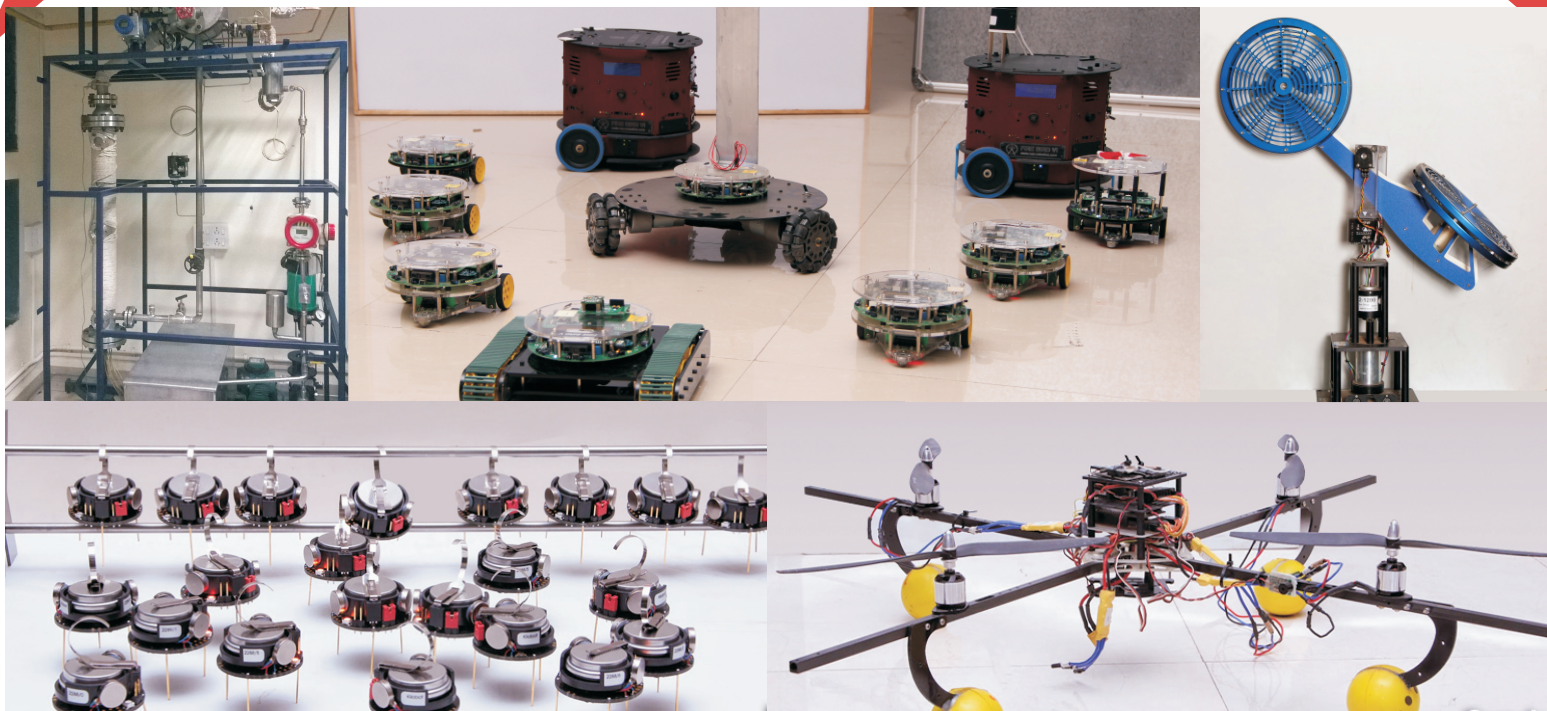# Master's Handbook
2016 - 2017

IIT Bombay

Systems and Control

" Simplicity is the
Ultimate Sophistication "

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 9 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, 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, 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.

SysCon - Indian Institute of Technology Bombay

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 fruitful and productive.

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

Welcome note from AURAA

Hello all,
Its my pleasure to extend a cheerful welcome to you. My hearty congrats for being a part of the prestigious institute of IIT Bombay and SysCon. You are now part of an engaged academic community of learners and professionals who will help you to excel both academically and professionally. SysCon exposes you to modern facilities which motivate you to achieve new horizons in future.

Do take advantage of all that the campus offers; attend events, engage in sports and culturals, meet new people, explore new neighborhoods, open up to new experiences and become the person you want to be. Also exploit the knowledge of individuals at SysCon to your best. Once again, welcome to the SysCon family and good luck!

Misha Gupta
Dept. AURRA

About ISCP

Hello all,
Institute Student Companion Programme was an initiative taken by IIT Bombay in the year 2011 after seeing the success a similar programme going on for the UG students. In this programme, all the freshers will be assigned under a student who will be your first friend on the campus and your means of contact for any help. These volunteer students are "Student Companions" who will help you and guide you through any difficulty faced by freshers in academic and non-academic areas.

Change and transition from favourable environment to a whole new environment is not easy for everyone. Many face difficulties in adjusting with new environment and some of them find it hard to approach someone unknown. To get over this situation, this programme was started. New freshers should feel comfortable in approaching your companion in any difficulty; they are here to help you in adjusting in this new place. Not just in initial days, but throughout the year you will be facing a lot of problems, at any such time you just need to contact your companion and he/she will help you out.

Once again on behalf of the entire team of ISCP, we all welcome you to one of the best Institute of our country and we hope you enjoy your time in this campus.

Kushal Parmar
ISCP Department Coordinator

SysCon - Indian Institute of Technology Bombay

The Department Faculty and their Research Interests

Prof. B. Bandyopadhyay

Modelling of dynamical systems, Large size nuclear reactor modelling and control Modelling, control and implementation of smart structures, Large scale systems, System reduction (model order reduction), Variable structure systems, Higher order sliding mode control, Discrete-time sliding mode control, Design of power system stabiliser, Control of underactuated systems, Multirate output feedback based control, Fractional order systems

Prof. P. S. V. Nataraj

Robust and fractional order control
Quantitative feedback theory techniques
Global optimization
Reliable computing using interval analysis techniques
Parallel computing (GPU)
Robust statistics

Prof. R. N. Banavar

Optimal control
Nonlinear control
Geometric mechanics (Lagrangian and Hamiltonian mechanics) Application areas - mechanical (robotics) Aerospace (launch vehicles, spacecrafts) and electrical power system networks

Prof. Arpita Sinha

Guidance and control of mobile robots
Multi-robot systems
Distributed decision making
Cooperative control of multi-agent systems
Resource allocation
Team theory and its application
Game theory

Prof. Leena Vachhani

Robotic path planning algorithms
Motion planning of autonomous vehicles
Autonomous Tasks for Underwater Vehicle
Embedded control systems
Hardware optimization
Reconfigurable hardware
Hardware/software co-design

Prof. D. Chatterjee

Constrained and optimization based control
Control under communication and computation constraints
Stochastic control
Applications of stochastic process in engineering systems
Stochastic model-predictive/receding-horizon control
Switched and hybrid systems

Prof. S. Srikant

Nonlinear and adaptive control with emphasis on non-autonomous controller and observer design
Spacecraft navigation and control
Control of biomechanical systems
Robotics, Autonomous vehicle design
Decentralized control, Cooperative and network control
Hybrid systems with applications to power systems, wireless networks, formation flight and consensus

Prof. Ankur Kulkarni

Game theory
Stochastic control and games
Optimization and variational analysis
Information theory and combinatorial coding theory
Operations research
Systems biology

Prof. Vivek Natarajan

Distributed parameter systems
Output regulation
Adaptive control
Power system stability
Nonlinear Schrödinger equation
Multiagent networks
Repetitive control
Periodic systems, Vibration control

M.Tech 2015-2016 Batch

Akash Gotmare (153230016)
akashgotmare@sc.iitb.ac.in / 989 045 8472

Department General Secretary

Misha Gupta (153230011)
misha_gupta@sc.iitb.ac.in / 887 914 9476

Academic Unit Representative for Academic Affairs

Atul Kumar Chatter (15323005)
atulchatter@sc.iitb.ac.in / 978 467 3465

Dept Sports Secretary / Student Companion

Smita Solanki (153230017)
shsolanki@sc.iitb.ac.in / 809 711 0789

Dept Cult Secretary / Reading group-Overall Coordinator / Student Companion

Apoorva Sohani (15323008)
apoorva_sohani@sc.iitb.in / 976 982 2939

Dept Placement Coordinator

Nilesh Kadam(153230013)
nileshkadam151@sc.iitb.ac.in / 8888944590

Student Companion

Kushal Parmar (153230014)
kushal.parmar@sc.iitb.in / 916 726 8708

ISCP Dept Coordinator

M. Tech. Projects Of 2015-16 Batch

Student's name	Topic	Guide
Apoorva Sohani	Sliding mode control of grid tied PV System	Prof. Bijnan Bandyopadhyay
Kushal Parmar	High performance tracking control for non-minimum phase system	
Smita Solanki	Analysis of mutual rating systems in shared economy like Uber, Ola, eBay etc	Prof. Ankur Kulkarni
Atul Kumar Chatter	Modelling Simulation and Control of Water Drum Boiler	Prof. P. S. V. Nataraj
Nilesh Kadam	A new platform for low power embedded computing and control	
Ajay Kumar	Hybrid 2 tank System Temperature Control	
Akash Gotmare	Simulation and advanced control of turbo fan engines	
Nipun Agarwal	Vision based trolley positioning of 3D crane	Prof. Leena Vachhani
Misha Gupta	Landmark based localization using steering control law using vision sensor	
Bhanupriya Purohit	State constrained control implementation for a quadcopter	Prof. S. Srikant

M. Tech. Projects Of 2014-15 Batch

Student's	Topic	Guide
Arjun Narayanan	Modeling and controllability studies of VSCMGs in geometric framework	Prof. R. N. Banavar
Gunmeet Singh Mallan	System Identification and Controller studies and Design Of DC motor and Hybrid 2 tank System	Prof. P. S. V. Nataraj
Karishma Patnaik	Steady state and dynamic modelling of single spool gas turbine engine	

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 interaction 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.

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://www.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 will hopefully 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 any department. However if not on the list of electives approved by Syscon Department, you will have to take the sanction of Faculty Advisor to register.

    d. **Institute Elective** – These are non engineering courses offered by various departments. These are graded and will be reflected in your final Grade sheet.

2. **Content:** Course content/syllabus for every subject is available online in the asc website alongwith the name of the professor offering it.

3. **Grading:** If you are worried about your grades, you can check the grades awarded in the previous years for every subject. The number of students also indicates the popularity of the course.

4. **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.

" For any query/ doubt regarding academics you can speak to our AURAA representative – Misha Gupta "

M.Tech course work Details

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

	Course	Course Title	L	T	P	C
First Semester	SC 601	Modeling and Identification of Dynamical Systems	3			6
	SC 629	Introduction to Probability and Random Processes	3			6
	SC 620	Automation and Feedback Control	3			6
	SC 625	Systems Theory	3			6
	SC 694	Course Seminar	0			4
	HS 791	Communication Skills (Institute side)	3			4
	SC 792	Communication Skills (Department side)	3			
		Elective I / Institute Elective				6
						34 + 4

	Course	Course Title	L	T	P	C
Second Semester	SC 602	Control of Nonlinear Dynamical Systems	3		0	6
	SC 607	Optimization	3		0	6
	SC 626	Systems and Control Engineering Lab			0	4
		Elective I / Institute Elective				6
		Elective II				6
						28

	Course	Course Title	L	T	P	C
3rd Semester		Elective III / Institute Elective				6
	SC 697	I Stage Project				54
						60

	Course	Course Title	L	T	P	C
4th Sem		II Stage Project				36

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

SysCon - Indian Institute of Technology Bombay

Course's Offered by Syscon ~ Autumn 2016**

Course Code	Course Title	Instructor
SC 601*	Modeling and Identification of Dynamical Systems	B. Bandyopadhyay
SC 629*	Introduction to Probability and Random Processes	D. Chatterjee
SC 620*	Automation and Feedback Control	P. S. V. Nataraj
SC 625*	Systems Theory	R. N. Banavar
SC 694*	Course Seminar	R. N. Banavar
SC 792*	Communication Skills (Department side)	B. Bandyopadhyay
SC 631	Games and Information	Ankur Kulkarni
SC 636	Theory of Output Regulation	Vivek Natarajan
SC 634	Introduction to Mobile Robotics	Leena Vachhani Arpita Sinha

* Compulsory / Core course
** only SC 6xx and SC 7xx courses are listed.

Basics of TA Work, Attendance and Stipend

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

• Attendence is compulsory and every M.Tech student (TA category) is expected to mark her/his daily attendence in the SysCon office by 17:30 hours.

• 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: ₹12,400/- as on 15.06.2016.

• 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.

SysCon - Indian Institute of Technology Bombay

Facilities in the department

Lab facilities in SysCon

Room No	Name	Description (Equipments)
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	Embedded Control boards such as FPGA, ARM based processor, control on various microprocessor boards.
204	Experimental Lab B	This lab houses hybrid tank, pneumatic actuator, 2 dof quadcopter, 3D crane, plant Emulator, mini gas turbine engine, gyroscope, inverted pendulum for experiments and projects
214	Experimental Lab A	Primarily dedicated to robotics, this lab houses set ups of different kind of differential drive robots(Firebird VI, Firebird V, Spark V), a parrot drone, kilobots etc.

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.

Tea/Coffee Room

Tea/Coffee/Green Tea is available here for a nominal charge. Students can have the food items they bring here in this room.

SysCon Email and Server

Upon filing the appropriate forms at the office, an id and 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, library and tea/coffee rooms are biometric access controlled. Separate permission has to be taken from the department office to enable access to each room.

Welcome to SysCon family

Systems and Control Engineering

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

email: syscon_office[at]sc.iitb.ac.in

Phone: +91 22 2576 7884