CHENNAI MATHEMATICAL INSTITUTE

Information about BSc Entrance Examination

The purpose of this document is to give a more detailed description of our practice and expectations with regard to the BSc entrance examination. There is no actual change in the syllabus or in the way we set the question paper.

The entrance examination for the B.Sc. programs at CMI is a test of aptitude to do mathematics. We are looking for (1) the ability to solve problems that require correct and creative mathematical reasoning, and (2) the ability to write this reasoning in a logically coherent and complete manner (including writing proofs where necessary).

The test will be mostly based on mathematics that is normally covered up to 12^{th} standard, see below for details. The major topics are calculus, algebra and geometry, but in addition there will be problems involving combinatorics, number theory, a combination of topics listed below and possibly other problems testing mathematical thinking, like logical puzzles. More than memorization and routine application of the content, the examination will require independent thinking.

We expect the students to be familiar with the following.

- *All* topics normally covered up to 12^{th} standard in the NCERT syllabus for mathematics. More specifically this includes relations and functions, algebra, calculus, coordinate geometry, vectors and matrices (up to 3 dimensions), counting, probability AND all topics covered until 10^{th} standard including in particular Euclidean geometry and basic number theory.

- You will need to know and be able to reason about standard real valued functions. This includes, for example, analyzing their roots and other quantitative/qualitative aspects of their graphs. The functions include polynomials, exponential, logarithmic, trigonometric, inverse trigonometric functions AND functions built by combining these basic functions using the four arithmetic operations (e.g., rational functions) and composition. The reasoning may require a *combination* of tools drawn from multiple topics, in particular including algebra, geometry and calculus.

- The following topics from number theory: unique factorization of a natural number as a product of prime numbers, GCD via Euclid's long division algorithm and via Bezout's lemma, and modular arithmetic.

- Complex numbers, both in the form $z = a + ib$ and in the form $r\,e^{i\theta} = r\cos\theta + i\,r\sin\theta$ where $r = |z| = \sqrt{a^2 + b^2}$ and θ is the appropriate angle (for nonzero z), roots of unity on the unit circle in the complex plane, and the statement of the fundamental theorem of algebra.

Suggestions for preparation →

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- **Solve lots of varied problems.** This is the best way to prepare for the examination. Good sources include the books listed below and past entrance exams for CMI and ISI.

  1. V. Krishnamoorthy, C.R. Pranesachar, K. N. Ranganathan, B.J.Venkatachala, *Challenge and Thrill of Pre-College Mathematics*, New Age International Publishers.
  2. M.R. Modak, S.A. Katre, V.V. Acharya, *An Excursion in Mathematics*, Bhaskaracharya Pratishtan (Pune).
  3. D. Fomin, S. Genkin, I. Itenberg, *Mathematical Circles: Russian experience*, Universities Press (Hyderabad) 1998.

- **Learn problem solving one topic at a time.** Start with easy problems and work your way up in a calibrated manner. Spend a good amount of time on any given problem. After that get help if needed. For example, look at the solution one sentence at a time. Stop as soon as you encounter a new idea and see if you can progress from there on your own. If you find some problem too hard even with this method, reassess. Maybe skip the problem and come back after more experience? If difficulties persist, maybe start with easier problems?

- **Make each problem count.** Quality of understanding trumps quantity of problems "solved". The number of ideas that get used is not very large. The same ideas repeat but with variations and in different combinations. For each problem you encounter, carefully look at the solution (whether yours or someone else's) and isolate the idea(s) used. Be alert to the possibility of using that idea later as you do more problems. Repeat this with every problem, making notes for the future (a "mind map") and comparing with notes from previous experience. If you do it right, this process will *slowly* build a web of ideas and strengthen your thinking by helping you recognize patterns.

- **Find a like minded study partner.** This can be tremendously beneficial to both parties. You can also look for an online support group, e.g., find a suitable forum here.

- **Learn how to write in a logically correct way.** This is a separate skill requiring separate practice, but it is easier than learning to solve tricky problems. As a yardstick, try to write a solution that can be published as a model solution in a solution guide for other students to learn from. Multiple attempts may be needed, especially in the beginning, to produce a solution that is not only correct and complete, but also well organized and easy to follow. It is difficult but worthwhile to write such a solution because writing your ideas clearly also helps a lot in improving them. Becoming a better *writer* makes you a better *solver* too. A study partner can be especially helpful here as an external quality control. Reverse the roles, and be a tough but rational and constructive opponent. Both roles will help both of you.

- **Be patient with yourself.** It is a long journey to learn how to solve challenging problems. Everybody can get better by doing the right kind of practice. Right means what is right for *you*. If the above steps do not work, you can look online for suggestions. For example you may find some of the advice (like this) about preparing for the international mathematics olympiad useful, even though that is a much harder exam with a different emphasis. Find a good method that works for you and then enjoy the process. Learning mathematical problem solving has its own rewards by sharpening your mind, no matter what happens in any exam.