies of Rotary inverted Pendulum	Prof. Bijnan Bandhopadhyay
Annavarapu Naidu	Design of adaptive predictive control for Boilers	Prof. PSV Nataraj Prof. Sachin Patwardhan
Sairengpuia Sailo	Development and Evaluation of Dual adaptive predictive control algorithms	Prof. PSV Nataraj Prof. Sachin Patwardhan

M.Tech Placement Report 2019

NAME	COMPANY	JOB PROFILE
Sishir Kumud	Hitachi Limited	---
Neeraj Adwani	GE	Edison Engineer
Saurabh Dhamne	GE	---
Piyush Tripathy	Ubisoft	Programmer
Ponala Vankata Eswar sai	Mercedes	R&D
Saiprasad Pampatwar	CapGemini	Associate Consultant

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.

Webmail
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 an 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.

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

L - Lectures per Week | T - Tutorials per Week | P - Practical per Week | C - Credits

First Semester

Course	Course Title	L	T	P	C
SC 601	Modelling and Identification of Dynamical Systems	2			6
SC 629	Introduction to Probability and Random Processes	2			6
SC 620	Automation and Feedback Control	2			6
SC 625	Systems Theory	2			6
SC 639	Mathematical Structures for control	2			6
SC 694	Course Seminar	0			4
HS 791	Communication Skills (Institute side)	1			4
SC 792	Communication Skills (Department side)	1			
					34+4

Second Semester

Course	Course Title	L	T	P	C
SC 602	Control of Nonlinear Dynamical Systems	2		0	6
SC 607	Optimization	2		0	6
SC 626	Systems and Control Engineering Lab	0		1	4
	Elective I / Institute Elective				6
	Elective II				6
					28

3rd Semester

Course	Course Title	L	T	P	C
	Elective III / Institute Elective				6
SC 697	I Stage Project				54
					60

4th Sem

Course	Course Title	L	T	P	C
SC 698	II Stage Project				36

SysCon - Indian Institute of Technology Bombay

Facilities in the department

Lab facilities in SysCon

Room No	Name / Lab-Incharge	Description (Equipment)
108	Computational Lab A	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.
109	Embedded Control Lab Prof Leena Vachhani	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.
204	Experimental Lab B Prof PSV Nataraj	This lab houses hybrid tank, pneumatic actuator, 2 dof, quadcopter, 3D crane, plant Emulator, gyroscope, the inverted pendulum for experiments and projects
214	Experimental Lab A Prof S Srikant	Primarily dedicated to robotics, this lab houses setups of different kind of mobile and aerial robots.
301	Autonomous Robots & Multi-robot Systems (ARMS) Lab Prof Arpita Sinha	The 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.

Department Library

The SysCon dept. the 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 year's 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.

SysCon - Indian Institute of Technology Bombay

DEPARTMENT ACHIEVEMENT

ACADEMIC

- Prof. B.Bandyopadhyay has been elected as fellow of Indian Academy of Sciences(FASc) w.e.f 01-01-2020.

- Research scholar Rihab Abdul Razak, student of Prof S Srikant has won the Best Student Paper award at the Sixth Indian Control Conference 2019 for their paper, "Estimating Scalar Fields with Mobile Sensor Network".

- Article by Dr.Karamvir Singh Phogat who worked with Prof. Ravi Banavar and Prof. Debasish Chatterjee during his doctoral studies is one of the three papers to receive the Automatica Paper Prize for the years 2018-2020.

SPORTS

- Finished at 4th position in football Postgraduate general championship(PG-GC).

- Finished at 4th position in squash PG-GC.

STUDENT WELLNESS CENTRE

After securing admission at the Institute and starting your stay here, you may feel that a lot of parameters around you are different. You would have more responsibilities to handle at the hostel and at the academic level. Take heart, you will not be the only one. There are a few issues that almost everyone in the Institute faces initially like academic concerns, social (family and peer) pressure etc, leading to feelings of loneliness, low confidence, anxiety, stress, anger and sadness, to name a few.

It is important to understand that students often lose their focus and give in to these pressures. If not attended to at the right time, this could lead to poor performance -- both academically and personally.

At **STUDENT WELLNESS CENTRE (SWC),** there are professional and experienced Counsellors, who encourage you to approach them for any problem that you are facing- be it academic, emotional, social or financial- without hesitation.

Counselling provides an opportunity for individuals to learn to make better choices, improve interpersonal skills, develop confidence and increase educational effectiveness. In a one-on-one meeting with a counsellor, students are helped to explore and express feelings, examine beliefs and ways of thinking about their present situation, reflect on patterns of behaviour, and work toward making healthier and happier changes.

If someone approaches SWC for counselling regarding any problem, it is ensured that the information regarding the request and counselling session remains confidential.

Typical concerns of students who seek counselling are :

- Transition and change

- Uncertainty about values and goals

- Academic pressure

- Dealing with new academic patterns

- Personal relationships with the special one and with friends

- Family concerns

- Issues of grief and loss

- Stress, depression and anxiety

- Lack of motivation; concentration difficulties

- Others...

To know more about student wellness centre, feel free to contact the department coordinator or the student companion or visit SWC IITB website.
http://www.iitb.ac.in/swc/en/about-student-wellness-centre

GENDER CELL

IIT Bombay's Women's Cell has been in existence since 2002. With the enactment of the Institute's policy on sexual harassment, the Cell has been renamed the Gender Cell (GC). In recognition of the Institute's belief that its employees and students have a right to be treated with dignity and respect, the Cell works proactively towards developing a safe and secure environment for employees, and to ensure that all students may gain their education without fear of prejudice, gender bias, hostility or sexual harassment.

The IIT Bombay Gender Cell (GC) inquires into complaints of sexual harassment through its Internal Complaints Committee (GC-ICC). The GC and GC-ICC strive to work towards an egalitarian environment where men and women are afforded equitable treatment and equality of opportunity conducive to their professional growth.

Gender cell conducts many activities and training sessions with the above-mentioned goal at its heart. Its have its office in the main building on the 3rd floor, next to the student wellness centre.

For further details related to gender cell(GC), feel free to contact your mentor or department coordinator or you can also visit the GENDER CELL website.

http://www.gendercell.iitb.ac.in/en

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

SysCon
Systems & Control iitb