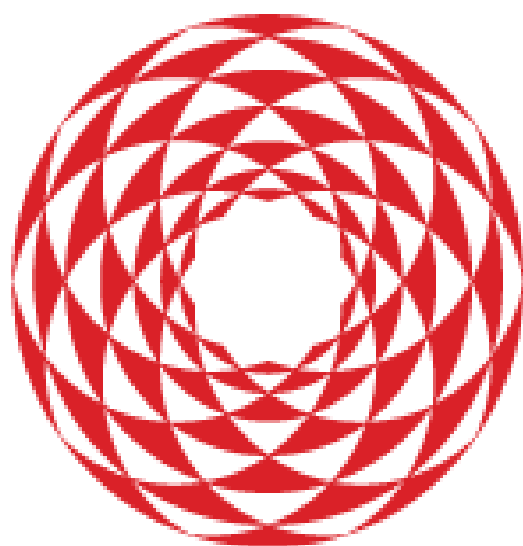


MATHEMATICS HANDBOOK

(For students who joined in 2019 or 2020)



ASHOKA
UNIVERSITY

YEAR 2020-21

Some of the most powerful and beautiful ideas occur in the field of Mathematics. The wide applicability of these ideas and their deep connection with the natural sciences have made this discipline one of the most fruitful arenas of human inquiry. Combining, as it does, the greatest creative freedom with the most stringent standards of rigor, Mathematics also happens to be the ideal training ground for learning a broad range of analytical and problem-solving skills. Ashoka University's Mathematics major program has been designed to meet two primary goals:

1. Students should get a broad exposure to the primary areas and the central ideas of contemporary Mathematics (as well as their applications) and
2. Students should develop rigorous, analytical reasoning skills, along with problem-solving ability.

In addition to the Foundation courses that are common across disciplines, students aiming to choose Mathematics as their major should take the enabling course on Calculus as early as possible. This will be followed by **11 required** and **3 elective** courses in Mathematics. The required courses cover the areas of Analysis, Algebra, Linear Algebra, Probability, and Differential Equations. Elective courses vary from semester to semester depending on student and faculty interests. In addition, students have the opportunity to study some special topics in depth under the guidance of a faculty member.

At the end of the program of study, we expect students to be able to read and understand mathematical proofs; learn and apply new mathematical concepts; and, construct and communicate a correct and rigorous argument on their own. Most importantly, we expect students to be able to solve *new* mathematical problems on their own. Students completing this program will be well prepared to pursue Mathematics further or to take up positions that call for innovative problem solving in concert with strong analytical abilities.

Pre-requirements for taking Mathematics Courses

As a rule, a student should have taken Mathematics at the +2 level in school. Very rarely exceptions can be made at the discretion of the Faculty. To qualify for an exception, the student should demonstrate that they have picked up adequate mathematics before coming to the University. They should take the mathematics Foundation Course and the Calculus course as early as they can, and only then decide whether they want to pursue further mathematics courses.

Students are advised that they should have extra-ordinary interest and commitment to succeed in studying college level mathematics if they did not study it in classes 11 and 12 in school. In addition, they are required to pick up several topics on their own. For example, if they are not familiar with trigonometric functions and identities, or with the binomial theorem, it would be impossible to go ahead with the Calculus course in two semesters.

Course Requirements

Major in Mathematics

Requirements: Each student will take a total of 15 mathematics courses. For completing a major in Mathematics, one must take the following courses (12 required courses and 3 elective courses).

Required Courses

100 Level Courses

The following is expected to be offered in every semester

- [Calculus](#)

The following are expected to be offered in even semesters

- [Linear algebra](#)
- [Multivariable calculus](#)
 - Prerequisite: Calculus

200 Level Courses

The following are expected to be offered in odd semesters

- [Algebra 1](#)
- [Probability](#)
- [Real analysis](#)
 - Prerequisite: Calculus

The following are expected to be offered in even semesters

- [Algebra 2](#)

- Prerequisite: Algebra 1
- [Metric and topological spaces](#)
 - Prerequisites: Calculus, Real Analysis

300 Level Courses

The following are expected to be offered in odd semesters

- [Complex analysis](#)
 - Prerequisites: Calculus, Multivariable calculus, Real analysis, Linear algebra
- [Differential equations and mathematical modeling](#)
 - Prerequisites: Calculus, Multivariable calculus, Real analysis, Linear algebra
- [Advanced linear algebra and matrix analysis](#)
 - Prerequisites: Calculus, Linear algebra, Real analysis

The following is expected to be offered in even semesters

- [Elementary differential geometry](#)
 - Prerequisites: Calculus, Linear algebra, Real analysis, Metric and topological spaces

Elective Courses

In addition to the 12 required courses, three electives are required. The elective courses offered vary from semester to semester depending on student interest and the availability of faculty. The elective courses offered by the department so far are as follows.

CTS Course

- [Introduction to proofs](#)
 - This cannot be counted as a math elective if counted as a CTS requirement.

300 Level Courses

- [Introduction to statistical inference](#)
- [Fourier analysis](#)
- [Introduction to combinatorics](#)
- [Linear programming](#)

400 Level Courses

- [Topological spaces](#)
- [Measure theory](#)
- [Functional analysis](#)
- [Random graphs](#)
- [Topics in analysis](#)
- [Mathematical foundations of data sciences](#)

Minor in Mathematics

Required Courses

1. Calculus

2. Multivariable calculus

3. Linear algebra

4. Algebra I

5. Probability

6. Real analysis

Students taking a course in probability as part of their major are required to replace the Probability theory course with another course of their choice.

Concentration in Mathematics

Required Courses

1. Calculus

2. Linear algebra

3. Algebra I

*One more course (of the student's choice) must be taken. Note that this course **cannot** be Probability theory if the student has done a course on Probability in their major.*

Suggested Course Progression

A student majoring in math should take Calculus in the first semester. This course is a prerequisite to further mathematics courses. Students thinking of studying mathematics should take this course as early as possible, possibly the first or the second semester. A student who wants to decide later can take the Math FC in the first semester. If interested in the mathematics major, the student should follow the suggested course sequence for math majors starting from the second semester. The following tables show the intended course sequence for math majors (for students who joined in 2019 or later).

For Students taking Calculus in the First Semester (2019 or later)

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
<i>Calculus*#</i>	Linear Algebra *#	Algebra I *#	Algebra II	Complex Analysis	Differential Geometry
	Multivar. Calculus*#	Probability *	Met. & Top. Spaces	Diff. Eqns. & Math. Modeling	Elective I
					Elective II
		Real analysis *		Ad. Linear Algebra & Matrix Anal.	Elective III

Please see notes below for markings.

For Students taking Calculus in the Second Semester (2019 or later)

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
	Linear Algebra *#	Algebra I *#	Algebra II	Complex Analysis	Differential Geometry
	<i>Calculus</i> *#	Probability *	Met. & Top. Spaces	Diff. Eqns. & Math. Modeling	Elective I
					Elective II
		Real analysis *	Multivar. Calculus #	Adv. Linear Algebra & Matrix Anal.	Elective III

Notes

Calculus is a mandatory course for all Mathematics majors and minors.

Courses **marked*** are **mandatory** for Mathematics minors.

For a Concentration in Mathematics one needs to do courses **marked#** and **one more** course of their choice, provided prerequisites are met.

Frequently asked questions

Q: Is the 1000/2000/3000 level system an equivalent of the 100/200/300 level system?

A: Yes.

Q: Is it mandatory for majors to take Calculus by the end of first year?

A: Yes. Otherwise it would be very difficult to complete your math major in 3 years. Indeed, it is extremely helpful to take calculus by the end of first year in case you intend to major in other, mathematically-oriented majors, such Physics, Computer Science and Economics.

Q: Is Multivariable Calculus the same course as Calculus II?

A: Yes.

Q: Is it mandatory for majors to take multivariable calculus by the end of the first year?

A: No, it is not mandatory. But it would be helpful for doing real analysis. But if you cannot do it in first year, you can still do it in the 4th semester.

Q: Is it mandatory for majors to take linear algebra by the end of first year?

A: No. But it is strongly recommended that you take it in the second semester. But you must take it by the end of the second year.

Q: What is the policy on cross-listed courses?

A: Cross-listed courses are those courses which arise out of a discipline different from Mathematics but are cross-listed with mathematics. The students can take cross-listed courses towards their Major. The information of cross-listed courses (if there are any) will be shared with the students.

Q: I took a course in Monsoon 2019 which was cross-listed with CS. It is being offered again in 2020 but is not showing as cross-listed. Is this a problem?

A: No. It is normal for courses to not be cross-listed with other departments in every semester that they're offered. If you took a course, which was cross-listed in the semester that you took it, it will count towards your degree. Please cross-check the course code of such courses in your LMS.

Q: Can I write a thesis in the third year?

A: No. Only ASPs with a prior approval from the department can write a capstone thesis with the department.

Q: I'm going on a semester abroad. Can I substitute the required courses with a summer abroad course?

A: The specific course along with its detailed syllabus will need to be shared with the Department's HOD and a decision will be taken on a case-by-case basis.

Q: I'm interested in TA-ing for the Monsoon semester. How should I proceed?

A: Only 3rd year and 4th year students are eligible to TA for courses. The Department notifies the students about TA requirements in the beginning of the semester and calls for applications.

Q: I am confused about which elective courses to opt for. Is there someone I can talk to?

A: You may consult the course descriptions provided on the LMS or may reach out to your peers or seniors who have already taken courses you may be interested in. You may also seek guidance from the respective instructor.

Q: Is there an order that courses have to be taken in?

A: Yes. The course progression section provides a recommended order, which takes into account the prerequisites of each course.

Q: Where can I find more information related to course descriptions and syllabus?

A: Consult the website <https://ashoka.edu.in/mathematicsdepartment> under the tab 'Programmes' click on 'Math Major'. Each semester's courses will have descriptions on LMS as well.

Q: Whom should I contact for further queries?

A: Please email Pratik Apshinge with a cc to Tejasvi Anand. For course-related matters, please write to Professor Kumarjit Saha.

Important Contacts:

Pratik Apshinge (Student representative): pratik.apshinge_ug21@ashoka.edu.in

Tejasvi Anand (Department Manager): tejasvi.anand@ashoka.edu.in

Professor Kumarjit Saha (Teaching Coordinator): kumarjit.saha@ashoka.edu.in

