Ayan Nath

Undergraduate

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Education

Chennai Mathematical Institute — Chennai, India

Bachelor of Science (Mathematics and Computer Science) — *September 2021 – April 2024*

Graduate courses:

- Fall 2022: Commutative Algebra
- Spring 2023: Algebraic Geometry 2
- Fall 2023: Algebraic Number Theory, Arithmetic of Elliptic Curves, Function Field Arithmetic
- Spring 2024: Geometric Class Field Theory, Topology of Algebraic Varieties, Representation Theory, Distribution of Primes

Projects

Abelian Varieties and their Moduli

École Normale Supérieure - PSL, Paris — *May 2024 - June 2024*

- Supervisor: Professor Benoit Stroh.

Artin-Verdier duality for function fields

Chennai Mathematical Institute — *April 2024*

- As part of the assessment for the Geometric Class Field Theory elective course, I studied and gave a talk on Christopher Deninger's variant of Artin-Verdier duality [Math. Z. 188 (1984)].
- Report: www.cmi.ac.in/~ayannath/artin-verdier.pdf.

Hodge-Tate decomposition for abelian varieties with good reduction

Chennai Mathematical Institute — *April 2024*

- As part of the assessment for the Topology of Algebraic Varieties elective course, I studied and gave a talk on the Hodge-Tate decomposition for abelian varieties over p-adic fields with good reduction.
- Report: www.cmi.ac.in/~ayannath/hodge-tate-decomposition.pdf.

Galois Representations, Modular Forms, and Modular Curves (Advisor: Prof. Aditya Karnataki)

Chennai Mathematical Institute — *January 2023 - December 2023*

- I followed Diamond-Shurman's text for the classical theory of modular forms and the first 8 chapters of Silverman's AEC to cover the basic theory of elliptic curves.
- In addition, I studied étale cohomology from Milne's lecture notes and local class field theory from Kedlaya's online notes.
- I studied Deligne's construction of ℓ-adic Galois representations attached to normalized cuspidal newforms of weight $k \geq 2$ [Sém. Bourbaki (1968/79), exp. 355]. Notes: www.cmi.ac.in/~ayannath/deligne-galois-reps.pdf
- I followed this up by reading Deligne-Serre's paper "*Formes modulaires de poids 1*" [Ann. Sci. Éc. Norm. Supér. 7 (1974)]. Notes: www.cmi.ac.in/~ayannath/deligne-serre.pdf
- As an application of these ideas, I studied Ribet's celebrated article *"A modular construction of unramified p-extensions of* $\mathbb{Q}(\mu_p)$*"* [Inv. Math. 34 (1976)]. This led me to also study the theory of Néron models and finite flat group schemes. Notes: www.cmi.ac.in/~ayannath/ribet-herbrand.pdf
- As a first step in understanding the moduli of elliptic curves, I studied the construction of moduli stacks of generalized elliptic curves, and how rigidifying level structures are imposed to produce smooth projective moduli schemes. My reference was "*Les Schémas de Modules de Courbes Elliptiques*" by Deligne-Rapoport.
- This project introduced me to many new topics– algebraic spaces and stacks, deformation theory, formal schemes, GIT quotients, etc. Notes: www.cmi.ac.in/~ayannath/deligne-rapoport.pdf

Mod p Local Langlands Correspondence for $\mathbf{GL}_2$ (Advisor: Prof. Eknath Ghate)

TIFR Mumbai - Visiting Students' Research Program — *May 2023 – June 2023*

- I read about mod p representations of p-adic groups and of the local Galois group $\mathrm{Gal}(\overline{\mathbb{Q}}_p/\mathbb{Q}_p)$, leading to a mod p local Langlands correspondence for $\mathrm{GL}_2(\mathbb{Q}_p)$. We mainly followed Florian Herzig's course notes.
- Report: www.cmi.ac.in/~ayannath/vsrp-report.pdf ; Slides: www.cmi.ac.in/~ayannath/vsrp-slides.pdf.

Alterations
Chennai Mathematical Institute *April 2023*

- As part of the assessment for the Algebraic Geometry II elective course, I delivered a talk on resolution of singularities in arbitrary characteristic and studied A. J. de Jong's celebrated paper "*Smoothness, semi-stability and alterations*" [Publ. Math. IHÉS 83 (1996), 51-93].
- Report: www.cmi.ac.in/~ayannath/alterations.pdf; Slides: www.cmi.ac.in/~ayannath/alterations-slides.pdf

The Cohen-Macaulay property of invariant rings
Chennai Mathematical Institute *November 2023*

- As part of the assessment for the Commutative Algebra elective course, I studied and delivered a talk on F. Knop's unpublished note "*Die Cohen-Macaulay-Eigenschaft von Invariantenringen*", giving a very short proof of the Hochster-Roberts theorem in Invariant theory.
- Report: www.cmi.ac.in/~ayannath/hochster-roberts.pdf.

Algebraic Geometry (Advisor: Prof. Krishna Hanumanthu)
Chennai Mathematical Institute *May 2022 - August 2022*

- I studied the classical theory of varieties from Fulton's "Algebraic Curves" and the first chapter of Hartshorne. I followed this up by learning Scheme theory from Ravi Vakil's "Foundations of Algebraic Geometry" and taking the Algebraic Geometry II elective course at CMI.

Algebraic Number Theory (Advisor: Prof. B. Sury)
Indian Statistical Institute, Bangalore *June 2022 – September 2022*

- I studied Algebraic Number Theory from Marcus' Number Fields and Neukirch's Algebraic Number Theory.
- I also read a paper "*Super-multiplicativity of ideal norms in number fields*" [Acta Arith. 193 (2020), 75-93].
- Report: www.cmi.ac.in/~ayannath/supermultiplicative.pdf

Publications and other works

- Ayan Nath and Abhishek Jha, *On the Least Common Multiple of Polynomial Sequences at Prime Arguments*, **International Journal of Number Theory**, 18(06), 1227-1237, doi:10.1142/S1793042122500622 (2022)
- Ayan Nath and Abhishek Jha, *On Quotients of Values of Euler's Function on Factorials*, **Bulletin of the Australian Mathematical Society**, 105(3), 353-364, doi:10.1017/S0004972721000939 (2021)
- Ayan Nath, *On the divisibility* $a! + b! \mid (a + b)!$, **The American Mathematical Monthly**, 129(3), 246-254, doi:10.1080/00029890.2022.2010495 (2022)
- Ayan Nath, *A Taste of Analytic Number Theory*, Art of Problem Solving, https://www.cmi.ac.in/~ayannath/olympiad-analytic-nt.pdf (2020)

Presentations

2024 **Artin-Verdier duality for function fields**, talk delivered as part of the assessment for the Geometric Class Field Theory elective course.

Hodge-Tate decomposition for abelian varieties with good reduction, talk delivered as part of the assessment for the Topology of Algebraic Varieties elective course.

2023 **Preparing for INMO**, invited talk at INMO Training Camp organized by Assam Academy of Mathematics

Ribet's converse to Herbrand's theorem, CMI-IMSc Number Theory Seminar.

Alterations, CMI Student Seminar. Slides: www.cmi.ac.in/~ayannath/alterations-slides.pdf.

The LCM of Polynomial Sequences at Prime Arguments, CMI Student Seminar. Based on my original paper. Slides: www.cmi.ac.in/~ayannath/lcm-slides.pdf.

Mod p local Langlands correspondence for $\mathbf{GL}_2(\mathbb{Q}_p)$, talk delivered as part of the culmination of the TIFR Visiting Students' Research Program. Slides: www.cmi.ac.in/~ayannath/vsrp-slides.pdf.

Resolution of Singularities in Arbitrary Characteristic, talk delivered as part of the assessment for the Algebraic Geometry II elective course.

2022 **The Cohen-Macaulay property of invariant rings**, talk delivered as part of the assessment for the Commutative Algebra elective course.

Olympiad Combinatorics: Games, Tiling, Invariants, Govt. Girls' HS & MP School, Tezpur; Instructor in olympiad training camp organized by the Assam Academy of Mathematics

2020 **Graph Theory and Probability**, Kaliabor College, Assam; talk delivered to high school and undergraduates students

2019 **Angle Chasing** and **Invariants**, Darrang College, Tezpur; Instructor in olympiad training camp organized by the Assam Academy of Mathematics

Teaching Experience

Calculus 1 (Instructor: Prof. Krishna Hanumanthu)
Chennai Mathematical Institute *January 2024 - April 2024*

- I am a **teaching assistant** for this core course offered to first-year undergraduate students at CMI. I conduct tutorial sessions.

Calculus 2 (Instructor: Prof. Sukhendu Mehrotra)
Chennai Mathematical Institute *August 2023 – December 2023*

- I was a **teaching assistant** for this core course offered to second-year undergraduate students at CMI. I conducted tutorial sessions and graded assignments.

Analysis 2 (Instructor: Prof. Srinivasan Vasanth)
Chennai Mathematical Institute *August 2023 – December 2023*

- I was a **teaching assistant** for this core course offered to second-year undergraduate students at CMI. I conducted quizzes, tutorial sessions, and graded assignments.

Discrete Mathematics (Instructor: Prof. Amit K. Sinhababu and Prof. V. Arvind)
Chennai Mathematical Institute *January 2023 – April 2023*

- I was a **teaching assistant** for this core course offered to first year BSc Math & CS students at CMI. I conducted tutorial sessions and graded assignments.

Workshops

Hida Theory and Iwasawa Main Conjecture over $\mathbb{Q}$
Chennai Mathematical Institute *December 2023*

- Unofficial participant.

Rational Points on Modular Curves
International Centre for Theoretical Science (ICTS-TIFR) *September 2023*

- I was a selected participant for this international workshop on the geometry of modular curves, their rational points, classical and non-abelian Chabauty methods, and related computational aspects.

Dualities in Topology and Algebra
International Centre for Theoretical Science (ICTS-TIFR) *May 2023*

- I was a selected participant for this international workshop on duality phenomena and also on classification problems in various tensor-triangulated categories that arise in algebraic topology, commutative algebra, and the modular representation theory of finite groups.

Elliptic curves and the special values of L-functions
International Centre for Theoretical Science (ICTS-TIFR) *August 2022*

- I was a selected participant for this international workshop on the recent developments in the arithmetic of elliptic curves and special values of L-functions.

Achievements

2024 **MIT Presidential Fellowship**, Massachusetts Institute of Technology.

2023 **Selected for TIFR VSRP (Visiting Students' Research Program)**, Tata Institute of Fundamental Research (TIFR), Mumbai.

Selected for JNCASR SRFP (Summer Research Fellowship Program), Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru (not availed)

Selected for IMSc Summer Research Programme, Institute of Mathematical Sciences (IMSc), Chennai (not availed).

2022 **Simon Marais Mathematics Competition 2022 score: 36**, Individual

Madhava Mathematics Competition winner, S.P. College & HBCSE

SRIRAM Scholarship, tuition fee waiver and monthly stipend for undergraduate studies at CMI.

2021 **2nd in Mathathon**, Indian Institute of Technology, Bombay

Spirit of Ramanujan, Professor Ken Ono

Indian National Mathematical Olympiad Awardee (2019, 2020, 2021), Homi Bhabha Centre For Science Education

2020 **2nd in Gaussian Gamble**, Indian Institute of Science, Bangalore

2019 **Qualified STEMS**, Chennai Mathematical Institute

Gold Medal in ELMO 2019 as a guest contestant, USA MOP

2018 **Qualified International Sharygin Geometry Olympiad Correspondence** with the highest number of solves from India, Moscow Center for Continuous Mathematical Education

Skills

Languages	Python, Haskell, Unix/Linux shell scripting, HTML & CSS
Tools	LaTeX, PARI/GP