IISER
THIRUVANANTHAPURAM

BS-MS Dual Degree Programme
Integrated and Interdisciplinary Sciences (i^2 Sc)

i^2 Biological Sciences
i^2 Chemical Sciences
i^2 Data Sciences
i^2 Mathematical Sciences
i^2 Physical Sciences

ver. 12 August 2020

About IISER TVM

Founded in 2008, the Indian Institute of Science Education and Research Thiruvananthapuram (IISER TVM) is dedicated to scientific research and science education. Traditionally, teaching has been segregated from research in undergraduate science curricula in India, and the IISERs were established by the Government of India, to bridge this dichotomy. The Institute aims to provide high quality education in modern science, integrating it with outstanding research and to develop a spirit of enquiry cutting across disciplines. IISER TVM is an autonomous institution offering five-year BS-MS, Integrated Ph. D. and Ph.D. programmes.

Situated in a lush green campus cradled by the mighty Western Ghats, the Institute presents itself as an ideal platform with an awesome ambience for innovation and cross pollination of ideas and knowledge. The faculty members of the Institute are the alumni of the most prestigious institutions across the world, who are devoted to research and dedicated to educate as well as train students in the frontier areas of basic and applied sciences. The reputed faculty fraternity and the vibrant student community are supported by a team of constructive administrative staff, ensuring that the Institute makes significant advancements in research and education.

"The mandate of IISERs is to impart undergraduate education with research as an integral part. With world-class infrastructure, enviable facilities and scientists of exemplary calibre, IISERs have emerged as sought-after destinations for inquisitive and passionate young minds to conduct both blue sky research as well as research with societal relevance. IISER TVM, nestled in the beautiful Western Ghats of 'God's own country', is unrivalled for high-quality education through research engagement in the most tranquil atmosphere. The newest additions to its academic programmes, namely BS-MS i^2 Sciences, have been conceptualized, devised and developed to produce graduates with topical education and skill sets for the science of today and tomorrow. The curricula of these ambitious creations uniquely blend the core syllabi in each of the disciplines with developments in contemporary and emergent areas, and integrate applied research.

I am certain that the new advanced and vibrant science programmes, in conjunction with the existing ones in our perennially lush-green exquisite campus, will lead to germination of scientists, professionals and leaders of science and technology in India. I extend a warm welcome to the brilliant young minds for a journey with education that is integrated with core as well as topical content and research that is quite interdisciplinary!"

Image: View of Kurisumala peak from IISER TVM campus

- Prof. J. N. Moorthy, Director, IISER TVM

Contents

Integrated & Interdisciplinary Sciences (i^2 Sc)

Introduction

Integrated and Interdisciplinary Sciences (i^2 Sc) is a newly-conceptualised 5-Year BS-MS programme, launched by IISER TVM to impart unique education and training to a younger generation of students. It aims to equip tomorrow's workforce with skills that meet the evolving needs, demands and challenges of the modern world. The major challenges that the world faces today, namely, climate change, food security, healthcare, sustenance, etc., are too complex to be solved by biologists, chemists and physicists independently. Efforts to tackle them require integrated expertise and interdisciplinary knowledge in areas that span physics, chemistry, biology and mathematics.

The digital age has ushered in a new era of automation and big data, revolutionising the way we practice science, technology and medicine. From detecting neutron star mergers to cancer diagnosis, today we employ tools and skills that have often been developed separately. The necessity of symbiotic application of skills and tools from these different genres of science has led to a new paradigm for scientific investigations and analysis. This is precisely the purview of the i^2 Sc programme, which leverages the strengths of core disciplines and blends it uniquely with topical and modern developments - offering an integrated mix of core and thematic courses. The thematic areas have been curated to offer expertise in topics that are relevant to today's as well as tomorrow's science and technology.

The i^2 Sc programme includes 5 different streams, each based on a core discipline and associated thematic areas, as outlined below. At the end of the common Foundation Courses taught over the first two years, students may opt for any ONE of these five streams to study advanced courses in the core discipline and specialise in the associated thematic areas, culminating in a year-long research project in the year five.

i^2 Biological Sciences	Systems & Synthetic Biology and Precision Imaging & Medicine
i^2 Chemical Sciences	Chemical Biology and Biomaterials
i^2 Data Sciences	Data Science as applied to Natural Sciences
i^2 Mathematical Sciences	Mathematical Modelling and Scientific Computing
i^2 Physical Sciences	Materials, Devices, Energy and Modelling

Each of the five streams offers a unique, yet integrated paradigm to gain analytic and cognitive skills based on an interdisciplinary curriculum and training in research. The new frontier, i^2 Data Sciences, also fits in harmoniously with other streams as well as with regular science programmes of the Institute in its applicability, in addressing both frontier research as well as real-world problems.

National Eligibility Tests

The curriculum covers adequate material to prepare the students for national eligibility tests such as CSIR-NET, UGC-NET, JGEEBILS, JEST, NBHM, etc. to pursue doctoral programmes in India and worldwide.

Internships and Research Projects

Internships and research projects constitute an integral part of the i^2 Sc programme. Students will be required to pursue internships in research organisations - either in industry or academic institutions during the recess periods in third and fourth years. The final year research project may be conducted in partnership with national and international R&D laboratories.

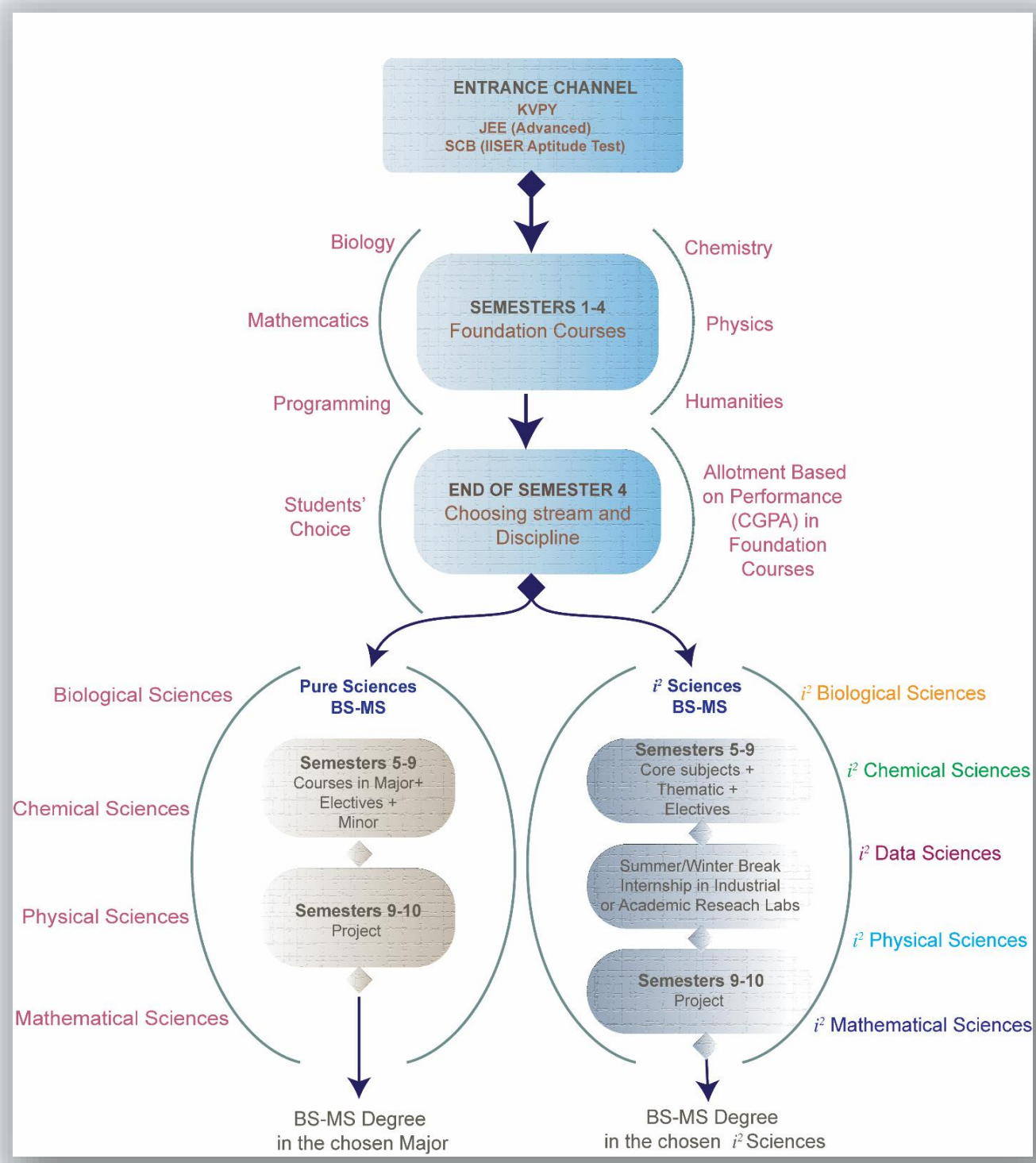
Associated and Soft Skills

The curriculum includes courses in allied topics like Scientific Communication, Intellectual Property Rights (IPR), Entrepreneurship and Ethics to contextualise the learning experience. Included are opportunities to inculcate soft skills that are absolutely essential for the future success of the highly skilled graduates of the programme.

Overall the programme offers each student ample scope for tailoring one's interests to pursue education aligned towards one's own career goals. It will allow one to integrate and sharpen one's skills through interactions and experimentation, and showcase capability for innovation and creativity.

Course Code	I2X
Duration	5 Years
Entrance	Common IISER BS-MS Admissions https://www.iiseradmission.in
Contact	+91 471 277 8007 isquare@iisertvm.ac.in
Number of Seats	80 (across all disciplines)

Overall Structure



Course Structure

At IISER TVM, one starts with an open mind. The curriculum provides training in the fundamentals of natural sciences, mathematics and computation, and then lets one choose the area that one would like to pursue and specialise in. Information regarding the structure of the programme spanning five years (10 semesters), their salient features, courses offered and further details are provided below.

Years 1 & 2	
Foundation Courses	Introductory Courses on: Biology, Chemistry, Mathematics, Physics, Programming + courses in Communication Skills and Languages The Foundation Courses provide a broad and robust base for all the BS-MS programmes.
After successful completion of the foundation courses, students may opt for ONE of the five i^2 Sciences programmes.	

Years 3 & 4	
Core Courses	Advanced Courses in the core discipline of the selected i^2 Sciences stream. The Foundation and Core courses together prepare students for Competitive Examinations and various National Eligibility Tests for doctoral studies in India and worldwide.
Thematic Courses	Interdisciplinary courses on topics in the associated thematic areas of the selected i^2 Sciences stream. The thematic courses are uniquely designed to impart advanced level education with interdisciplinary content and practical training.

Year 5	
Research	Independent year-long research in industry and/or academic institutions.
Additional Content	
Elective Courses	Courses allied to the core disciplines and thematic areas are offered as electives in years 3, 4 and 5.
General Courses	Courses in diverse areas such as Scientific Writing, Science Society and Ethics, Intellectual Property Rights, Entrepreneurship, Management Principles, Psychology, Anthropology, Music, Health, Economics, and Languages are offered in years 3, 4 and 5.
Internship	Training in national and international R&D laboratories (industry or academia).

Each academic year at IISER TVM is divided into 2 semesters (Varsha and Vasant) interspersed by the summer and winter breaks. The courses in the first four semesters (years 1 and 2) comprise the **Foundation Courses**, common to all BS-MS programmes offered by the Institute. The curriculum covers fundamentals of natural sciences, mathematics and computation along with courses that enrich language and scientific communication skills. Typically, each course consists of 3 hours of lectures per week, supplemented by a 1-hour tutorial held in small groups under the supervision of lecturers and dedicated teaching assistants. The laboratory-based courses are held in staggered batches to ensure adequate opportunities for all individuals to access instruments and other facilities.

At the end of the fourth semester (year 2), one can opt for any one of the five i^2 Sciences streams. Years 3 and 4 comprise **Core Courses** in the chosen core discipline, that is, biology, chemistry, mathematics, physics and data sciences, and **Thematic Courses** in the respective thematic areas. Ample opportunities are offered in 3rd, 4th and 5th years to personalise one's own unique learning experience by way of elective courses, which provide further expertise in niche areas.

The independent research project in semesters 9 and 10 (year 5) allows one to apply one's training to tackle real problems of science, industry and society. Beyond the academic and technical expertise, opportunities exist to gain essential experience in project management, communication and presentation skills, and teamwork.

General Credit Structure

Year	Semester	Credits	Courses/Project
1 - 2	1 - 4	76	Foundation Courses
3 - 5	5 - 9	78	Core Courses Thematic Courses Elective Courses
3 - 5	5 - 8	6	General Courses
5	9 - 10	30	Research Project
Total Credits		190	

Note: Minimum credit requirement and semester-wise division of courses between Core – Thematic – Electives vary between the five i^2 Sciences streams.

Course Codes

The FOUNDATION, CORE and THEMATIC courses are numbered in the format,

XYZ LSC (LTPC)

The ELECTIVE courses are numbered in the format,

XYZ LSCD (LTPC)

The numbering may be understood as

XYZ	:	Subject/Programme Code
L	:	Level of the course (1, 2, 3, 4 or 5)
S	:	Semester (1 = Varsha, 2 = Vasant)
C (CD)	:	Course number in that Semester
L	:	Lecture hours per week
T	:	Tutorial hours per week
P	:	Practical hours per week
C	:	Credits

Subject codes:

BIO : Biological Sciences
MAT : Mathematical Sciences
IDC : Interdisciplinary Studies
DSC : Data Sciences
I2C : i^2 Chemical Sciences
I2M : i^2 Mathematical Sciences
CHY : Chemical Sciences
PHY : Physical Sciences
HUM : Humanities
I2B : i^2 Biological Sciences
I2D : i^2 Data Sciences
I2P : i^2 Physical Sciences

Foundation Course Structure (Semesters 1 - 4)

Semester 1	Semester 2	Semester 3	Semester 4
BIO 111 Ecology and Evolution (3103)	BIO 121 Biomolecules (3103)	BIO 211 Genetics and Molecular Biology (3103)	BIO 221 Introduction to Cell Biology and Microbiology (3103)
CHY 111 Atomic Structure & Chemical Bonding (3103)	CHY 121 Basic Concepts in Organic & Inorganic Chemistry I (3103)	CHY 211 Basic Concepts in Organic & Inorganic Chemistry II (3103)	CHY 221 Physical Chemistry I (3103)
MAT 111 Single Variable Calculus (3103)	MAT 121 Introduction to Linear Algebra (3103)	MAT 211 Multivariable Calculus (3103)	MAT 221 Introduction to Probability (3103)
PHY 111 Mechanics (3103)	PHY 121 Electromagnetism (3103)	PHY 211 Optics (3103)	PHY 221 Thermal and Statistical Physics (3103)
BIO 112 Biology Lab I (0031)	BIO 122 Biology Lab II (0031)	BIO 212 Biology Lab III (0031)	
CHY 112 Chemistry Lab I (0031)		CHY 212 Chemistry Lab II (0031)	CHY 222 Chemistry Lab III (0031)
PHY 112 Physics Lab I (0031)	PHY 122 Physics Lab II (0031)		PHY 222 Physics Lab III (0031)
IDC 111 Mathematical Tools I (2102)	IDC 121 Mathematical Tools II (3103)	IDC 211 Physical Principles in Biology (3103)	IDC 221 Principles of Spectroscopy (3103)
IDC 112 Fundamentals of Programming (0031)	IDC 122 Numeric Computing (0031)	IDC 212 Data Handling and Visualisation (0031)	IDC 222 Scientific Computing (0031)
Communication Skills I (1001)	Communication Skills II (1001)	Economics (1001)	Languages (1001)
[19 credits]	[19 credits]	[19 credits]	[19 credits]

Biology has been interwoven strongly as never before with other natural sciences and mathematics to address the issues relevant to human health and the environment. To tackle the ever-expanding questions in biology pertinent to health care, a new generation of innovative scientists who not only master biological sciences but also have more in-depth knowledge of other disciplines of natural sciences and mathematics are sought after globally. Interdisciplinary teaching, integrated with research is a high priority in Indian academia and worldwide.

This 5-Year degree program in Biological Sciences will offer a strong foundation of basic sciences and advanced training in core biological sciences and the rapidly emerging fields of next-generation biology. Students will obtain rigorous training in theory complemented with laboratory exercises in both core and thematic areas.

Content and Opportunities

- Years 1 & 2: Foundation Courses - basic courses in physics, chemistry, biology, mathematics and computation. The Foundation Courses form the broad and robust base for all the interdisciplinary BS-MS programmes.
- Years 3 & 4: Core Biology Courses - cover the essential modern biology including Biochemistry, Genetics & Genomics, Cell & Molecular Biology, Microbiology, Immunology, Physiology, etc. Together, the foundation and core courses provide the material for preparing for relevant National Eligibility Tests (NET) and competitive examinations in India and Ph.D. requirements worldwide.
- Years 3 & 4: Thematic Courses - develop knowledge in the thematic areas of systems biology, synthetic biology, Imaging and personalized medicine, with adequate practical training.
- Year 5: Independent research work in a specific area.

The flexible course structure provides one with an ample scope for choosing courses to engineer one's personal experience with tailored outcomes and expertise. The learning experience is further enriched by national and international internships in industry and research laboratories.

Why should one opt for i^2 Biological Sciences?

Training young scientists with passion for deciphering and unravelling the wonders of life with a sound scientific basis and interdisciplinary outlook is mandatory to meet challenges of the human society of future. Our program has been devised and structured with this objective. Its innovative curriculum that strikes an optimal balance of teaching modern biological sciences with adequate breadth in relevant interdisciplinary fields combined with full-time research. Students of our program will be uniquely poised to pursue an advanced doctoral degree or confidently engage in next-generation health care and bio-inspired industries.

i^2 Biological Sciences – List of Courses (Semesters 5 – 10)

Thematic Areas: Systems & Synthetic Biology and Precision Imaging & Medicine

Core - Biology
Biochemistry
Bioinformatics
Biostatistics
Cell Biology
Developmental Biology
Genetics & Genome Biology
Immunology
Microbiology
Molecular Biology
Physiology
Structural Biology

Thematic - Systems & Synthetic Biology
Systems Biology - theory & applications
Synthetic Biology
Biomaterials
Microbiome & Vaccinology

Thematic - Precision Imaging & Medicine
Biological spectroscopy & microscopy
Bio-imaging & Processing
Stem Cells & Regenerative Medicine
Human Genetics, Gene Therapy
Personal Genomics

Electives - Biology
Neurobiology
Chronobiology
Ecological Interactions
Evolutionary Ecology
Cancer Biology
Plant Molecular Biology
Host Pathogen Interactions
Cryo-Electron microscopy and 3D image processing for Life sciences.

Electives - Open
Machine Learning
Biophysical Chemistry
Enzymology & Biocatalysts
Chemical Genomics
Probability & Stochastic Processes
Theory of Ordinary Differential Equations

General Courses
Communication Skills + Technical Writing
Intellectual Property Rights
Languages
Economics
Psychology

Research
Full time research project + project management, presentation and entrepreneurial skills.

Research Internships

i^2 Biological Sciences – Credit Structure

Thematic Areas: Systems & Synthetic Biology and Precision Imaging & Medicine

Sems.	Courses	Credits	Total
1	Foundation Courses	19	76
2	Foundation Courses	19	
3	Foundation Courses	19	
4	Foundation Courses	19	
5	Biological Sciences Core Courses	18	18
	Thematic Courses	0	
	Electives	0	
6	Biological Sciences Core Courses	18	18
	Thematic Courses	0	
	Electives	0	
7	Biological Sciences Core Courses	3	20
	Thematic Courses	14	
	Electives	3	
8	Thematic Courses	15	18
	Electives	3	
9	Electives	6	18
	Project	12	
10	Project	18	18
5 - 10	General Courses (IP/Ethics/Languages/Music/Psychology)	4	4
	Total	190	190

Chemistry, being the central science, plays a major role in different branches of science. The traditional boundaries between the branches of science are fast changing! In the current scenario and in the near future, great research explorations and technology developments are expected to happen in the interdisciplinary areas of science. One of the important areas of future is the emergent new discipline, where chemistry, biology and materials science meet. To attract young and bright minds to this area and to equip the next generation of scientists with the necessary repertoire of skills to take up research in this challenging and highly rewarding area and to make professionally competent science practitioners. School of Chemistry offers an Integrated and Interdisciplinary Science course namely BS-MS in i^2 Chemical Sciences.

This 5-Year degree program in chemical sciences will offer an unparalleled preparation for a range of satisfying careers in research, medicine and industry. The curriculum is primarily centred on practical teaching in a research environment. Along with advanced theoretical studies, original research is pursued in world-class laboratories under the mentorship of leading experts of the field.

Content and Opportunities

- Years 1 & 2: Foundation Courses - basic courses in physics, chemistry, biology, mathematics and computation. The Foundation Courses form the broad and robust base for all the interdisciplinary BS-MS program.
- Years 3 & 4: Core Chemistry Courses - Core courses in physical, organic and inorganic chemistry. The course is centered in chemistry curriculum and has been designed to equip the students for clearing important national and international level competitive exams in Chemistry.
- Years 3 & 4: Thematic Courses - develop knowledge in the thematic areas of Chemical Biology and Materials. Students have the option of choosing electives in the 4th year to specialize in the thematic track.
- Year 5: Independent research work in a specific area.

The flexible course structure provides one with an ample scope for choosing courses to engineer one's personal experience with tailored outcomes and expertise. The learning experience is further enriched by national and international internships in industry and research laboratories.

Why should one opt for i^2 Chemical Sciences?

The highlight of this programme are the internships at reputed industries engaged in such research and product development related to this interdisciplinary area. The programme will provide one a proper base for graduate studies in these interdisciplinary areas. Students will acquire the in-depth lab experience and theoretical knowledge that elite employers look for and establish a network in pharma, medicine and academia that will help their career progress. This programme provides a number of opportunities both in India and abroad that includes academic research (doctoral and postdoctoral), medical research, private sector research and development, patent office and regulatory bodies, sales etc

i^2 Chemical Sciences - List of Courses (Semesters 5 – 10)

Thematic Areas: Chemical Biology & Biomaterials

Core - Chemistry
Organic Chemistry Reaction and Mechanism
Coordination Chemistry
Quantum Chemistry
Physical Chemistry II
Organic Chemistry Synthetic Methods
Organometallic Chemistry
Advanced Organic Chemistry
Main Group Chemistry
Chemical Kinetics and Dynamics
Instrumental Methods for Structure Determination

Thematic - Chemical Biology, Medicinal Chemistry
Molecular Biology
Cell Biology
Medicinal Chemistry
Biophysical Chemistry
Enzymology and Biocatalysts
Pharmacology and Pharmacokinetics
Computational Chemical Biology
Chemical Genomics

Thematic - Biomaterials
Biochemistry & Bio-conjugation
Biomaterials
Soft Matter and Polymers

Electives - i^2 Sciences
Bioinformatics
Immunology
Developmental Biology
Microbiome and Vaccinology
Solid-State Chemistry
Drug Discovery Design and Development
Supramolecular Chemistry
Modern Organic Synthesis
Principles of Digital Imaging
Sensor Technology
Digital Image Processing
Material Characterization

General Courses
Communication Skills + Technical Writing
Intellectual Property Rights
Languages
Economics
Psychology
Music

Research Projects + Internships
Independent research projects + project management, presentation and entrepreneurial skills.

i^2 Chemical Sciences - Credit Structure

Thematic Areas: Chemical Biology & Biomaterials

Sems.	Courses	Credits	Total
1	Foundation Courses	19	76
2	Foundation Courses	19	
3	Foundation Courses	19	
4	Foundation Courses	19	
5	Chemistry Core Courses	15	18
	Thematic Courses	3	
	Electives	0	
6	Chemistry Core Courses	9	18
	Thematic Courses	6	
	Electives	3	
7	Chemistry Core Courses	9	18
	Thematic Courses	9	
	Electives	0	
8	Chemistry Core Course	3	18
	Thematic Courses	15	
	Electives	0	
9	Electives	6	18
	Project	12	
10	Project	18	18
5 - 10	General Courses (IP/Ethics/Languages/Music/Psychology)	6	6
	Total	190	190

i^2 Data Sciences

Thematic Areas: Data Science as applied to Natural Sciences

The i^2 data sciences programme is designed to train data science professionals whose skills are honed to meet the demands of data analytics, especially in natural sciences. These trained individuals are not only expected to fill the anticipated demand for such professionals but are also foreseen to bring value addition to their chosen fields using their background in research and innovation.

This 5-Year programme aims to provide the highest level of interdisciplinary education in science and technology to students and to produce competent, creative and imaginative data scientists with a strong foundation. It aims to provide hands-on training on real-time projects related to research topics in science and technology.

Content and Opportunities

- Years 1 & 2: Foundation Courses - basic courses in physics, chemistry, biology, mathematics and computation.
- Years 3 & 4: Core Data Science Courses - Fundamentals of mathematics, computer science and data sciences.
- Years 3 & 4: Thematic Courses - develop knowledge in the thematic areas such as machine learning, artificial intelligence, big data analytics, machine learning, and other various applications of data sciences.
- Year 5: Independent research work in a specific area.

The flexible course structure provides one with ample scope for choosing courses to the satisfaction of one's personal experience with tailored outcomes and expertise. The learning experience is further enriched by national and international internships in industry and research laboratories.

Why should one opt for i^2 Data Sciences?

This programme trains one to understand and analyse large datasets. Modern science, technology and even social life, are getting increasingly data-driven. Progress in each field is closely tied to one's ability to collect, analyse, assimilate and gain a better understanding of a large amount of data. Data science has emerged in recent years as a discipline of its own with the development of new tools, techniques, algorithms and mathematics to work with data at large scales. These enabling tools and techniques allow for deriving insights from complex and unstructured data, which helps in solving real-world problems. Scientific research in diverse fields ranging from cosmology and particle physics to ecology and genetics routinely produce very large data sets of varying complexity and structure. Application of the techniques of data science to these data sets leads to a better understanding of natural phenomena, pushing the frontier forward in data sciences.

i^2 Data Sciences – List of Courses (Semesters 5 – 10)

Thematic Areas: Data Science as applied to Natural Sciences

Core – Mathematics
Mathematical Statistics
Scientific Computing
Optimization Techniques
Discrete Mathematics
Statistical Modelling
Stochastic Processes

Core – Data Science
Machine Learning – 1
Data Science Lab – 1
Machine Learning – 2
Data Science Lab – 2
Data Warehousing and Business Intelligence
Artificial Intelligence
Data Analysis and Visualization
Big Data Analytics

Core – Computer Science
Advanced Data Structures
Computer Organization and Operating System
Design and Analysis of Algorithms
Database Management System
Parallel and Distributed Computing

Electives – Thematic
Data Science in Chemistry
Quantum Information Theory
Internet of Things and Cloud Computing
Big Data in Ecology and Environmental Sciences
Text Mining and Natural Language Processing
Clinical Data Analysis
Bioinformatics
Probabilistic Machine Learning
Statistical Simulation and Computation
Data Science for Finance
Machine Learning for Material Science
Particle Physics Data Processing
Data science in Chemistry
Computer Vision

Electives - Open
Systems Biology
Advanced Genetics and Genomics
Computational Fluid Dynamics
Computational Chemical Biology
Modelling Materials

General Courses
Communication Skills + Technical Writing
Intellectual Property Rights
Languages
Economics
Psychology

Research
Full time research project + project management, presentation and entrepreneurial skills.

Research Internships

i^2 Data Sciences – Credit Structure

Thematic Areas: Data Science as applied to Natural Sciences

Sems.	Courses	Credits	Total
1	Foundation Courses	19	76
2	Foundation Courses	19	
3	Foundation Courses	19	
4	Foundation Courses	19	
5	Core Courses	19	19
	Thematic	0	
	Electives	0	
6	Core Courses	15	18
	Thematic	0	
	Electives	3	
7	Core Courses	15	18
	Thematic	0	
	Electives	3	
8	Core Courses	7	19
	Electives	12	
9	Electives	6	18
	Project	12	
10	Project	18	18
5 – 10	General Courses (IP/Ethics/Languages/Music/Psychology)	5	5
	Total	191	191

Mathematics is the language of science. Traditionally, disciplines such as physics and engineering have strongly relied on mathematics to describe natural phenomena or even to design a machine. On the other hand, disciplines such as life sciences and chemical sciences were considered to be less mathematical. However, last few decades have seen a paradigm shift in how problems in life sciences or chemical sciences are perceived and studied. Progressively, the boundaries between various disciplines are getting blurred and practice of science and technology are becoming interdisciplinary in nature. At this juncture, mathematics has become absolutely indispensable for science and technology, simply because mathematics is the only language by which different areas of science can correspond with each other.

The proposed programme, i^2 Mathematical Sciences, is designed such a way that it does justice to both phrases namely, "integrated" and "interdisciplinary". On one hand, the programme integrates the knowledge of foundation in abstract mathematics with applications, while on the other hand, the interdisciplinary nature of the program provides one with an ability to understand and adapt to the necessities and challenges of other disciplines. This programme aims to provide broad yet rigorous training in areas of mathematics and computer science related to mathematical modelling and scientific computing.

Content and Opportunities

- Years 1 & 2: Foundation Courses - basic courses in physics, chemistry, mathematics, biology and computation.
- Years 3 & 4: Core Mathematics Courses - develop strong base in the classical areas, e.g. in Algebra, Topology, Analysis, Applied Analysis, Probability and Statistics.
- Years 3 & 4: Thematic Courses - develop knowledge in the thematic areas of mathematical modelling and scientific computing, integrated with the modern techniques of applied statistics, machine learning, and applications of data sciences.
- Years 3 & 4: Elective Courses - help to build expertise in specific application domains, e.g. market and finance, atmospheric sciences, biological sciences.
- Year 5: Independent research work in a specific area.

The flexible course structure provides one with an ample scope for choosing courses to engineer one's personal experience with tailored outcomes and expertise. The learning experience is further enriched by national and international internships in industry and research laboratories.

Why should one opt for i^2 Mathematical Sciences?

This programme in mathematical sciences will generate a pool of experts, who can survive and excel in an industrial as well as academic environment. Among industry- and market-based career options, one can think of, to name a few, finance and banking sectors, software development, environment and climate change, big data analysis, bioinformatics, etc. For the academically-inclined, this program also offers an excellent opportunity and provides the mathematical foundation to pursue research in pure or applied mathematics or various other related and interdisciplinary areas such as physical sciences, environmental sciences, etc.

Core - Mathematics
Real Analysis
Linear Algebra
Group Theory
Topology
Complex Analysis
Measure Theory
Functional Analysis
Mathematical Statistics
Probability and Stochastic Processes
Theory of Ordinary Differential Equations
Partial Differential Equations
Numerical Analysis
Data Structures and Algorithms

Thematic - Mathematical Modelling and Scientific Computing
Machine Learning I
Data Science Lab I
Scientific Computing
Mathematical Modelling
Applied Stochastic Analysis
Numerical Solutions of Differential Equations
High Performance Computing
Finite Element Methods
Variational Methods and Control Theory

Electives - Mathematics
Methods of Applied Mathematics
Sobolev Spaces and Elliptic Boundary Value Problems
Computational Stochastic Modelling
Mathematical Finance and Option Pricing
Statistical Methods in Finance
Financial Data Analysis
Mathematical Biology
Stochastic Modelling of Biological Processes

Electives - Open
Machine Learning - II
Big Data Analytics
Artificial Intelligence
Bioinformatics
Systems Biology
Fluid Dynamics
Computational Fluid Dynamics
Modelling Environment Systems
Atmosphere and Big Data

General Courses
Communication Skills + Technical Writing
Intellectual Property Rights
Languages
Economics
Psychology

Research
Full time research project + project management, presentation and entrepreneurial skills.

Research Internships

Sems.	Courses	Credits	Total
1	Foundation Courses	19	76
2	Foundation Courses	19	
3	Foundation Courses	19	
4	Foundation Courses	19	
5	Mathematics Core Courses	16	20
	Thematic Courses	4	
6	Mathematics Core Courses	12	19
	Thematic Courses	7	
7	Mathematics Core Courses	10	19
	Thematic Courses	6	
	Electives	3	
8	Mathematics Core Courses	3	18
	Thematic Courses	9	
	Electives	6	18
9	Electives	6	
	Project	12	
10	Project	18	18
5 - 10	General Courses (IP/Ethics/Languages/Music/Psychology)	4	4
	Total	192	192

i^2 Physical Sciences

Thematic Areas: Materials, Devices, Energy and Modelling

Physics is a branch of science that describes the workings of the natural world from the smallest sub-nuclear particles to the largest cosmological structures. This programme on integrated and interdisciplinary physics (i^2 Physical Sciences) is designed for the passionate and inquisitive minds that long to comprehend the tangible and intangible aspects of the physical world. It aims to enable further applications of physics in areas that are of relevance today and will be in future.

The 5-Year degree programme in i^2 Physical Sciences offers an integrated foundation in mathematics and natural sciences along with rigorous training in both classical and modern physics. Further, training is imparted in the art of scientific methodology, honing skills in critical thinking and analysis of complex phenomena. The programme's interdisciplinary scope – both in supplementing the core expertise in physics and enabling applications to diverse areas will equip one with flexible skill set to adapt, manage and respond to the evolving demands of science and technology.

Content and Opportunities

- Years 1 & 2: Foundation Courses - basic courses in physics, chemistry, biology, mathematics and computation.
- Years 3 & 4: Core Physics Courses - fundamentals of modern physics, quantum mechanics, statistical physics, condensed matter, electronics etc.
- Years 3 - 5: Thematic Courses - develop knowledge in the thematic areas of materials, energy and devices, integrated with the modern techniques of scientific computing and analysis like finite element method and machine learning, and applications of data sciences.
- Years 3 - 5: Electives - Either gain further knowledge in pure physics like electrodynamics, particle physics, quantum field theory, cosmology, etc. or pursue courses closer to the thematic areas like sensor technology, chemical kinetics, machine learning, etc.
- Year 5: Independent research work in a specific area.

The flexible course structure provides one with ample scope of choosing courses to engineer one's personal experience with tailored outcomes and expertise. The learning experience is further enriched by national and international internships in industry and research laboratories.

Why should one opt for i^2 Physical Sciences?

This programme trains one for broad labour market – oriented towards research, development and analysis that requires expertise in the physical sciences and computation. Potential career pathways include education, research and planning in areas like devices and sensors, energy materials, environment and climate change and other technical portfolios in bioinformatics, finance, telecommunications, information technology, process development, etc. In spite of the distinct interdisciplinary flavour, the curriculum ensures a robust base that is required for pursuing doctoral programmes in pure or applied physics, computational physics, astronomy, meteorology, biophysics, etc.

i^2 Physical Sciences – List of Courses (Semesters 5 – 10)

Thematic Areas: Materials, Devices, Energy and Modelling

Core - Physics
Mathematical Methods in Physics
Classical Mechanics
Quantum Mechanics
Electronics
Statistical Mechanics
Condensed Matter Physics I
Condensed Matter Physics II

Thematic - Materials, Energy, Devices
Electrochemical Energy Systems
Soft Matter & Polymers
Experimental Methods
Semiconductor Physics & Technology
Fluid Mechanics & Transport Phenomena
Optoelectronic Devices
Thermal Transport & Thermo-electrics
Device Technology

Thematic - Analysis, Modelling
Applied Statistics
Numerical Methods
Modelling Materials
Finite Element Modelling
Machine Learning for Physical Sciences

Electives – Physics
Electrodynamics and STR
Quantum Information Theory
Nonlinear Dynamics
Numerical Simulation Techniques in Physics
Introduction to Cosmology
Theory of Open Quantum Systems
Nonlinear Optics and Photonics
Astrophysics
Probes in Condensed Matter Physics
Quantum Transport
Lasers and Fibre Optic Communications
Physics at Low Temperatures
Nanoscale Physics

Electives - i^2 Sciences
Computer Interfacing
Digital Image Processing
Principles of Digital Imaging
Cryo-Electron microscopy and 3D image processing for Life sciences
Battery & Fuel Cell Laboratory
Organic Photovoltaic Devices Laboratory
Energy Materials Laboratory
Nanoscale Devices Laboratory
Electronic Devices and Computer Interfacing
Organic Semiconductors: Fundamentals and Applications
Chemical Kinetics and Dynamics
Renewable Energy Systems
Sensor Technology
Statistical Modelling
Data Science for Physical Sciences
Applied Mathematical Methods
Machine Learning I
Data Science Lab I
Machine Learning II
Data Science Lab II
Artificial Intelligence
Humans and Data

General Course
Communication Skills + Technical Writing
Intellectual Property Rights
Languages
Economics
Psychology
Music

Research Projects + Internships
Independent research projects + project management, presentation and entrepreneurial skills.

i^2 Physical Sciences – Credit Structure

Thematic Areas: Materials, Devices, Energy and Modelling

Sems.	Courses	Credits	Total
1	Foundation Courses	19	76
2	Foundation Courses	19	
3	Foundation Courses	19	
4	Foundation Courses	19	
5	Physics Core Courses	12	18
	Thematic Courses	3	
	Electives	3	
6	Physics Core Courses	6	18
	Thematic Courses	9	
	Electives	3	
7	Physics Core Courses	3	18
	Thematic Courses	12	
	Electives	3	
8	Thematic Courses	15	18
	Electives	3	
9	Electives	6	18
	Project	12	
10	Project	18	18
5 - 10	General Courses (IP/Ethics/Languages/Music/Psychology)	6	6
	Total	190	190

Admission Requirements

The BS-MS i^2 Sciences programme is available only at IISER TVM. Admission to the IISER TVM BS-MS programmes is common with the joint BS-MS admissions of all IISERs. Students interested in joining the i^2 Sciences programme must gain admission to IISER TVM.

Candidates who have passed 10+2 or equivalent level examination with science stream in 2019 or 2020 are eligible to apply for the joint BS-MS admissions of IISERs. Candidates will be admitted to only through the following three channels.

- Kishore Vaigyanik Protsahan Yojana **(KVPY)** channel
- Joint Entrance Examination **(JEE-Advanced)** of the Indian Institutes of Technology
- State and Central Boards Channel **(SCB)**

Indian nationals and students belonging to PIO or OCI category are eligible to apply subject to them satisfying the advertised eligibility criteria.
See https://www.iiseradmission.in for further details.

Selection into one of the 5 i^2 Sciences streams

The i^2 Sciences programme is available only to BS-MS students at IISER TVM. At the end of the first two years, student may opt for joining any ONE of the five streams of the i^2 Sciences programme,

i^2 Biological Sciences

i^2 Chemical Sciences

i^2 Data Sciences

i^2 Mathematical Sciences

i^2 Physical Sciences

Final selection to the above streams will be based on competition between all candidates who opt for each of the streams. Selection will be based on the performance of the candidates in the Foundation Courses with weightage given to performance in the courses relevant to the core discipline of the stream opted for. Currently, the maximum number of students that can be admitted is restricted to 15 each for i^2 Biological Sciences, i^2 Chemical Sciences, i^2 Mathematical Sciences and i^2 Physical Sciences, and 20 for i^2 Data Sciences.

Contact

Dr. Joy Mitra
Coordinator, i^2 Sciences Programme
IISER Thiruvananthapuram
Maruthamala PO, Vithura
Thiruvananthapuram - 695551
Kerala, India

0471-277 8007
isquare@iisertvm.ac.in

image credits: Robins Kurian, Kalika Prasad, Shaijumon M M, J. Mitra
concept and design: SUTVJ, IISER TVM, 2020