Indian Institute of Technology Madras

International Interdisciplinary Master's Programs (I2MP)

August 2022

Proposed Curriculum

Overview

The International Interdisciplinary Master's Programs (I2MP) are specially curated two-year programs that provide international students from any engineering background with a great opportunity to be part of the vibrant and world-class learning environment at IIT Madras. This document is aimed at providing a brief overview of the syllabus for the program.

IIT Madras is one of the only educational Institutions in India to offer this Interdisciplinary Master's Degree, providing students an unprecedented level of academic flexibility to learn and work in current areas that would define the future of global engineering and technology.

The International Interdisciplinary Master's degrees are available in nine interdisciplinary areas:

- Energy systems,
- Robotics,
- Quantum Science and Technology,
- Computational Engineering,
- Advanced Materials and Nanotechnology,
- Data Science,
- Cyber Physical Systems,
- Complex Systems and Dynamics, and
- Biomedical Engineering

The International Interdisciplinary Master's Program provides a platform for international students with exceptional performance in their undergraduate programs to participate in these activities. In addition to courses in Data Science, and Biomedical Engineering, among others, the international students will take up courses in Indian culture as well. A dedicated research skills course will prepare them for their master's thesis work.

IIT Madras is constantly striving to expand the horizons of traditional engineering education and research and is home to the best and brightest. The institute has a rich culture of deep research, technology development and entrepreneurship, which have been developed over the decades without compromise on the teaching/learning of foundational science and engineering.

The Interdisciplinary Master's programs - offered to international students via the I2MP (International Interdisciplinary Master's Program), and to Indian students through the hugely popular Interdisciplinary Dual Degree (IDDD) - represent the culmination of decades of excellence at IIT Madras.

The first batch of foreign students joined the program in July 2022.

Program Structure:

The 2-year program is offered over 4 semesters. Students complete Core Courses, Electives (Free and Core) and a Research project.

The core courses are designed to give a complete overview of the entire domain, the students are free to choose electives that will enable them to chalk out a further path of their choice. A large set of carefully selected electives are provided which will the student to explore a particular aspect of the program according to their area of interest.

Students will learn the skills of carrying out research in the research skills course. It is designed to build a foundation for the thesis work that will be completed in the third and fourth semester.

The thesis will involve one year of work completed in third and fourth semester and will be supervised by faculty from IIT Madras.

*Note: This document is meant to be a guide and is subject to final approval by departments. There may be periodic revisions to the syllabus. Students are requested to confirm their course choices and electives with their respective program coordinators before registering.

Topic	Page

Basket of I2MP Core Courses

Course No.	Course Name	Semester	Course No.	Course Name	Semester
CH5020	Statistical Design and Analysis of Experiments	Jul - Nov	CE5235	Introduction to Climate Dynamics and its Mysteries	Jul – Nov
CH5650	Molecular Data Science and Informatics	Jan - May	ED5015	Computational Methods in Design	Jan – May
CH5170	Process Optimization	Jan – May	ED5017	Digital Signal Processing for Engineering Design	Jan – May
CH5019	Mathematical Foundations of Data Science	Jan - May	ED5317	Strategies for Managing innovation	Jul – Nov
CH5023	Unconventional Oil and Gas Resources	Jan - May	ED5340	Data Science: Theory and practice	Jul – Nov
EE6432	Stochastic Control	Jul - Nov	ED6002	Optimization methods in Engineering Design	Jul – Nov
EE6180	Advanced Topics in Artificial Intelligence		ED5318	Biomimetic Design	Jan – May
EE6150	Stochastic Modeling and the Theory of Queues		PH5820	Classical Physics	Jul-Nov
EE5413	Linear Dynamical Systems	Jul - Nov	PH5825	Quantum Physics	Jan-May
EE5412	Mathematical Methods in System Engineering	Jul - Nov	EE5120	Applied Linear Algebra	Jul – Nov
EE5401	Measurements and Instrumentation	Jul - Nov	ED5012	Advanced Applications of Human Factors	Jan – May
EE5121	Convex Optimization	Jul - Nov	ME5201	Computational Methods in Engg	Jul - Nov
EE6430	Fundamentals of Linear Optimization	Jan - May	ME5204	Finite Element Analysis	Jul - Nov

EE6415	Nonlinear Control Systems	Jan - May	ME5207	Design with Advanced Engineering Materials	Jul - Nov
EE6412	Optimal Control	Jan - May	ME6355	Topology optimization	Jan – May
EE6150	Stochastic Modeling and the Theory of Queues	Jan - May	ME6127	Energy & Environment	Jan – May
EE6112	Topics in Random Processes and Concentrations	Jan - May	ME5204	Finite Element Analysis	Jan – May
EE5180	Introduction to Machine Learning	Jul – Nov	MA5892	Numerical Methods in Scientific Computing	Jul-Nov
MA5910	Data Structures in Scientific Computing	Jul - Nov	MA5470	Numerical Analysis	Summer

HSS Elective Courses Basket

Course Number	Course Number	Semester
HS6080	An Intro. to Classical Sanskrit Literature	
HS6026	Indian Aesthetic Thought	
HS5711	Ethics	Jul - Nov
HS5650	Drama	Jul - Nov
HS5712	Advanced Topics in Economic Development	Jul - Nov
HS5813	Post-Colonial & New Writings	Jul - Nov
HS6520	Culture and Development	Jan – May
HS6160	The Literature of Environmental Justice	Jul – Nov
HS5060	Technology & Sustainable Development	Jan – May

*All courses will be taken with prior approval of faculty advisors and ID coordinator

Advanced Materials and Nanotechnology

Understanding the physics and chemistry of matter and processes at the nanoscale is essential to all scientific disciplines. Advanced Materials and Nanotechnology are both interdisciplinary research fields with opportunities to collaborate across diverse research areas and to share knowledge, tools, and techniques. The International Interdisciplinary Master's Program in Advanced Materials and Nanotechnology is carefully tailored to provide avenues to explore the rapidly expanding scientific horizons in these research areas where great strides are expected in the coming decades. The core courses of this program lay a solid foundation in this research area. The student can subsequently leverage upon the large basket of electives and choices of pursuing final year project across participating Departments.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	HS Elective							9 to 12
4	PH5011	Core 1: Science and Technology of Solid State	3	1	0	0	6	10
5	PH6022	Core 2: Introduction to Nanoscience	3	0	0	0	6	9
		Total Credits						40 to 46
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2		I2MP Core 2*						9 to 12
3	PH6011	Nanomaterials and Nanotechnology	3	0	0	0	6	9
4	PH6015	Advanced Materials and Nanotechnology Lab	0	0	0	6	2	8
5	Elective 1		3	0	0	0	6	9
6	Elective 2		3	0	0	0	6	9
		Total Credits						47 to 50
Summer								
1	PH5361	Project I (Summer) (in IITM)	0	0	0	0	25	25
		Total Credits						25

Semester 3								
1	**Elective 3**		3	0	0	0	6	9
2	**Elective 4**		3	0	0	0	6	9
3	**PH5362**	Project II (in IITM)	0	0	0	0	20	20
		Total Credits						**38**
Semester 4								
1	**PH5363**	Project III (in IITM)	0	0	0	0	40	40
		Total Credits						**40**

- Electives as per *Pg 57 & 58 of DD curriculum 2019*
- I2MP & HSS courses as mentioned in Pg 4-5 (PH courses may be preferred for the I2MP Core)

Biomedical Engineering

With the increasing need for developing newer efficient technologies and devices in healthcare and diagnostics, Biomedical Engineering (BME) professionals have a high demand all over the world. With its truly interdisciplinary nature, I2MP on BME offers a very flexible curriculum tailored to the specific background and requirements of the students. The program emphasizes on the subject fundamentals, as well as familiarizing the latest developments in the field of BME. The students get hands on experience and expertise from several internship opportunities in industry / academia in diverse aspects of biomedical device design, instrumentation, image / signal processing and data analysis.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	AM5119	Core 1: Physiology for Engineers	3	0	0	0	6	9
4	AM5010	Core 2: Biomechanics	3	0	0	0	6	9
5	Elective 1	Elective 1: To be selected from BME / core basket	3	0	0	0	6	9
6	AM5023	Physiological measurements and Instrumentation Laboratory	0	0	0	2	2	4
		Total Credits						43 to 46
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2		I2MP Core 2*						9 to 12
3	HS Elective		3	0	0	0	6	9
4	AM or MMXXX	To be selected from basket of core courses	3	0	0	0	6	9
5	AM5XXX	To be selected from basket of core courses	3	0	0	0	6	9
6	Elective 2	To be selected from BME / core basket*	3	0	0	0	6	9
7	AM5019	Advanced BME lab	0	0	0	3	2	5
		Total Credits						53 to 56
Summer								
1	AM5210/ AM5200	Project-I (Summer) / Summer internship	0	0	0	0	15	15
		Total Credits						15

Semester 3								
1	Elective 2	To be selected from BME / core basket*	3	0	0	0	6	9
2	Elective 3	Elective 3: To be selected from BME / core basket	3	0	0	0	6	9
3	AM5401	Project II (in IITM)	0	0	0	0	30	30
		Total Credits						**39**
Semester 4								
1	AM5402	Project III (in IITM)	0	0	0	0	40	40
		Total Credits						**40**

***Elective 2 can be done either in Semester 2 or 3**

- Some courses are there in both core and elective list to enable the subject choices. No course is to be repeatedly taken by the student.
- I2MP core courses & HSS electives as shown in Pg 4-5 of this document

List of courses:

S.No.	Course No.	Basket of core courses	L	T	+	P	O	C
1	AM5160	Biomedical Imaging systems	3	0	0	0	6	9
2	AM5130	Quantitative physiology	3	0	0	0	6	9
3	AM5140	Biomedical instrumentation	3	0	0	0	6	9
4	AM5510	Biomedical Signals and Systems	3	0	0	0	6	9
5	AM5050	Biomedical sensors and measurements	3	0	0	0	6	9
6	AM5017	Statistics for biomedical engineers	3	0	0	0	6	9
7	MM5040	Medical materials	3	0	0	0	6	9
S.No.	**Course No.**	**Basket of Elective Courses**	**L**	**T**	**+**	**P**	**O**	**C**
1	AM5150	Biomedical nanotechnology	3	0	0	0	6	9
2	AM7010	Classics in Neuroscience	3	0	0	0	6	9
3	AM5190	Haptics and biomedical engineering	3	0	0	0	6	9
4	AM5060	Psycophysics	3	0	0	0	6	9
5	AM5160	Biomedical Imaging systems	3	0	0	0	6	9
6	AM6516	Neuromechanics of human movement	3	0	0	0	6	9

7	ME6012	Mechanics of human movement	3	0	0	0	6	9
8	AM5110	Biofluid mechanics	3	0	0	0	6	9
9	AM5050	Biomedical sensors and measurements	3	0	0	0	6	9
10	AM5140	Biomedical instrumentation	3	0	0	0	6	9
11	AM5100	Biomedical laser instrumentation	3	0	0	0	6	9
12	AM5013	Operating theatre instrumentation and surgical technology	3	0	0	0	6	9
13	AM5115	Systems approach in Biomedical engineering	3	0	0	0	6	9
14	EE6403	Transducers for instrumentation	3	0	0	0	6	9
15	EE6402	Biomedical electronic systems	3	0	0	0	6	9
16	EE6501	Optical sensors	3	1	0	0	8	12
17	EE5502	Optical engineering	2	3	0	0	7	12
18	AM6518	Biophysical aspects of tumor microenvironment	3	0	0	0	6	9
19	AM5190	Cellular structures and mechanics	3	0	0	0	6	9
20	BT5011	Biomaterials engineering	3	0	0	0	6	9
21	BT5130	Tissue Engineering	4	0	0	0	6	10
22	BT5480	Stem cells and Regenerative medicine	3	0	0	0	6	9
23	BT5430	Drug delivery	3	0	0	0	6	9
24	EE5500	Introduction to photonics	3	0	0	0	6	9
25	EE6506	Computational electromagnetics	4	0	0	0	0	12
26	CS6300	Speech Technology	4	0	0	0	8	12
27	CS5691	Pattern recognition and Machine learning	4	0	0	3	8	15
28	AM5020	Biomedical Ultrasonics	3	0	0	0	6	9
29	AM5015	Regulations and standards in Medical device technology	3	0	0	0	6	9
30	EE5175	Image signal processing	4	0	0	0	8	12

Complex Systems and Dynamics

The aim of the program is to provide students with a curriculum on dynamics, complex networks, and mathematical and data analysis techniques which contributes to both the fundamental understanding of these problems as well as enable technology useful in these real-life contexts.

The focus of the I2MP-CSD is on training students to find solutions for the complex problems that we encounter in the real world and in the laboratory. Major examples of such problems include climate systems, brain dynamics and function, epidemics and spread of infectious diseases, fake news propagation, the behavior of banking and other financial networks as well as numerous others. The analysis of such systems and the prediction of catastrophes, such as climate change and stock market crashes that occur in them has enormous practical importance. To find solutions to such problems requires the development of new techniques of mathematical modelling together with data science-based analysis. The aims of the program are two-fold, to enable students to identify and understand the key elements which can lead to the understanding the behavior of such complex systems, as well as to data driven approaches which can analyze and predict the behavior of such systems.

Towards this end, the I2MP program in CSD interfaces the state-of-art techniques of physics and dynamics-based modelling with recent developments in Data Sciences. The curriculum is therefore designed for students to gain expertise in both the techniques that enable the handling of big data, as well as mathematical modelling and the analysis of dynamical behavior. More details are available in the website https://web.iitm.ac.in/ccsd

The Complex Systems and Dynamics program is therefore truly interdisciplinary in that it encompasses the fields of engineering and technology, science, mathematics, economics, and humanities. The importance and impact of this interdisciplinary area has received recent recognition via the 2021 Nobel prize in physics.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	Networks Basket	ID 5080 (CSD Core Basket 1)	3		0	3	6	12
4	Non-Linear Dynamics Basket	PH 5500 or AM5650 (CSD Core Basket 2)	3	0	0	0	6	9
5	Mathematics Basket	CSD Core Basket 3	3	0	0	0	6	9
		Total Credits						**42 to 45**
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2		I2MP Core 2*						9 to 12
3	HS Elective*		3	0	0	0	6	9
4	Core/ Elective*	CSD Core 2/3 or CSD Elective Basket						9 to 12
5	Core/ Elective*	CSD Core 2/3 or CSD Elective Basket						9 to 12
6	Elective	CSD Elective Basket						9 to 12
		Total Credits						**48 to 60**
Summer								
1		Project I (Summer)	0	0	0	0	15	15
		Total Credits						**15**
Semester 3								
1	Elective 3	CSD Elective Basket						9 to 12
2	Elective 4	CSD Elective Basket						9 to 12
3		Project II (during semester)	0	0	0	0	30	30
		Total Credits						**48+**
Semester 4								
1	PH5363	Project III	0	0	0	0	40	40
		Total Credits						**40**

Elective 45 credits min [either (5x9 =45 credits from 5 courses) or (3x12+1x9 = 45 credits from 4 courses) or some combination], *Core2 /3 in Sem 1 can be replaced by electives but all cores 1-3 need to be completed by semester 3.

*HS Elective from Semester 2 can be taken in Semester 1 instead

- I2MP & HSS courses as mentioned in Pages 4-5
- Students cannot take more than 1 course from the elective basket which has significant overlap of content

Core baskets:

Name of Basket	Course Code	Course Name	L	T	E	P	O	C
Core Basket 1 - Networks	ID5080	Complex Networks	4	0	0	0	8	12
Core Basket 1 - Networks	EE5154	Complex Network Analysis	4	0	0	0	8	12
Core Basket 1 - Networks	CS6012	Social Network Analysis	4	0	0	0	8	12
Core Basket 2 - Non Linear Dynamics	AM5650	Non Linear Dynamics	3	0	0	0	6	9
Core Basket 2 - Non Linear Dynamics	PH5500	Dynamical Systems	3	0	0	0	6	9
Core Basket 2 - Non Linear Dynamics	PH5830	Advanced Dynamical Systems	3	0	0	0	6	9
Core Basket 2 - Non Linear Dynamics	MA6050	Dynamical Systems	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	PH5050	Mathematical Physics II	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	PH5730	Methods of Computational Physics	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	MA5470	Numerical Analysis	3	0	0	0	6	9

Core Basket 3 - Mathematics and Numerical Analysis	MA6005	Applied Linear Algebra	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	MA5014	Applied Stochastic Processes	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	MA5312	Stochastic Differential Equations	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	MA5890	Numerical Linear Algebra	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	MA5892	Numerical Methods in Scientific Computing	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	AM5117	Analytical Methods in Engineering Mechanics	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	AM5600	Computational Methods in Mechanics	3	0	0	0	6	9
Core Basket 3 - Mathematics and Numerical Analysis	AS6520	Mathematics for Aerospace Engg	3	0	0	0	6	9

Elective Basket

Course No.	Course Name	L	T	E	P	O	C
AM5340	Stochastic processes in mechanics	3	0	0	0	6	9
AM5630	Foundation of Computational Fluid Dynamics	3	0	0	0	6	9
AM5116	Structural Control	3	0	0	0	6	9

AM5450	Fundamentals of Finite Element Analysis	3	0	0	0	6	9
AM5030	Linear Dynamical Systems	3	0	0	0	6	9
AM5080	High Performance Computing for Engg App	3	0	0	0	6	9
AM5530	Advanced Fluid Mechanics	3	0	0	0	6	9
AM5570	Introduction to Turbulence	3	0	0	0	6	9
AM5850	Advanced Finite Elements	3	0	0	0	6	9
AM6110	Biofluid Mechanics	3	0	0	0	6	9
AM6291	Computational Structural Dynamics	3	0	0	0	6	9
AM6512	Application of Molecular Dynamics	3	0	0	0	6	9
AM6513	Advanced Computational Fluid Dynamics	3	0	0	0	6	9
AS6050	Dynamic Fluid Structure Interaction	3	0	0	0	6	9
AE6830	Finite Element Analysis	3	0	0	0	6	9
AE5760	Aeroelasticity	3	0	0	0	6	9
AE6130	Finite element analysis	3	0	0	0	6	9
AE6160	Computational Aerodynamics3	3	0	0	0	6	9
AE6120	Unsteady aerodynamics	3	0	0	0	6	9
AS5970	Structural dynamics and aeroelasticity	3	0	0	0	6	9
AS5470	Unsteady aerodynamics of moving bodies	3	0	0	0	6	9
AS6041	Advanced CFD-Eddy Resolving Methods	3	0	0	0	6	9
BT5270	Principles of Neuroscience	3	0	0	0	6	9
BT6270	Computational Neuroscience	3	0	0	0	6	9
BT5240	Computational Systems Biology	4	0	0	0	6	10
CE5290	Transportation Network Analysis	3	0	0	0	6	9
CE5235	Understanding Climate Dynamics & its Mysteries	3	0	0	0	6	9
CE5610	Finite Element Analysis	3	0	0	0	6	9
CH5350	Applied Time Series Analysis	3	0	0	0	6	9
CH5115	Parameter and State Estimation	3	1	0	0	6	10
CH6020	Computational Fluid Dynamics Tech	3	0	0	0	6	9

CH5230	Data driven modelling of Process Systems	3	0	0	0	6	9
CH6760	Hydrodynamics of Complex Fluids	3	0	0	0	6	9
CH5019	Mathematical Foundations for Data Science	4	0	0	0	8	12
EE5121	Convex Optimization	4	0	0	0	8	12
EE6418	Dynamic Games: Theory and Applications	3	0	0	0	6	9
EE6430	Fundamentals of Linear Optimization	3	0	0	0	6	9
EE6419	Geometric Nonlinear Control Theory	3	0	0	0	6	9
MA5013	Applied Regression Analysis	3	0	0	0	6	9
ME6151	Computational Heat and Fluid Flow	3	0	0	0	6	9
ME5103	Incompressible Fluid Flow	3	0	0	0	6	9
ME5127	Introduction to Atmospheric Science	3	0	0	0	6	9
ME5204	Finite Element Analysis	3	0	0	0	6	9
ME5205	Theory of Vibrations	3	0	0	0	6	9
ME6121	Microfluidics and Microsystems	3	0	0	0	6	9
ME7225	Signal Processing of Mechanical Systems	3	0	0	0	6	9
PH5010	Mathematical Physics-1	4	0	0	0	6	10
CS5820	Probability and Computing	4	0	0	0	8	12
CS5691	Pattern recognition and Machine Learning						15
CS6023	GPU Computing	4	0	0	0	8	12
CS6910	Fundamentals of Deep Learning	4	0	0	0	8	12
CS6720	Data Mining	4	0	0	0	8	12
CS7015	Deep Learning	4	0	0	0	8	12
EE5180	Introduction to Machine Learning	4	0	0	0	8	12
EE5351	Linear Algebra Techniques for data analysis	3	0	0	0	6	9
EE5413	Linear Dynamical Systems	4	0	0	0	8	12
EE6415	Nonlinear Systems Analysis	4	0	0	0	8	12
EE6430	Fundamentals of Linear Optimization	3	0	0	0	6	9
ID5090	Data Science of Complex Systems	4	0	0	0	8	12

ID5030	Machine Learning for Engg & Sc Applications	3	0	0	0	6	9
ID5130	Parallel Scientific Computing	3	0	0	1	6	10
ID6015	Advances in Machine learning Sol for Engg Prob	3	0	0	1	6	10
ID6105	Computational tools: Algorithms, data struc & prog	3	0	0	0	6	9
ID6107	Perturbation Methods for Engg Problems	3	0	0	0	6	9
ID7010	Adv Finite Element Analysis	3	0	0	0	6	9

Computational Engineering

The development of Engineering Analysis and design tools for Complex Engineering problems is facilitated through the International Masters programme in Computational Engineering. Computing tools for the development of Engineering software tools are pervasive. They involve CPU intensive calculations in most disciplines such as, Aerospace, Civil, Chemical, Electrical, Mechanical, Materials, Naval Engineering etc. The graduates from this program will reinforce their Simulation and Mathematical modelling expertise in their core Engineering discipline. This is facilitated through a focused bundle of courses that hone their skill set on tools and techniques from Computer Science, Applied Mathematics, and their own discipline in a structured and systematic way. The graduates are expected to compete and reinforce the development of Engineering software development.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	Core - 1	CORE-1 basket	3	0	0	0	6	9
4	Core - 2	CORE-2 basket	3	0	0	0	6	9
5	Elective - 1	Elective 1: Preferably chosen from a chosen elective stream	3	0	0	0	6	9
6	AM5801	Computational Laboratory	0	0	0	3	2	5
		Total Credits						44 to 47
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2		I2MP Core 2*						9 to 12
3	HS Elective		3	0	0	0	6	9
4	Core – 3	CORE - 3 basket	3	0	0	0	6	9
5	Core – 4	CORE - 4 basket	3	0	0	0	6	9

6	AM5035*	High Performance Computing Lab	0	0	0	3	2	5
7	Elective- 2	Elective 2: Preferably chosen from the same Elective stream	3	0	0	0	6	9
		Total Credits						**53 to 56**
Summer								
1	ID5390	Summer Project / Summer Industrial internship (Project I)	0	0	0	0	15	15
		Total Credits						**15**
Semester 3								
1	Elective - 3	Elective 3: Preferably chosen from the same Elective Stream	3	0	0	0	6	9
2	ID5391	Project II	0	0	0	0	30	30
		Total Credits						**39**
Semester 4								
1	ID5392	Project III	0	0	0	0	40	40
		Total Credits						**40**

I2MP Core and HS Electives are given on pages 4-5

Baskets of Core Courses

		Basket of courses for CORE - 1 : Numerical Methods						
1	AM5600	Computational Techniques in Mechanics	3	0	0	0	6	9
2	ME6000	Computational Methods in Engineering	3	0	0	0	6	9
3	ME6150	Numerical Methods in Thermal Engineering	3	0	0	6	6	10
4	MA5470	Numerical Analysis	3	0	0	0	6	9
5	PH5730	Methods of Computational Physics	3	0	0	0	6	9
6	CH6060	Numerical Techniques for Engineers	3	0	0	0	6	9

7	MM5024	Numerical Methods for Metallurgists	3	0	0	0	6	9
8	OE5450	Numerical Techniques in Ocean Hydrodynamics	3	0	1	0	6	12
9	MA5890	Numerical Linear Algebra	3	0	0	0	6	9
10	MA5892	Numerical Methods in Scientific computing	3	0	0	0	6	9

		Basket of courses for CORE - 2 : Computational Implementation						
1	MA5910	Data Structures in Scientific Computing	3	0	0	0	6	12
2	ID6105	Computational Tools: Algorithms, Data Structures and Programs	3	0	0	0	6	9
3	EE4371	Introduction to Data Structures and Algorithms	3	0	0	0	6	9

		Basket of courses for CORE - 3: Discretization Methods						
1	CE5610	Finite Element Analysis	3	0	0	0	6	9
2	AM5630	Foundations of Computational Fluid Dynamics	3	0	0	0	6	9
3	CH6110	Finite Element Methods in Engg	3	0	0	0	6	9
4	ME6800	Finite Element Analysis	3	0	0	0	6	9
5	OE5500	FEM applied to Ocean Engineering	3	0	0	0	6	9
6	CH6020	Computational Fluid Dynamics Techniques	3	0	0	0	6	9
7	AM5450	Fundamentals of Finite Element Analysis	3	0	0	0	6	9
8	ME5204	Finite Element Analysis	3	0	0	0	6	9
9	OE5450	Numerical Techniques in Ocean Hydrodynamics	3	0	0	0	6	9

		Basket of courses for CORE - 4: HPC/ Parallel Computing						
1	AM5080	High Performance Computing for Engineering Applications	3	0	0	0	6	9
2	ID5130	Parallel Scientific Computing	3	0	0	1	6	10

		Suggested Elective streams						
	Stream 1	Computational Fluid Dynamics						
1	AM5630	Foundations of Computational Fluid Dynamics	3	0	0	0	6	9
2	AM5570	Introduction to Turbulence	3	0	0	0	6	9
3	AM6513	Advanced Computational Fluid Dynamics	3	0	0	0	6	9
4	AM5640	Turbulence Modeling	3	0	0	0	6	9
5	ME6650	Computational Fluid Dynamics of Turbomachinery	3	0	0	0	6	9
6	ME6151	Computational Heat and Fluid Flow	3	0	0	0	6	9
7	CH6020	Computational Fluid Dynamics Techniques	3	0	0	0	6	9
8	AM6512	Application of Molecular Dynamics	3	0	0	0	6	9
9	ME6280	Design and Optimization of Energy systems	3	0	0	0	6	9
10	OE6020	Meshfree methods applied to hydrodynamics	3	0	3	0	6	12
11	PE6031	Reservoir Simulation	3	0	0	0	6	9
12	AM5530	Advanced Fluid Mechanics	3	0	0	0	6	9
13	CH5140	Process Analysis and Simulation	3	0	0	0	6	9
14	CH5541	Advanced Momentum Transport	3	0	0	0	6	9

15	ME5110	Inverse Methods in Heat Transfer	3	0	0	0	6	9
16	AS5420	Introduction to CFD	3	0	0	0	6	9
17	AS6041	Advanced CFD - Eddy Resolving Methods	3	0	0	0	6	9

	Stream 2	Computational Solid Mechanics						
1	AM5450	Fundamentals of Finite Element Analysis	3	0	0	0	6	9
2	AM6512	Application of Molecular Dynamics	3	0	0	0	6	9
3	AM6291	Computational Structural Dynamics	3	0	0	0	6	9
4	ME7680	Optimization Methods for Mechanical Design	3	0	0	0	6	9
5	ME6280	Design and Optimization of Energy systems	3	0	0	0	6	9
6	E7730	Advanced Finite Element Analysis	3	0	0	0	6	9
7	AM5390	Advanced Structural Mechanics	3	0	0	0	6	9
	Stream 3	Computational Materials Engineering						
1	ME7244	Foundations of Computational Materials Modeling	3	0	0	0	6	9
2	MM6010	Computational Materials Thermodynamics	3	0	0	0	6	9
3	ME7160	Computational Methods in Design & Mfg.	3	0	0	0	6	9
4	AM6512	Application of Molecular Dynamics	3	0	0	0	6	9
5	MM5011	Modeling of Transport Phenomena in multi-phase systems	3	0	0	0	6	9
6	MM5003	Atomistic Modeling of Materials	2	1	0	0	6	9
7	ED5053	Mechanics of Materials with Microstructure	3	0	0	0	6	9

	Stream 4	Computational Biology						
1	BT6090	Intro. to Bioinformatics & Computational Biology	3	0	0	0	6	9
2	BT6270	Computational Neuroscience	3	0	0	0	6	9
3	BT5420	Computer Simulations of Biomolecular Systems	3	0	0	0	6	9
4	BT5240	Computational Systems Biology	3	0	0	0	6	9
5	ME5560	Heat and Mass Transfer in Biological Systems	3	0	0	0	6	9
6	AM6110	Bio-Fluid Mechanics	3	0	0	0	6	9
7	AM5510	Biomedical Signals and Systems	3	0	0	0	6	9
8	AM5515	Digital Healthcare Technology and Applications	3	0	0	0	6	9

	Stream 1/2/3/4	Other Relevant Computational Courses (This list is based on the list of all acceptable courses, based on COT).						
1	CS6350	Computer Vision	3	0	0	0	6	9
2	CS6360	Computer Graphics	3	0	0	0	6	9
3	EE6130	Advanced Topics in Signal Processing	3	0	0	0	6	9
4	CS5691	Machine learning	3	0	0	0	6	9
5	CS6023	GPU programming	3	0	0	0	6	9
6	AM5011	Virtual Reality Engineering	3	0	0	0	6	9
7	ED6005	Deep Learning for Medical Image Analysis	4	0	0	0	6	12

Cyber-Physical Systems

The Cyber-Physical Systems program is the first-of-its-kind and brings together several interdisciplinary areas into its fold, to train students to solve challenges faced by the world today. Think of the complex power grid, water distribution networks, and transportation and health care systems in smart cities and industries! This program aims to equip students with the necessary and imperative skills for dealing with the future needs of smart infrastructure and services. They will work on the design, control, and optimization of cyber-physical systems, through a combination of core and elective courses, and project work. The program involves both theory and practice and welcomes students with diverse interests in control theory, wireless communication, data analysis, and so on.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	CH5120/ EE5413	Core 1- Basket: Control theory	3	0	0	0	6	9
4	EE5412/ CH5019	Core 2- Basket: Data Science/ Maths	4	0	0	0	8	12
5	EE5705	Data analytics Lab	0	0	0	3	3	6
		Total Credits						**39 to 42**
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2	HS Elective		3	0	0	0	6	9
3		Core 3: Cyber security		0	0	0	6	9
4		Core 4: Communication networks for IoT	0	0	0	6	2	8
5	CH5XXX	CPS lab	3	0	0	0	6	9
6	CH5019	*Core 2- Data Science/ Maths (Replaces the second I2MP Core)	4	0	0	0	8	12
		Total Credits						**50**
Summer								
1	IDXXXX	Project I (Summer)	0	0	0	0	25	25
		Total Credits						**25**
Semester 3								
1	Elective 3		3	0	0	0	6	9
2	Elective 4		3	0	0	0	6	9
3	IDXXXX	Project II (in IITM)	0	0	0	0	20	20
		Total Credits						**38**

Semester 4								
1	IDXXXX	Project III (in IITM)	0	0	0	0	40	40
		Total Credits						**40**

- Electives basket as given in *https://ioe.iitm.ac.in/program/cyber-physical-systems/*
- CPS will use a subset of the I2MP Core basket as given below

I2MP Core Basket Subset:

Course Code	Course Name	Dept	Semester
CH5020	Statistical Design and Analysis of Experiments	CH	Jul - Nov
CH5170	Process Optimization	CH	Jan - May
CH5019	Mathematical Foundations of Data Science	CH	Jan - May
EE6432	Stochastic Control	EE	Jul - Nov
EE6180	Advanced Topics in Artificial Intelligence	EE	Jul - Nov
EE6150	Stochastic Modeling and the Theory of Queues	EE	Jul - Nov
EE5413	Linear Dynamical Systems	EE	Jul - Nov
EE5412	Mathematical Methods in System Engineering	EE	Jul - Nov
EE5401	Measurements and Instrumentation	EE	Jul - Nov
EE5121	Convex Optimization	EE	Jul - Nov
EE6430	Fundamentals of Linear Optimization	EE	Jan - May
EE6415	Nonlinear Control Systems	EE	Jan - May
EE6412	Optimal Control	EE	Jan - May
EE6150	Stochastic Modeling and the Theory of Queues	EE	Jan - May
EE6112	Topics in Random Processes and Concentrations	EE	Jan - May
EE5180	Introduction to Machine Learning	EE	Jan - May
MA5892	Numerical Methods in Scientific Computing	MA	Jan - May
MA5470	Numerical Analysis	MA	Summer
ED5340	Data Science: Theory and practice	ED	Jul - Nov
ED6002	Optimization methods in Engineering Design	ED	Jul - Nov
ED5012	Advanced Applications of Human Factors	ED	Jan - May

Note: Students are advised to do both the math basket courses as core courses, viz., EE 5412 (in the odd semester) CH 5019 (in the even semester).
That will require the students to do only one course from the I2MP core basket.

Electives basket

https://ioe.iitm.ac.in/program/cyber-physical-systems/

S.No.	Course No.	Course Name	Credits
1	CH5230	Data-driven modelling of Process Systems	9
2	CH5170	Process Optimization	9
3	CH5020	Statistical design and analysis of experiments	9
4	CH5115	Parameter and state estimation	10
5	EE6432	Stochastic Control	12
6	EE6433	Distributed Optimization for Control	9
7	EE6430	Fundamentals of Linear Optimization	9
8	EE6415	Nonlinear Control Systems	9
9	EE6412	Optimal Control	9
10	EE5156	Internet of Things and Management of discrete entities	9
11	EE5180	Introduction to Machine Learning	12
12	EE5141	Introduction to Wireless and Cellular Communication	9
13	CS6650	Smart Sensing for Internet of Things	12
14	CS6700	Reinforcement Learning	12
15	CS6330	Digital System Testing and Testable Design	12
16	AM5140	Biomedical Instrumentation	9

Data Science

The interdisciplinary master's degree in Data Science is a unique offering from IIT Madras. Data Science brings together all aspects of technology required for gathering, storing, analysing and understanding data. The program includes coursework and projects on several elements of data science such as storage technology, distributed computing, data driven modeling, data analytics and mining, visualization, and security. The core courses are hands-on and fundamental in nature, while a diverse set of topics - spanning an eclectic mix of advanced algorithmic or theoretical courses and applied data science courses - are offered as electives to help the student hone their specific interest, within the larger umbrella of data science. The students will also choose a project in their area of interest, and deep dive into it in their final year.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2	CH5019	Mathematical foundations of Data Science						12
3	MA5910	Data Structures in Scientific Computing						12
4	MS5600	Introduction to Data Analytics	4	0	0	0	8	12
	Elective 1							9
		Total Credits						48
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
3	HS Elective		3	0	0	0	6	9
4	CS5830	Big Data Laboratory	0	0	0	3	3	6
5	EE5708	Data Analytics Laboratory	0	0	0	3	3	6
5	Elective 2	To be chosen from a basket of Data Science Electives						9
6	Elective 3	To be chosen from a basket of Data Science Electives						9
7	Elective 4	*Possible Split between 2nd and 3rd sem						10
		Total Credits						52

Summer								
1	**CS5610**	Project I (Summer)	0	0	0	0	20	20
		Total Credits						**20**
Semester 3								
1	**CS5620**	Project II	0	0	0	0	30	30
		Total Credits						**50**
Semester 4								
1	**CS5630**	Project III	0	0	0	0	40	40
		Total Credits						**40**

*36 credits from the approved list of electives. These can be taken 2nd or 3rd semesters. We recommend they take these in the 2nd semester.

*List of Elective courses in Page 70 of *DD curriculum 2019*

* HSS electives as mentioned in Page 5

Energy Systems

Energy is a key factor in the growth of countries and their development. Yet, the world is now facing a need to re-assess its approach to derive energy due to effects that the large energy consumption is having on the environment.

Energy sources are multiple and involve different disciplines for its use and operation. The I2MP program aims to provide the student with the basic skill sets that spread across the multiple domains of energy, as its core content. Electives offer a way to specialize in certain aspects as well. The Project aims to provide the candidate with a working experience in their chosen field in an interdisciplinary manner. It is expected that the student after graduation would be capable of tackling the issues in this highly interdisciplinary field in industry or in academic research.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3		I2MP Core 2*						9 to 12
4	ME5129	Principles of Thermal Energy Conversion	3	0	0	0	6	9
5	HS Elective							9
6	Elective 1		3	0	0	0	6	9
		Total Credits						48 to 52
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2	ME6148	Renewable Energy Technology	3	0	0	0	6	9
3	ID5070	Energy Economics	3	0	0	0	6	9
4	ID6106	Materials for Energy Storage and Conversion	3	0	0	0	6	9
5	Elective 2		3	0	0	0	6	9
6	Elective 3		3	0	0	0	6	9
		Total Credits						48

Semester 3								
1	**EE5910**	Project I (summer)	0	0	0	0	15	15
2	**EE5920**	Project II (during semester)	0	0	0	0	30	30
3	**Elective 4**		3	0	0	0	6	9
		Total Credits						**54**
Semester 4								
1	**EE5930**	Project III	0	0	0	0	40	40
		Total Credits						**40**

- Electives as per *Pg 73 & 74 of DD curriculum 2019*
- I2MP & HSS courses as mentioned in pages 4-5

Quantum Science and Technology

Quantum computing has heralded a fundamental technological shift, wherein the laws of quantum mechanics are being harnessed to perform computing tasks that would be otherwise intractable, even for supercomputers. Quantum science and technologies have taken giant strides over the last decade, with companies like IBM, Google and Honeywell showcasing quantum devices with 100s of quantum bits (qubits). IIT Madras has introduced the international interdisciplinary master's program (I2MP) in quantum science and technologies (QuST) keeping in mind the widespread need for a quantum-skilled workforce, across academia and industry. The core courses of the I2MP QuST programme are offered by faculty from the departments of Physics and Electrical Engineering, while the suggested elective courses are spread out across Physics, Electrical Engineering, Mathematics and Computer Science. The program aims to provide the students with a solid grounding in various aspects of QuST, including quantum algorithms, quantum error correction, quantum hardware and quantum cryptography.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	HS Elective		3	0	0	0	6	9
4	PH5840	Core 1: Quantum Computation and Quantum Information	3	0	0	0	6	9
5	EE5347	Core 2: Quantum Electronics and Lasers	3	0	0	0	6	9
6	ID5841	Quantum Computing Lab	0	0	0	1	2	3
		Total Credits						**42 to 45**
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2		I2MP Core 2*						9 to 12
3	ID5840	Core 3: Experimental Techniques for Quantum Computation and Metrology	3	0	0	0	6	9
4	EE6502	Core 4: Optical Signal Processing and Quantum Communications	3	0	0	0	6	9
5		Elective 1	3	0	0	0	6	9
6		Elective 2	3	0	0	0	6	9
		Total Credits						**48 to 51**
Summer								
1	ID5790	Project I (Summer)	0	0	0	0	25	25
		Total Credits						**25**

Semester 3								
1		Elective 3	3	0	0	0	6	9
2		Elective 4	3	0	0	0	6	9
3	ID5791	Project II	0	0	0	0	20	20
		Total Credits						**38**
Semester 4								
1	ID5792	Project III	0	0	0	0	40	40
		Total Credits						**40**

- I2MP & HSS courses as mentioned in Pages 15-16
- Electives as given in *https://ioe.iitm.ac.in/program/quantum-science-technology/*

Electives

	Course No.	Course Name	Dept.
A	PH5842	Advanced Topics in Quantum Information	PH
A	PH5170	Quantum Mechanics – II	PH
A	PH5620	Coherent and Quantum Optics	PH
A	PH5480	Advanced Statistical Physics	PH
A	PH5680	Superconductivity and applications	PH
A	PH5500	Dynamical Systems	PH
A	PH5815	Ultrafast Lasers and Applications	PH
B	EE5120	Linear Algebra	EE
B	EE5142	Introduction to Information and Coding theory	EE
B	EE5160	Error control coding	EE
B	EE5347	Electronic and Photonic Nanoscale Devices	EE
B	EE6500	Integrated Optoelectronic Devices and Circuits	EE
B	EE6700	Advanced Photonics Laboratory	EE
B	EE7500	Advanced topics in RF and Photonics	EE
C	MA5310	Linear Algebra	MA

C	CS5011	Introduction to Machine Learning	CS
C	CS6111	Foundations of cryptography	CS
C	CS7111	Advanced Topics in Cryptography	CS
C	CS7260	Postquantum Cryptography	CS

Robotics

The International Interdisciplinary Master's Degree program (I2MP) in Robotics is proposed to nurture and develop the next-generation professionals in the area of robotics who can contribute to the design, development, and implementation of robotic systems in the industry and help the industry to improve their productivity, leading to the overall economic growth. The I2MP in Robotics will have its focus on Design, Analysis, and Application development (new system development) and the curriculum has been developed with this focus. The program is offered by faculty from the departments of Aerospace Engineering, Applied Mechanics, Civil Engineering, Computer Science and Engineering, Electrical Engineering, Engineering Design, Mechanical Engineering and Ocean Engineering. The true interdisciplinary nature of Robotics is reflected in this joint program collectively offered by faculty from various Depts.

Sl. No.	Course No.	Course Name	L	T	E	P	O	C
Semester 1								
1	GN5004	Research Skills	0	0	0	3	0	3
2		I2MP Core 1*						9 to 12
3	ID6040	Core 1: Introduction to Robotics	4	0	0	0	8	12
4		I2MP Core 2*						9 to 12
5	Elective	Elective						9
		Total Credits						**42 to 48**
Semester 2								
1	HS5050	Indian Culture	0	0	0	3	0	3
2	ED6007	Core 2: Mechanics and Control of Manipulators	4	0	0	0	8	12
3		HS Elective	3	0	0	0	6	9
4	Elective	Elective						9
		Total Credits						**33**
Summer								
1	ID5690	Project I (Summer)						20
		Total Credits						**20**
Semester 3								
1	ED5315	Core 3: Field and Service Robotics	3	0	0	0	6	9
2	ID6100	Core Lab1: Robotics Laboratory	0	0	0	3	3	6
3	ID5691	Project II						25
4	Elective	Elective						9
5	Elective	Elective						9
		Total Credits						**58**

Semester 4								
1	ID5692	Project III	0	0	0	0	40	40
		Total Credits						**40**

- Electives: 36±2 credits to be completed from the approved list in Pg 76 & 77 of *DD curriculum 2019*
- Project: 85 credits to be completed in 2nd, 3rd, and 4th semester
- HSS Elective as given in Page 5
- I2MP courses are to be chosen from basket 1 and 2 as given below

Robotics I2MP core basket

Basket 1 **I2MP - Core 1**

Course Number	Course Name	Dept	Semester
CH5019	Mathematical Foundations of Data Science	CH	Jan - May
EE5412	Mathematical Methods in System Engineering	EE	Jul - Nov
ED5340	Data Science: Theory and practice	ED	Jul - Nov
EE6430	Fundamentals of Linear Optimization	EE	Jan - May
ED6002	Optimization methods in Engineering Design	ED	Jul - Nov
MA5892	Numerical Methods in Scientific Computing	MA	Jan-May
MA5470	Numerical Analysis	MA	Summer
PH5050	Mathematical Physics II	PH	Jul - Nov

ED5015	Computational Methods in Design	ED	Jan - May
ME5201	Computational Methods in Engg	ME	Jul - Nov

Basket 2- I2MP -Core 2

Course Number	Course Name	Dept	Semester
ED5017	Digital Signal Processing for Engineering Design	ED	Jan - May
ED5318	Biomimetic Design	ED	Jan - May
ME5204	Finite Element Analysis	ME	Jul - Nov
ME6355	Topology optimization	ME	Jan - May
EE5413	Linear Dynamical Systems	EE	Jul – Nov
EE5401	Measurements and Instrumentation	EE	Jul – Nov
EE5180	Introduction to Machine Learning	EE	Jan – May

Useful Links:

I2MP website: https://ge.iitm.ac.in/I2MP/

Dual Degree Curriculum: https://www.iitm.ac.in/sites/default/files/Academic%20Curricula%20Files/DualDegree-Curriculum-2019.pdf

IoE Website: https://ioe.iitm.ac.in/student/