

Chennai Mathematical Institute

National Undergraduate and Postgraduate
Programmes in Mathematical Sciences

Information Brochure, 2022–2023

*3-Year B.Sc. (Honours) Programme in Mathematics
and Computer Science*

*3-Year B.Sc. (Honours) Programme in Mathematics
and Physics*

2-Year M.Sc. Programme in Mathematics

2-Year M.Sc. Programme in Computer Science

2-Year M.Sc. Programme in Data Science

Ph.D. Programme in Mathematics

Ph.D. Programme in Computer Science

Ph.D. Programme in Physics

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The Chennai Mathematical Institute

Chennai Mathematical Institute (CMI), a university under Section 3 of the UGC Act 1956, is recognized both within the country and abroad as one of the important centres in India for research and teaching in mathematical sciences. CMI is set up under a Trust and is managed by a Governing Council made up of eminent academic personalities. The teaching programmes are overseen by the Academic Council, consisting of senior faculty from CMI and other leading institutions across India. The members of the Governing Council and Academic Council are listed on the front and back inside covers.

Research at CMI

The Institute is headed by Professor Madhavan Mukund, a well known computer scientist. CMI was founded in 1989 by Professor C. S. Seshadri, F.R.S.. The Institute has a talented group of faculty members who have strong academic ties with reputed institutions in India and abroad. The Institute also attracts a regular stream of academic visitors, both from India and from abroad.

The main areas of research in Mathematics pursued at the Institute are algebra, analysis, differential equations, geometry, probability, statistics, topology, number theory and differential geometry. In Computer Science, the main areas of research are formal methods in the specification and verification of software systems, design and analysis of algorithms, computational complexity theory and computer security. In Physics, research is being carried out mainly in gravitation, quantum field theory, string theory and mathematical physics.

The Institute has well-established Ph.D. Programmes in Mathematics, Computer Science, and Physics.

Teaching at CMI

The aim of the Institute is to pursue excellence in both research and teaching. It is recognized all over the world that academic excellence is best cultivated by enabling the interaction between high quality researchers and talented students. In India, research institutions had traditionally been set up outside the university system. As a result, the

wealth of scholarship and teaching talent available in these institutions could not be tapped by students in our colleges and universities.

With this in mind, CMI initiated, in 1998, a 3-year programme in Mathematics and Computer Science leading to a B.Sc. (Honours) degree, with the aim of training a select group of talented students for academic and professional careers requiring exceptional mathematical and computational skills. In 2001, the teaching programme at CMI was extended to include separate 2-year M.Sc. programmes. The Institute currently has two B.Sc. (Honours) programmes: Mathematics and Computer Science, and Mathematics and Physics, and three M.Sc. programmes: Mathematics, Computer Science, and Data Science.

CMI directly awards its B.Sc., M.Sc. and Ph.D. degrees. In December 2006, CMI was recognized as a university under Section 3 of the UGC Act 1956. In the initial years, the degrees were awarded by the Madhya Pradesh Bhoj (Open) University (MPBOU), Bhopal.

The Curriculum and the Teaching Faculty

The teaching curriculum is perhaps the best that is available in the country at the undergraduate and postgraduate levels.

All B.Sc. (Honours) students undergo the same core set of basic and advanced undergraduate courses in Mathematics. In addition, the B.Sc. (Honours) Mathematics and Computer Science programme also includes a number of courses on fundamental topics in Computer Science. Students in the B.Sc. (Honours) Mathematics and Physics programme undergo, instead, basic undergraduate courses oriented towards theoretical Physics. All these courses are taught by active researchers in mathematics, computer science and physics, who draw on their professional expertise to offer new insights into the subject matter.

The M.Sc. curriculum takes students into more advanced topics in Mathematics, Computer Science and Data Science. The course structure is flexible and designed so that students can lay a firm foundation for pursuing further research while also acquiring advanced skills that will enhance their effectiveness in professional careers.

All students at CMI have access to a well-equipped computer laboratory with a high-speed Internet connection and are strongly encouraged to acquire computer related skills as part of their education.

The B.Sc. (Honours) programmes consist of six semesters of study over three years. The M.Sc. programmes consist of four semesters of

study over two years. Each year, the first semester runs from August to November and the second semester runs from January to April.

The courses are taught by the faculty of CMI well as distinguished visiting scientists from other academic institutions such as Institute of Mathematical Sciences (IMSc), the Tata Institute of Fundamental Research (TIFR), the Indian Statistical Institute (ISI), IGCAR, IIT Madras, the Inter-University Centre for Astronomy and Astrophysics (IUCAA), and the École Normale Supérieure (ENS), Paris.

Humanities

The undergraduate programme includes two compulsory Humanities courses. Electives are offered in areas such as literature, economics, art and music. The CMI Arts Initiative organizes regular cultural programmes and seminars throughout the year and supports an international writers' residency in collaboration with Sangam House, Bangalore.

Exchange Programmes

Chennai Mathematical Institute has a formal agreement with the École Normale Supérieure in Paris, France, one of the leading institutions in the world for teaching and research in Mathematics, for regular exchanges of visits by faculty and students.

The Institute has also had a formal agreement with the École Normale Supérieure Paris-Saclay in Cachan, France, for exchange of B.Sc. and M.Sc. students and for a joint Ph.D. programme.

CMI is a partner institution in the Future Research Talent Awards programme of the Australian National University (ANU) in Canberra that provides research internships for B.Sc. and M.Sc. students from CMI at ANU.

From 2017, CMI has hosted an Indo-French Research Lab in Computer Science, an international joint research laboratory (IRL) under the French National Centre for Scientific Research (CNRS), which also provides opportunities for exchanges of students and faculty with French partners in the IRL. Since 2019, CMI is also a partner in an international research project (IRP) in Mathematics under CNRS.

For several years, CMI was a partner in the Erasmus Mundus Master Programme ALGANT (ALgebra Geometry And Number Theory), funded by the European Union. The ALGANT programme allows students to pursue Masters and Doctorate degrees across the institutions participating in the programme.

Placement

Students from CMI have gone on to pursue further studies at the best academic institutions in India and abroad. These include Berkeley, Caltech, Chicago, Cornell, Harvard, MIT, Penn, Princeton, Stanford and Yale in USA, ENS-Paris, Univ Paris-Sud and Univ Bordeaux in France, the Max Planck Institutes and Humboldt University in Germany and IITs, IISc, IMSc, ISI and TIFR in India. Though the majority of students from the Institute continue in Mathematics, Computer Science and Physics, CMI graduates have also moved into areas such as financial mathematics, management and economics.

Students from CMI are also much sought after by industry across a variety of sectors, including software development, semiconductors, investment banking, analytics and healthcare. Several CMI alumni have also founded startups in India and abroad.

External engagement

CMI has set up a separate society called Algolabs to promote interaction with the industry. Algolabs undertakes training programmes and projects in areas such as analytics, optimization and risk management and provides opportunities for faculty and students to engage with industry on real-life applications of mathematical sciences.

CMI also engages with the government on projects related to data-driven decision making. CMI has signed an agreement to partner with the Tamil Nadu e-Governance Agency in such efforts.

In December 2020, CMI announced the creation of the Dr F C Kohli Centre of Excellence, named after the pioneer of the IT industry in India. The Centre will promote foundational research through an active visitors' programme and also engage actively with industry to address challenging problems in applied areas.

Campus and Hostel Facility

The Institute's campus is located in the SIPCOT Information Technology Park in Siruseri, on the outskirts of Chennai. CMI's programme is fully residential for B.Sc. students and students of M.Sc. Mathematics and Computer Science. Students are accommodated in the hostel on campus. The Institute has a regular transportation arrangement for students to visit the city for shopping and other activities.

Students pay hostel and mess fees at the start of each semester. Cur-

rently, the charges are Rs. 23,800 per semester, (Rs. 4,000, Rs. 16,800 and Rs. 3,000 towards hostel fees, mess and establishment charges respectively). These charges are adjusted periodically to account for inflation.

Funding

One of the unique features of CMI in the Indian context is that its funding comes from diverse sources, both public and private. This has given the Institute the freedom to organize its activities in a manner that is best suited to achieving its goal of excellence in research and teaching.

The Institute receives substantial support for its activities from the Department of Atomic Energy (DAE), through the National Board for Higher Mathematics (NBHM). CMI has also received support from the Department of Science and Technology (DST).

The Institute also receives generous contributions from the private sector. During the formative years of the Institute, the Southern Petrochemical Industries Corporation (SPIC) has been a major source of funding and infrastructural support for CMI. Currently, the Shriram Group Companies, Chennai play a crucial role in providing and organizing private funding for the Institute.

The land for CMI's campus at Siruseri was acquired through a grant from the Shriram Group Companies. Major financial contributions towards building up the campus have come from Matrix Laboratories, Hyderabad, the Chennai Willingdon Corporate Foundation, Take Solutions, Chennai, the Infosys Foundation, Bangalore and Tata Consultancy Services. A multistorey building with classrooms, faculty office space and guest rooms has been constructed with funds from the Ministry of Human Resource Development (MHRD) via the University Grants Commission (UGC).

The Institute received a major grant for the period 2006–2009 from the Board of Research in Nuclear Sciences (BRNS) and the Department of Science and Technology (DST). The Institute also received a generous three year grant from Tata Consultancy Services from 2008–2011 to support academic activities. The Infosys Foundation contributed a large corpus to CMI in 2014. The Tata Trust has also provided funding to the Institute. In addition, Microsoft Research has provided substantial support through research and travel grants.

CMI also receives funding for research projects, both from government agencies as well as from private organizations.

B.Sc. (Honours) Programmes (Mathematics and Computer Science, Mathematics and Physics)

Admission and eligibility Students who have already passed, or expect to pass in 2022, the 12th standard (or equivalent) examination from a recognized board are eligible for admission to the programme. Admission is through a written entrance examination to be conducted at centres throughout the country on **22 May, 2022**. Students with exceptionally good performance in National Science Olympiads may be exempted from writing the entrance examination at the discretion of the Admissions Committee. Details about the admission procedure are available at the CMI website, <https://www.cmi.ac.in/admissions>.

Fees and scholarships The tuition fee is Rs 1,00,000/- per semester (two semesters in a year). Thirty-five scholarships will be available, consisting of a full waiver of the tuition fees. In addition, a limited number of fellowships will be available, with a monthly allowance of Rs. 5,000. The eligibility of a student to receive scholarships and fellowships will be reviewed every semester and will depend on satisfactory academic performance.

CMI is committed to a policy of financial inclusion and strives to ensure that no student is denied an opportunity to study at CMI due to economic circumstances. Towards this goal, partial and total tuition fee waivers will also be available, based on the financial background of the student.

Course details

Regular full semester courses at CMI carry 4 credits. A student must complete a minimum of 112 credits (28 regular courses) to earn a BSc (Honours) degree. Some elective courses run for shorter periods and carry 2 credits or 1 credit. These may be accumulated to make up the credit requirement under Electives.

The **B.Sc. (Honours) Programme in Mathematics and Computer Science** is a three-year course. The following is the semester-wise schedule of courses.¹

Semester I

Algebra I
Analysis I
Humanities I (English)
Introduction to Programming
Classical Mechanics I

Semester II

Advanced Programming
Algebra II
Analysis II
Discrete Mathematics
Probability Theory

Semester III

Algebra III
Analysis III
Design and Analysis
of Algorithms
Calculus
Theory of Computation

Semester IV

Complex Analysis
Differential Equations
Programming Language
Concepts
Topology
Elective I

Semester V

Elective II
Elective III
Elective IV
Elective V

Semester VI

Humanities II
Elective VI
Elective VII
Elective VIII

All students must complete a compulsory one semester non-credit course in Environmental Science.

¹Small variations may be incorporated in this schedule, as recommended by the Academic Council.

The **B.Sc. (Honours) Programme in Mathematics and Physics** is a three-year course. The following is the semester-wise schedule of courses.²

Semester I

Algebra I
Analysis I
Humanities I (English)
Introduction to Programming
Classical Mechanics I

Semester II

Algebra II
Analysis II
Probability Theory
Classical Mechanics II
Electrodynamics I

Semester III

Algebra III
Analysis III
Calculus
Quantum Mechanics I
Thermal Physics

Semester IV

Complex Analysis
Differential Equations
Topology
Optics
Quantum Mechanics II

Semester V

Elective I
Elective II
Elective III
Elective IV

Semester VI

Humanities II
Elective V
Elective VI
Elective VII

Of the seven elective courses, one must be a laboratory course. All students must complete a compulsory one semester non-credit course in Environmental Science.

Detailed information about the courses is available at the CMI website, <https://www.cmi.ac.in/teaching>.

²Small variations may be incorporated in this schedule, as recommended by the Academic Council.

M.Sc. Programme in Mathematics

Admission and eligibility Students who have obtained, or expect to obtain in 2022, undergraduate degrees such as B.A., B.Sc., B.Math., B.Stat., B.E., B.Tech., ... with a strong background in Mathematics are eligible to apply for the programme. Admission is through a written entrance examination to be conducted at centres throughout the country on **22 May, 2022**, followed by an interview in Chennai. Details about the admission procedure are available at the CMI website, <https://www.cmi.ac.in/admissions>.

Fees and scholarships The tuition fee is Rs 1,00,000/- per semester (two semesters in a year). A substantial number of scholarships will be available, consisting of a full waiver of the tuition fees. The number of scholarships will be roughly equal to the number of students admitted in recent batches of MSc Mathematics. In addition, a limited number of fellowships will be available, with a monthly allowance of Rs. 6,000. The eligibility of a student to receive scholarships and fellowships will be reviewed every semester and will depend on satisfactory academic performance.

CMI is committed to a policy of financial inclusion and strives to ensure that no student is denied an opportunity to study at CMI due to economic circumstances. Towards this goal, partial and total tuition fee waivers will also be available, based on the financial background of the student.

Courses

Regular full semester courses at CMI carry 4 credits. A student must complete a minimum of 64 credits (16 regular courses) to earn an MSc degree in Mathematics. Some elective courses run for shorter periods and carry 2 credits or 1 credit. These may be accumulated to make up the credit requirement under Electives. Part of the course-work for the MSc Mathematics programme is concurrent with the PhD Mathematics programme.³

³Small variations may be incorporated in this schedule, as recommended by the Academic Council.

Semester I

Graduate Algebra I
Graduate Analysis I
Graduate Topology I
Introduction to Manifolds

Semester II

Graduate Algebra II
Graduate Analysis II
Graduate Topology II
Complex Analysis

Semester III

Directed Reading
Elective I
Elective II
Elective III

Semester IV

MSc Thesis
Elective IV
Elective V

The MSc Thesis in the final semester carries 8 credits (equivalent to two regular courses). At the discretion of the Board of Studies, a student who has already completed any of the compulsory courses as an undergraduate may substitute these courses by a suitable number of optional courses to make up the overall course requirements.

The list of elective courses being offered each year will be announced at the beginning of the academic year. Detailed information about all courses is available at the CMI website, <https://www.cmi.ac.in/teaching>.

M.Sc. Programme in Computer Science

Admission and eligibility Students who have obtained, or expect to obtain in 2022, undergraduate degrees such as B.A., B.Sc., B.Math., B.Stat., B.E., B.Tech., ... with a strong background in Computer Science are eligible to apply for the programme. Admission is through a written entrance examination to be conducted at centres throughout the country on **22 May, 2022**. Details about the admission procedure are available at the CMI website, <https://www.cmi.ac.in/admissions>.

Fees and scholarships The tuition fee is Rs 1,00,000/- per semester (two semesters in a year). A substantial number of scholarships will be available, consisting of a full waiver of the tuition fees. In addition, a limited number of fellowships will be available, with a monthly allowance of Rs. 6,000. The eligibility of a student to receive scholarships and fellowships will be reviewed every semester and will depend on satisfactory academic performance.

CMI is committed to a policy of financial inclusion and strives to ensure that no student is denied an opportunity to study at CMI due to economic circumstances. Towards this goal, partial and total tuition fee waivers will also be available, based on the financial background of the student.

Courses

Regular full semester courses at CMI carry 4 credits. A student must complete a minimum of 64 credits (16 regular courses) to earn an MSc degree in Computer Science. Some elective courses run for shorter periods and carry 2 credits or 1 credit. These may be accumulated to make up the credit requirement under Electives. The list of courses in the programme is given below.⁴

1. Core courses

- Programming Languages
- Basic Programming Laboratory
- Design and Analysis of Algorithms
- Theory of Computation
- Mathematical Logic

⁴Small variations may be incorporated in this schedule, as recommended by the Academic Council.

At the discretion of the Board of Studies, a student who has already completed any of the core courses as an undergraduate may substitute these courses by a suitable number of alternative courses to make up the overall course requirements.

2. Electives

The elective courses that have been offered at CMI in recent years include:

Approximation Algorithms, Automata Theory and Verification, Coding Theory, Complexity Theory, Computer Vision, Concurrent Programming, Cryptography and Security, Basic and Advanced Machine Learning, Digital Systems Design and Modelling, Finite Model Theory, Logical Foundations of Databases, Model Checking and Systems Verification, Natural Language Processing, Optimization, Probability and Statistics, Program Analysis, Quantitative Automata Theory, Quantum Computing, Randomized Algorithms, Reinforcement Learning, Theorem Proving

The exact list of elective courses being offered will be announced at the beginning of each semester.

3. Project/Dissertation

The project/dissertation carries 16 credits (the equivalent of four regular courses).

Detailed information about the courses is available at the CMI website, <https://www.cmi.ac.in/teaching>.

M.Sc. Programme in Data Science

Admission and eligibility Students who have obtained, or expect to obtain in 2022, undergraduate degrees such as B.A., B.Sc., B.Math., B.Stat., B.E., B.Tech., . . . with a background in Mathematics, Statistics or Computer Science, are eligible to apply for the programme. Admission is through a written entrance examination to be conducted at centres throughout the country on **22 May, 2022**. Details about the admission procedure are available at the CMI website, <https://www.cmi.ac.in/admissions>.

Fees and scholarships The tuition fee is Rs 2,00,000/- per semester (two semesters in a year). Hostel accommodation is not guaranteed for this programme, but will be provided subject to availability.

CMI is committed to a policy of financial inclusion and strives to ensure that no student is denied an opportunity to study at CMI due to economic circumstances. Towards this goal, partial and total tuition fee waivers will also be available, based on the financial background of the student.

Courses

Regular full semester courses at CMI carry 4 credits. A student must complete a minimum of 64 credits (16 regular courses) to earn an MSc degree in Data Science. Some elective courses run for shorter periods and carry 2 credits or 1 credit. These may be accumulated to make up the credit requirement under Electives. The course structure is given below.⁵

Semester 1

Mathematical Methods – Analysis
Probability and Statistics with R
Programming and Data Structures with Python
Visualization (2 credits)
RDBMS and SQL (2 credits)

⁵Small variations may be incorporated in this schedule, as recommended by the Academic Council.

Semester II

Linear Algebra and its Applications
Data Mining and Machine Learning
Algorithms
Distributed Computing and Big Data

Semester III

Predictive Analytics – Regression and Classification
Advanced Machine Learning
Elective 1
Elective 2

Semester IV

Elective 3
Elective 4
Elective 5
Elective 6

Elective courses

1. Advanced Regression and Classification
2. Algorithmic Trading
3. Algorithms for Big Data
4. Bayesian Data Analysis
5. Computer Vision
6. Economics
7. Finance
8. Financial Data Analysis
9. Industry Project
10. Mathematical Modeling
11. Natural Language Processing
12. Optimization
13. Risk Management
14. Text Analytics

Detailed information about the courses is available at the CMI website,
<https://www.cmi.ac.in/teaching>.

Ph.D. Programmes (Mathematics, Computer Science, Physics)

Eligibility

- *Ph.D. in Mathematics*: Students with an M.Sc. degree in Mathematics or equivalent and students with a bachelors degree in Engineering or Science with a strong aptitude for research.
- *Ph.D. in Computer Science*: Students with a B.E., B.Tech., M.Sc., or M.C.A. degree and students with a bachelors degree in Science with a strong aptitude for research.
- *Ph.D. in Physics*: Students with an M.Sc. degree in Physics or equivalent.

Admission For PhD Mathematics and Computer Science, admission is through a written entrance examination to be conducted at centres throughout the country on **22 May, 2022**, followed by an interview in Chennai. For PhD Physics, students qualify for an interview based on the Joint Entrance Screening Test (JEST) in Physics. Details about the admission procedure are available at <https://www.cmi.ac.in/admissions>.

Courses and research Students admitted to the Ph.D. programme are expected to complete 1–2 years of compulsory course work. There is also a qualifying examination, to be taken within the first two years. Continuation in the programme is contingent on performance in the Ph.D. courses and the qualifying examination.

After passing the qualifying examination, students are assigned guides and begin their research work. Their progress is monitored periodically by a doctoral committee.

Fees and scholarships Research Scholars get a stipend of Rs 31000 per month for the first two years and Rs 35000 per month for the next three years, along with an annual book grant of Rs 10000. Scholars who do not stay in the hostel are eligible for a house rent allowance of 24% of stipend per month. The scholarship amounts are revised periodically, and are on par with the premier research institutes in India.

At the discretion of the Admissions Committee, students with a B.Sc. degree and those switching subjects may be admitted as Pre-Ph.D. students. For the first two years, Pre-Ph.D. students will be enrolled as a

regular M.Sc. students in the corresponding subject. Till they complete their M.Sc. coursework or pass the Ph.D. qualifying examination, Pre-Ph.D. students will receive a reduced scholarship, but will be eligible for other benefits similar to regular Ph.D. students.

Part-Time PhD Programme

CMI has a part-time PhD programme to allow students to complete a PhD while continuing to work for their parent organizations. Part-time students are admitted based on a written entrance examination and an interview, like regular PhD students. Students must already have a Masters degree to be admitted to the part-time PhD programme. There is a minimum residency requirement of one semester.

**Chennai Mathematical Institute
Governing Council**

1. Prof. R. Balasubramanian (Chairman),
National Centre for Mathematics, Mumbai
2. Prof. Manindra Agrawal,
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3. Prof. V. Balaji,
Chennai Mathematical Institute
4. Dr. Ravi Kannan,
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5. Prof. Rajeeva L. Karandikar,
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6. Prof. Madhavan Mukund,
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*University of Toronto
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9. Prof. Bimal Roy,
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10. Prof. V. Srinivas,
*Tata Institute of Fundamental Research, Mumbai
Chairman, National Board for Higher Mathematics*
11. Prof. K.V. Subrahmanyam,
Dean of Studies, Chennai Mathematical Institute
12. Prof. P.S. Thiagarajan,
National University of Singapore (retired)

**Chennai Mathematical Institute,
Academic Council**

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4. Prof. V. Balaji, *Chennai Mathematical Institute*
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National Centre for Mathematics, Mumbai
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Tata Institute of Fundamental Research, Mumbai (retired)*
7. Prof. R.L. Karandikar,
Former Director, Chennai Mathematical Institute
8. Prof. Gadadhar Misra, *Indian Institute of Science, Bangalore*
9. Prof. S. Kesavan, *Institute of Mathematical Sciences (retired)*
10. Prof. N. Mukunda, *Indian Institute of Science, Bangalore*
11. Prof. Rajaram Nityananda, *Azim Premji University, Bangalore*
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