Irish Debbarma

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EDUCATION

Indian Institute of Science (IISc) — **Bangalore, Karnataka, India**
Masters of Science in Mathematics — *Expected Graduation: July 2024*

Indian Institute of Science (IISc) — **Bangalore, Karnataka, India**
Bachelors of Science (Research) with Math major — *Graduation: July 2023*

Bansal Public School — **Kota, Rajasthan, India**
Central Board of Secondary Education (CBSE) — *Higher Secondary Education: 2019*

Holy Cross School — **Agartala, Tripura, India**
Indian Certificate of Secondary Education (ICSE) — *Secondary Education: 2017*

RESEARCH INTERESTS

I am interested in Number Theory and Algebra with specific interests in the theory of Modular Forms, congruences between modular forms and Galois representations.

PROJECTS

Masters thesis — *May 2023-ongoing*

Topic: Gross-Stark conjecture

Guide: Professor Mahesh Kakde from IISc Bangalore

- Main references are the papers by Dasgupta-Darmon-Pollack, Dasgupta-Kakde-Ventullo and J. Tate's book *Les conjectures de Stark sur les fonctions L d'Artin en* $s = 0$

Reading Project — *May 2023-ongoing*

Topic: Serre's conjecture

Guide: Professor Shaunak Deo from IISc Bangalore

- Main references are J.P. Serre's *Sur les représentations modulaires de degré* 2 *de* $\mathrm{Gal}(\overline{\mathbb{Q}}/\mathbb{Q})$ and W. Stein and K. Ribet's lecture notes on the conjectures

Bachelor thesis — *August 2022-May 2023*

Topic: Fourier analysis on number fields (Tate's thesis)

Guide: Professor Mahesh Kakde from IISc Bangalore

- Main references are Dinakar Ramakrishnan, Valenza's *Fourier Analysis on Number Fields*, Cassels and Fröhlich's *Algebraic Number Theory*, Bjorn Poonen's notes.
- Draft in preparation. Please find it here.

Semester project — *Dec 2022- May 2023*

Topic: Linear Algebraic groups

Guide: Professor Shaunak Deo from IISc Bangalore

- Read chapters $1-4$ T.A. Springer's *Linear Algebraic Groups.*

Summer project — *May 2022-August 2022*

Topic: Construction of p-adic L-functions

Guide: Professor Mahesh Kakde from IISc Bangalore

- Read chapters 1 to 4 of Washington's *Introduction to Cyclotomic Fields*

Summer project — *May 2022-ongoing*

Topic: Uncertainty principles in finite abelian groups and its applications

Guide: Professor Gautami Bhowmik from University of Lille, France

- Read Tao's paper on *Uncertainty Principle for cyclic group of prime order*
- Studied multiple proofs of a key proposition (Chebotarev's theorem) in Tao's aforementioned paper
- Studied a generalisation of Tao's result by Murty and Whang
- Studied a further generalisation of Tao's result by Meschulam achieved in a completely different manner
- Applied the result to additive problems such as zero sum problem, zeros of sparse polynomials and Cauchy-Davenport theorem.

Winter Project *December 2021*

Topic: Cubic and Quartic Reciprocity Laws

Guide: Professor Shaunak Deo from IISc Bangalore

- Read chapter 9 from the book *A Classical Introduction to Modern Number Theory* by Kenneth Ireland, Michael Rosen and solving end of chapter questions.

Summer Project *June 2021-August 2021*

Topic: Zero sum problems in finite abelian groups

Guide: Professor Venkatesh Rajendran from IISc Bangalore

- Read the expository article on *Zero sum problems*.
- Understood some preliminary results on Davenport's constant, Erdös-Ginzberg-Ziv constant, η-constant for Abelian groups of the type $C_n, C_m \oplus C_n, C_2 \oplus C_2 \oplus C_{2n}$.
- Wrote a detailed report on the proofs I encountered while reading. Please find my report here.

Summer Project *June 2020-August 2020*

Topic: Binary Quadratic Forms, and its reduction

Guide: Professor B. Sury from Indian Statistical Institute (ISI), Bangalore.

- Solved first 3 chapters of *Introduction to the Theory of Numbers* by Niven, Zuckerman, Montgomery.
- Read chapter 1 of this book by Lemmermeyer.
- Wrote a report on the three project topics (Gauss reduction, Gauss class number problem, Zagier's one line proof of the two squares problem) mentioned in the book . Please find my report here. Certificate of work by mentor can be found here.

COURSES TAKEN

Mathematics courses:

- *Fall semester 2023*: Linear Algebraic Groups, Commutative Algebra, Topics in Number theory: Galois representations, Masters project A.
- *Spring semester 2023*: Algebraic Geometry I (Sheaves and Schemes), Modular forms, Elliptic curves.
- *Fall semester 2022*: Topology, Commutative Algebra, Analytic Number Theory, Lie Algebras and their representations.
- *Spring semester 2022*: Algebra-II (Fields and Galois Theory), Complex Analysis, Measure Theory, Algebraic Number Theory.
- *Fall semester 2021*: Algebra-I (Groups, Rings and Modules), Linear Algebra, Multivariable Calculus, Representation theory of finite groups.
- *Spring semester 2021*: Introduction to Basic Analysis, Introduction to Algebraic Structures, Ordinary Differential Equations.
- *Fall semester 2020*: Probability and Statistics
- *Spring semester 2020*: Real Analysis and Linear Algebra-II
- *Fall semester 2019*: Real Analysis and Linear Algebra-I

ACHIEVEMENTS

- Charpak lab scholarship awardee 2022. Awarded by the French government to undertake a research project at a French laboratory. My summer project of 2022 was supported by this.
- Kishore Vaigyanik Protsahan Yojna (KVPY) Scholar, fellow since 2019. Awarded by the Department of Science and Technology, Govt. of India. Attended Vijyoshi Science Camp 2019 as a KVPY fellow.
- Percentile of 99.51 in the Joint Entrance Exam (JEE) Mains of 2019.

Conferences and Meetings

- Flatland Arithmetic: Spring Meeting
- L-functions, Circle method and applications
- Elliptic Curves and the special values of L-functions
- FPSAC-2022
- Advanced Instructional School on *Lie Groups and Lie Algebras*
- Advanced Instructional School on *An introduction to p-adic Methods in Arithmetic*
- Rational points on modular curves

- Preliminary Arizona Winter school on Abelian varieties over fintie fields; supervised by Lassina Dembele
- Gave a few lectures at the Graduate learning seminar series on Class Field theory (based on the Bonn lectures on Neukirch's Class Field Theory) organised at IISc in spring 2022.
- Giving a lecture at the Graduate learning seminar on Automorphic representations (based on Gelbart's Automorphic forms on Adele groups) organised at IISc in Fall 2023.