

# Chennai Mathematical Institute

National Undergraduate and Postgraduate  
Programmes in Mathematical Sciences

## Information brochure, 2011–2012

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

*3 Year B.Sc. (Honours) Course in Physics*

*2 Year M.Sc. Course in Mathematics*

*2 Year M.Sc. Course in Computer Science*

*2 Year M.Sc. Course in Applications of Mathematics*

*Ph.D in Mathematics*

*Ph.D in Computer Science*

*Ph.D 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 personalities from both academic and non-academic backgrounds. The academic matters of the Institute are guided by its Research Advisory Committee consisting of highly respected scientists. 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, Research Advisory Committee and Academic Council are listed on the front and back inside covers.

## **Research at CMI**

The Institute is headed by Professor Rajeeva L. Karandikar, an internationally renowned mathematician. CMI was founded in 1989 by Professor C. S. Seshadri, F.R.S., who is presently Director-Emeritus. 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 abroad.

The main areas of research in Mathematics pursued at the Institute are algebra, analysis, differential equations, geometry, probability, statistics and topology. 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 a well established Ph.D. Programme in Mathematics and Computer Science and has announced a Ph.D. Programme in Physics starting in 2011.

## Teaching at CMI

It has always been the aim of the Institute to pursue excellence not only in research but in teaching too. 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, this interaction has been inhibited by the fact that most research institutions have been set up outside the university system. As a result, the wealth of scholarship and teaching talent that is available in our research institutions cannot be tapped by students in our colleges and universities. There is a national need for educational institutions of quality to train our talented students at both B.Sc. and M.Sc. levels.

With this in mind, CMI initiated, in 1998, a 3-year course in Mathematics and Computer Science leading to a B.Sc. (Honours) degree. The aim is to train 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. courses in Mathematics and Computer Science. Given the success of the undergraduate programme in Mathematics at CMI, the teaching programme was extended in 2003 to include a 3-year B.Sc. (Honours) programme in Physics. In 2010, the Institute started an M.Sc. course in Applications of Mathematics.

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

### **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.

The B.Sc. (Honours) Mathematics and Computer Science curriculum covers basic and advanced undergraduate courses in Mathematics. The programme also includes a number of courses on fundamental topics in Computer Science, including the design and analysis of algorithms, programming languages and computability theory. The courses are taught by active researchers in mathematics and computer science who draw on their professional expertise to offer new insights into the subject matter.

The B.Sc. (Honours) Physics curriculum covers basic undergraduate courses in Physics in topics such as classical mechanics, electromag-

netism, thermodynamics, statistical and quantum physics. It also includes courses in programming and mathematics and offers an introduction to some advanced topics like relativity, cosmology, quantum field theory and condensed matter physics.

Physics students perform basic experiments at the in-house laboratory at CMI. In addition, students have an intensive laboratory programme at the Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam for students at the end of their second and third semesters.

The M.Sc. curriculum takes students into more advanced topics in Mathematics and Computer 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) Programme consists of six semesters of study over three years. The M.Sc. Programmes generally 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 M.Sc. Programme in Applications of Mathematics has a slightly different structure in the second year, with two shorter terms followed by an internship or project.

The teaching programmes at CMI are run in cooperation with the Institute of Mathematical Sciences (IMSc), Chennai. The courses are taught by the faculty of CMI and IMSc, Chennai, as well as distinguished visiting scientists from other academic institutions such as the Tata Institute of Fundamental Research (TIFR), Mumbai, the Indian Statistical Institute (ISI), IGCAR, Kalpakkam, IIT Madras, Chennai, the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune and the Ecole Normale Supérieure (ENS), Paris.

## **Humanities**

Chennai Mathematical Institute is also building up activities in the Humanities. The undergraduate programme includes two compulsory Humanities courses. The Institute has adjunct faculty in Literature and Music. A number of seminars have been organized in these subjects.

## **Exchange Programmes**

Chennai Mathematical Institute has a formal agreement with the Ecole 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 academic members of CMI and ENS, Paris. Each year, top-ranking senior B.Sc. Mathematics and Computer Science students from CMI spend the summer at ENS working on research problems with faculty there. In return, members of ENS visit CMI each year to participate in research and to teach in the B.Sc. programme.

The Institute has a similar arrangement with Ecole Polytechnique in Paris whereby top-ranking senior B.Sc. Physics students spend the summer in Paris working with faculty at Ecole Polytechnique.

The Institute also has a formal agreement with the Ecole Normale Supérieure in Cachan, France, for exchange of B.Sc. and M.Sc. students and for a joint Ph.D. programme in Computer Science and Mathematics.

CMI is one of three non-European partners 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 Caltech, Chicago, MIT, Princeton, U Penn and Yale in USA, ENS Paris, Univ Paris-Sud and Univ Bordeaux in France, the Max Planck Institutes and Humboldt University in Germany and the Harish-Chandra Research Institute, IITs, 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, both in India and abroad. Students from CMI have also been placed in some of the best software companies in India.

## **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. All students are accommodated in the hostel on cam-

pus. 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. Currently, the charges are Rs. 15,400 per semester, (Rs. 4,000, Rs. 9,000 and Rs. 2,400 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).

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 new building with an auditorium, guest rooms, hostel rooms and additional office space is currently being 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. In addition, Microsoft Research has provided substantial support annually 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, Physics)**

**Admission and eligibility** Students who have already passed, or expect to pass in 2011, the 12th standard (or equivalent) examination from a recognized board are eligible for admission to the programme. Admission is through an entrance examination to be conducted at centres throughout the country on **Thursday, May 26, 2011**. 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, <http://www.cmi.ac.in>.

**Fees and scholarships** There will be a fee of Rs.750/- per semester (two semesters in a year). A limited number of scholarships will be available. A full scholarship will consist of the waiver of tuition fees and a monthly allowance of Rs. 4000. A half-scholarship will consist of the tuition fee being waived. The eligibility of a student to receive a scholarship will be reviewed every semester and will depend on satisfactory academic performance. All students of B.Sc. (Honours) will receive an additional monthly scholarship of Rs. 1000, made possible through a generous private donation.

### **Course details**

The **B.Sc. (Honours) Programme in Mathematics and Computer Science** is an integrated three-year course in Mathematics and Computer Science. The following is the semester-wise schedule of courses.<sup>1</sup>

#### **Semester I**

Algebra I  
Calculus I  
Humanities I (English)  
Introduction to Programming  
Physics I

#### **Semester II**

Advanced Programming  
Algebra II  
Calculus II  
Discrete Mathematics  
Probability Theory

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

**Semester III**

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

**Semester V**

Algebra IV  
 Mathematical Logic  
 Elective II  
 Elective III

**Semester IV**

Complex Analysis  
 Differential Equations  
 Programming Language  
 Concepts  
 Topology  
 Elective I

**Semester VI**

Humanities II  
 Elective IV  
 Elective V  
 Elective VI

Of the six elective courses, at least two must be in Mathematics or Computer Science and at least one must be in Physics.

The following is the semester-wise schedule of courses for the **B.Sc. (Honours) Programme in Physics**.<sup>2</sup>

**Semester I**

Classical Mechanics I  
 Electrodynamics I  
 Mathematical Physics I  
 Introduction to Programming  
 Humanities I (English)  
 Physics Laboratory I

**Semester III**

Electrodynamics II  
 Quantum Mechanics II  
 Statistical Mechanics II  
 Mathematical Physics III  
 Physics Laboratory III

**Semester II**

Classical Mechanics II  
 Mathematical Physics II  
 Quantum Mechanics I  
 Statistical Mechanics I  
 Physics Laboratory II

**Semester IV**

Classical Mechanics III  
 Quantum Mechanics III  
 Electrodynamics III  
 General Theory of Relativity  
 Elective I

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

**Semester V**

Atomic and Molecular Physics  
Statistical Mechanics III  
Quantum Field Theory  
Elective II  
Project, Part I

**Semester VI**

Nuclear and Particle Physics  
Condensed Matter Physics  
Humanities II  
Elective III  
Project, Part II

The three Elective courses should all be Mathematics or Computer Science courses.

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

## M.Sc. Programme in Mathematics

**Admission and eligibility** Students who have obtained, or expect to obtain in 2011, degrees such as B.Sc., B.Math., B.Stat. or B.Tech. are eligible to apply for the programme. Admission is through an entrance examination to be conducted at centres throughout the country on **Thursday, May 26, 2011**, followed by an interview in Chennai. Details about the admission procedure are available at the CMI website, <http://www.cmi.ac.in>.

**Fees and scholarships** The total tuition fees for the M.Sc. programme in Mathematics will be Rs. 4800. A limited number of scholarships will be available. A full scholarship will consist of a waiver of tuition fees and a monthly allowance of Rs. 5000. A half-scholarship will consist of the tuition fees being waived. The eligibility of a student to receive a scholarship will be reviewed every semester and will depend on satisfactory academic performance.

### Courses

Students in this programme will be expected to complete the equivalent of 17 regular courses, normally over a period of four semesters, as follows.

#### Semester I

Linear Algebra  
Algebra I  
Advanced Calculus  
Real Analysis

#### Semester II

Algebra II  
Complex Analysis  
Topology  
Differential Equations  
Differential Geometry

#### Semester III

Measure Theory  
Algebraic Topology  
Elective I  
Elective II

#### Semester IV

Functional Analysis  
Elective III  
Elective IV  
Elective V

At the discretion of the admissions committee, 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.

There is also the possibility of substituting some regular courses with a dissertation, written under the supervision of one of the faculty members.

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, <http://www.cmi.ac.in>.

## M.Sc. Programme in Computer Science

**Admission and eligibility** Students who have obtained, or expect to obtain in 2011, degrees such as B.Sc., B.E. or B.Tech. in Computer Science, B.C.A. or B.Sc. in Mathematics with a strong background in Computer Science, are eligible to apply for the programme. Admission is through an entrance examination to be conducted at centres throughout the country on **Thursday, May 26, 2011**. Details about the admission procedure are available at the CMI website, <http://www.cmi.ac.in>.

**Fees and scholarships** The total tuition fees for the M.Sc. programme in Computer Science will be Rs. 4800. A limited number of scholarships will be available. A full scholarship will consist of a waiver of tuition fees and a monthly allowance of Rs. 5000. A half-scholarship will consist of the tuition fees being waived. The eligibility of a student to receive a scholarship will be reviewed every semester and will depend on satisfactory academic performance.

### Courses

The course work for the programme will consist of five categories, as follows.

#### 1. Core courses

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

#### 2. Foundational Topics courses

- Advanced Algorithms
- Distributed Systems
- Mathematical Logic in Computer Science
- Computer Systems Verification
- Algorithmic Complexity Theory
- Operations Research
- Cryptography and Computer Security
- Probability and Statistics

### 3. **Systems courses**

- Networks
- Databases
- Compilers
- Software Engineering
- Advanced Computer Organization
- Digital Systems Design

### 4. **Advanced level courses**

These will be offered from a list that will be updated periodically, including courses such as Mobile Computing, Computational Biology, Computational Geometry and Symbolic Computation.

### 5. **Project/Dissertation**

To earn an MSc, a student must complete the equivalent of 16 regular courses, normally over a period of four semesters. These 16 courses must include all four Core courses and a project/dissertation.

Each advanced level course is equivalent to two regular courses and the project/dissertation is equivalent to four regular courses. At the discretion of the admissions committee, 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.

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

## M.Sc. Programme in Applications of Mathematics

**Admission and eligibility** Students who have obtained, or expect to obtain in 2011, a B.Sc. degree in Mathematics, or degrees such as B.Sc. Physics, B.Sc. Statistics, B.E. or B.Tech. with a strong background in Mathematics, are eligible to apply for the programme. Admission is through an entrance examination to be conducted at centres throughout the country on **Thursday, May 26, 2011**, followed by an interview in Chennai. Details about the admission procedure are available at the CMI website, <http://www.cmi.ac.in>.

**Fees and scholarships** The total tuition fees for the M.Sc. programme in Applications of Mathematics will be Rs. 4800. A limited number of scholarships will be available. A full scholarship will consist of a waiver of tuition fees and a monthly allowance of Rs. 5000. A half-scholarship will consist of the tuition fees being waived. The eligibility of a student to receive a scholarship will be reviewed every semester and will depend on satisfactory academic performance.

### Courses

The first year of the two year course consists of two regular semesters of course work. The second year will have two shorter terms of course work, followed by an internship or project.

The programme is currently oriented towards two streams, financial mathematics and applications in computation. Additional streams may be introduced in the future. The course work for the two currently available streams are as follows.

### Financial Mathematics

#### Ist year

##### *Semester 1 (Aug-Nov)*

Linear Algebra  
Analysis  
Probability and Statistics  
Programming Techniques

##### *Semester 2 (Jan-Apr)*

Measure Theoretic Probability  
Differential Equations  
Algorithms  
Economics

## **IIInd year electives**

### *Term 3 (Aug-Oct)*

Stochastic Processes  
Econometrics I  
Finance I  
Computational Methods

### *Term 4 (Nov-Jan)*

Finance II  
Econometrics II  
Simulation Methods  
Risk Management

## **Applications in Computation**

### **Ist year**

#### *Semester 1 (Aug-Nov)*

Linear Algebra  
Analysis  
Probability and Statistics  
Programming Techniques

#### *Semester 2 (Jan-Apr)*

Discrete Mathematics  
Differential Equations  
Algorithms  
Economics

## **IIInd year electives**

### *Term 3 (Aug-Oct)*

Applied Statistics  
  
Advanced Algorithms  
Data Mining Techniques  
Simulation Techniques

### *Term 4 (Nov-Jan)*

Algorithms on Strings,  
Trees and Sequences  
Text and Web Mining  
Cryptography  
Verification

## **Internship/Project**

In both streams, the student will be required to complete an internship or project from February to June, at the end of the second year of the programme.

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

## 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 and students with a bachelors degree in Physics or Engineering with a strong aptitude for research.

**Admission** Admission is through an entrance examination to be conducted at centres throughout the country on **Thursday, May 26, 2011**, followed by an interview in Chennai. Details about the admission procedure are available at the CMI website, <http://www.cmi.ac.in>.

**Fees and scholarships** Research Scholars get a stipend of Rs 16000 per month for the first two years and Rs 18000 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 30% of stipend per month. The scholarship amounts are revised periodically, and are on par with the premier research institutes in India.

**Courses and research** Students admitted to the Ph.D. programme are expected to complete 1–2 years of compulsory course work. After this, students are assigned guides and begin their research work. Their progress is monitored periodically by a doctoral committee.

### 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 organisations. Part-time students are admitted based on an 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 two semesters, which can be spread over the first two years of the programme.

**Chennai Mathematical Institute  
Governing Council**

1. Shri A.C. Muthiah (Chairman),  
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Tata Institute of Fundamental Research, Bangalore*

**Chennai Mathematical Institute,  
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1. Prof. R. Balasubramanian,  
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2. Prof. David Mumford,  
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New York University, New York, U.S.A.*
6. Prof. M. Vidyasagar,  
*University of Texas at Dallas, U.S.A.*

**Chennai Mathematical Institute,  
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