Personal details

Personal details

First / given name	Akshay
Second given name	
Third given name	
Surname/family name	Sant
Date of birth	19 April 1998
Preferred first/given name	Akshay
Previous surname	
Country of birth	
Legal nationality	
Dual nationality	
Country of residence	Germany
Have you previously studied with us at the University of Bristol?	No

Contact details

Home address

Please provide your permanent residential address. If you have another address and would prefer for us to contact you at that address instead you have the opportunity to add a correspondence address in the next section.

Country	India
Postcode	421301
Address Line 1	301, Dattatraya Apt
Address Line 2	Lele Ali
City	Kalyan
County	Maharashtra
Telephone	

If you would like us to send any postal correspondence to an address which is not your home address please enter an alternative address here. If you want us to send correspondence to your home address then please select No.

Do you want to add a correspondence address?	Yes
Country	Germany
Postcode	67655
Address Line 1	Philippstr 2
Address Line 2	
City	Kaiserslautern
County	Rheineland Pfalz
Telephone	

Agent

Agent details

Agency Name	
Email address	

Other information

Additional Documents

Please upload required documents as outlined in your admissions statement

Mode of study

How would like to study this programme?	Full Time

Qualifications

Qualifications

Institution	Qualification	Type	Subject	Actual/predicted	Grade	Start date	End date
University of Kaiserslautern, Germany	Master's Degree (PG)	Academic Qualification	Mathematics	Predicted	1.5	01/Apr/2021	30/Sep/2023
Ramnarain Ruia Autonomous college	First degree BA/BSC etc	Academic Qualification	Mathematics	Actual	94.96%	01/Jun/2015	18/May/2018
Ramnarain Ruia Autonomous college	First degree BA/BSC etc OS	Academic Qualification	Mathematics	Actual	94.96%	01/Jul/2015	18/May/2018
University of Kaiserslautern, Germany	Master's Degree (PG) EU	Academic Qualification	Mathematics	Predicted	1.3	01/Apr/2021	01/Apr/2024

If these qualifications have altered since your last application please note the changes in the free text box here.

English Language

Is English your first language? No
What is your first language? Marathi
Did you study at school/university where you were taught in English? Yes
For how many years? 5
Have you sat a relevant English language test? Yes

TOEFL (internet-based)

Registration number
Date of TOEFL test
TOEFL reading score
TOEFL listening score
TOEFL speaking score
TOEFL writing score
TOEFL total score

IELTS (International English Language Testing System)

Test report form (TRF) number 18IN195690SANA001A
UKVI number (if applicable)
Date of IELTS test 15 September 2018
IELTS listening score 7.5
IELTS reading score 6.5
IELTS writing score 6.5
IELTS speaking score 6.5
IELTS total score 7.0

Pearson Test of English

Score report code
Date of Pearson test

Pearson listening score

Pearson reading score

Pearson speaking score

Pearson writing score

Pearson overall score

Other English Language test

Name of course

Registration number

Date of test

Listening score

Writing score

Reading score

Total score

Experience

Current Employer

Employer name and address RPTU Kaiserslautern Landau, Gottlieb-Daimler str 48, Kaiserslautern, 67663.

Job title and main duties Student research assistant for computational algebraic geometry and number theory. Duties involved a bit of theoretical and documentation work and programming in Julia.

Full time/Part time Part time

Date of Appointment 01 April 2021

End date (if applicable) 30 September 2023

Previous employment 1

Employer name and address

Job title and main duties

Full time/Part time

Date of Appointment

End date (if applicable)

Previous employment 2

Employer name and address

Job title and main duties

Full time/Part time

Date of Appointment

End date (if applicable)

Previous employment 3

Employer name and address

Job title and main duties

Full time/Part time

Date of Appointment

End date (if applicable)

Other Experience

Do you have any other relevant work experience to support your application?

Please provide details

Personal statement

Personal details

Do you have a personal statement to upload?	Yes
Please type your personal statement in the box	

Research proposal

Research proposal

Proposed supervisor 1	Tim Dokchitser
Proposed supervisor 1	Celine Meistret
Proposed project title (max 150 chars)	

Passport and visa

Visa required

Do you require a visa to study in the UK?	Yes

Please fill out your passport details below. If you are unable to provide these at the current time you will have another opportunity to upload your passport after you submit the form. If you do not provide us with this information we will be unable to issue you with your confirmation of acceptance number and you will be unable to obtain a visa.

Passport details

Passport number	

Further details

Have you previously studied in the UK?	No
What was the highest level of study in the UK?	
Please confirm the total length of your UK study in years	

Referees

Referee 1

Do you have a reference to upload?	No
Type of reference	Academic
Referee title	Professor
Forename	Gunter
Surname	Malle
Position	Professor
Institution/Company	RPTU Kaiserslautern-Landau
Email address	malle@mathematik.uni-kl.de
Country	Germany

Referee 2

Do you have a second reference to upload?	No
Type of reference	Academic
Referee title	Dr
Forename	Jeroen
Surname	Hanselman
Position	Researcher
Institution/Company	RPTU Kaiserslautern-Landau
Email address	hanselma@mathematik.uni-kl.de
Country	Germany

Funding

Funding 1

What is your likely source of funding?	Other
Please give the name of your scholarship or Studentship	
Please specify	I would like be considered for the Heilbronn Doctoral Partnership (in addition to all our other available funding sources)
Percentage from this source	100
Is this funding already secured?	No

Funding 2

What is your likely source of funding?	Scholarship
Please give the name of your scholarship or Studentship	University of Bristol PhD scholarship
Please specify	
Percentage from this source	100
Is this funding already secured?	No

Funding 3

What is your likely source of funding?	
Please give the name of your scholarship or Studentship	
Please specify	
Percentage from this source	
Is this funding already secured?	

Other funding

I would like to be considered for other funding opportunities	Yes

Submission

Documents

Document type	File name
Degree certificate	Certificate.pdf
Transcript	Transcripts.pdf
References	BristolAkshay.pdf
Language qualification	Official transcripts and English Proficiency.pdf
Personal statement	Bristol_Person_Sant.pdf
Research proposal	Research_Statement Sant.pdf
Transcript	Masters Transcripts_Sant.pdf
Curriculum vitae	CV_NO NAME.pdf

By ticking the checkbox below and submitting your completed online application form, you acknowledge the University of Bristol will use the information provided from time to time, along with any further information about you the University may hold, for the purposes set out in the University's full Data Protection Statement. Applicants applying to the collaborative programmes of doctoral training should also read the Data Protection Statement for collaborative programmes of doctoral training.

The information that you provided on your application form will be used for the following purposes:

- To enable your application for entry to be considered and allow our Admissions Advisors, where applicable, to assist you through the application process;
- To enable the University to compile statistics, or to assist other organisations to do so. No statistical information will be published that would identify you personally;
- To enable the University to initiate your student record should you be offered a place at the University.

All applicants should note that the University reserves the right to make without notice changes in regulations, courses, fees etc at any time before or after a candidate's admission. Admission to the University is subject to the requirement that the candidate will comply with the University's registration procedure and will duly observe the Charter, Statutes, Ordinances and Regulations from time to time in force.

By ticking the checkbox below and submitting your completed online application form, you are confirming that the information given in this form is true, complete and accurate and that no information requested or other material information has been omitted. You are also confirming that you have read the Data Protection Statement and you confirm the statement below.

I can confirm that the information I have provided is true, complete and accurate. I accept that the information given in my application will be stored and processed by the University of Bristol, in accordance with the *UK General Data Protection Regulation and Data Protection Act 2018*, in order to:

- Consider my application and operate an effective and impartial admissions process;
- Monitor the University’s applicant and student profile;
- Comply with all laws and regulations;
- Ensure the wellbeing and security of all students and staff;
- If my application is successful to form the basis of the statement made within my application.

If the University of Bristol discovers that I have made a false statement or omitted signification information from my application, for example examination results, I understand that it may have to withdraw or amend its offer or terminate my registration, according to circumstances.

Education

University of Bonn — Bonn
Partial cross-registered student, Department of Mathematics — *Winter Semester 2023-24*

Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau — Kaiserslautern
Master of Science, Mathematics International — *Apr.2021-Present*

Ramnarain Ruia Autonomous College — University of Mumbai
Bachelor of Science, Major in Mathematics, aggregate of 94.96% — *Aug. 2015 – Jun. 2018*

K.M. Agrawal College of Science, Commerce and Arts — Kalyan, India
High School, Ranked 3rd with an aggregate 88.15% — *Aug.2013- Jun. 2015*

Shree Gajanan Vidyalaya — Kalyan, India
Secondary School, aggregate 90.94% — *Aug.2013- Jun. 2015*

Work and Research Experience

Studentische/Wissenschaftslische Hilfskraft(HiWi) — November 2023 – Present
Fraunhofer(ITWM) research Institute for Mathematics — *Kaiserslautern*
Work responsibilities: Converting geometric data using databases and SQL and compare the performance with the state of the art software developed by Fraunhofer Institute.

Reading course on Drinfeld Modules — November 2023 – Present
With Professor Shripad Garge from Indian Institute of Technology(IIT),Mumbai — *Online*

Studentische/Wissenschaftslische Hilfskraft(HiWi) — April 2021 – September 2023
Department of Mathematics,Rheinland-Pfälzische Technische Universität, Kaiserslautern-Landau — *Kaiserslautern*
Work responsibilities: To implement classical algorithms in the OSCAR Package under Julia for the computational Algebraic Geometry.

Assistant Teacher — April 2020 – September 2020
Tambe Sir's classes, Savarkar road, Dombivali(west) — *Dombivali, India*
- **Courses taught**: Abstract algebra, Riemann integration, Sequences and series, and Real analysis.

Junior Lecturer — Aug. 2018 – Aug. 2019
Shete's Institute, Oak Baug Kalyan(West) — *Kalyan, India*
- **Responsibilities** : Teaching and setting up tests for students.
- **Courses taught** : Single and multivariate calculus, probability.

Assistant Teacher — June 2016– June 2018
Tambe Sir's classes, Savarkar road, Dombivali(west) — *Dombivali, India*
- **Courses taught**: Abstract algebra, Linear Algebra, Elementary Number Theory

Awards and Achievements

- **Deutschlandstipendium**(October2022-Present),RPTU Kaiserslautern-Landau.
- **DAAD-STIBET Scholarship** for Masters studies(January 2022-Present),RPTU Kaiserslautern-Landau.
- **Graduate School of Mathematics Scholarship** for Masters studies(April 2021-March 2022),RPTU Kaiserslautern-Landau.
- **INSPIRE Scholarship** during the undergraduate studies awarded by the **Department of Science and Technology(DST),The Government of India**.
- **The Mumbai Topper**, Madhava Mathematics Competition, 2016.
- Ranked in **Top 200** in IIT-JAM Mathematics Entrance exam in 2018.
- **TIFR, GS Entrance** in 2020, ranked in top 76 shortlisted candidates for in the first stage for TIFR CAM from all over India.

Conferences, Summer Schools, and Workshops Attended

- **Conference: Young Number theorists in Bonn** |*Max Planck Institute for Mathematics, Bonn* — September 2023
- **Conference on Arithmetic Statistics and Ergodic theory** |*Max Planck Institute for Mathematics,Bonn* — April 2023
- **Nikolaus school on Computational Algebraic Geometry** |*RPTU Kaiserslautern-Landau* — November 2022
- **Summer School: Modular forms in Number theory and beyond** |*Bielefeld University,Germany* — August 2022
  - Attended lectures and group discussions on L functions, Vertex Algebras, Monstrous Moonshine conjecture, and Modular forms on Unitary groups.
- **Workshop on Algebraic Number Theory** | *Assam University, Silchar,India* — Aug.2020 – Sep. 2020
  - Discussed some ideas on **L-function of an Elliptic curve**, Galois cohomology of Elliptic curves and concluded with the introduction to **Selmer Groups and Iwasawa Theory**.

- **Annual Foundation School-I** Apr. 2020 – May 2020

  * **Complex Analysis** :Basic introduction and then going up to Big Piccard's Theorem.
  * **Topology** : Basic point set topology till One point compactification.
  * **Algebra**: Group actions, Lie groups and a brief introduction to Representation Theory of finite Groups.

- **Summer research student,VSRP** |*TIFR, Mumbai,India* Jun. 2018 – July. 2019

  * Reading on Analytic Geometry, a bit of Elliptic curves and Number Theory.
  * Seminar on **Class Field Theory** and Modern applications of homology.

- **Nurture Camp, Madhava Mathematics Competition** |*ISI, Bangalore,India* Jun. 2017

  * Interaction with topics like Group actions, Field extensions.
  * Discussed several applications of spectral theorem and linear algebra in computing and image processing.

Technical and Language Skills

- **Programming Languages and Computer Algebra Systems :**
Python, C/C++, HTML/CSS, Macaulay 2, Singular, Julia.
- **IELTS:** Band 7.0/9.0.
- **Mathematical Typesetting:** LaTeX.
- **German Proficiency:**

B-2,1,Technische Universität Kaiserslautern.

B-1+, University of Regensburg. Final grade 1.3

A-1,A-2 Goethe Institute, Mumbai.
A1: 98/100, Grade:Sehr gut.
A2: 85/100, Grade :Gut.

Talks, Presentations and Seminars in Workshops/Schools/Universities

Speed Talk at Max Plank Institute for Mathematics, Bonn titled **An Arithmetic function related to the twin prime conjecture**.

Introduction to Sheaves: This presentation was given in the lecture Riemann surfaces, held at the RPTU Kaiserslautern in Summer 2023, where the teaching Professor Dr. Zintl asked me to cover for him and give a talk on Sheaves(which was required for further continuation of lecture) because he was busy and away at a conference.

Partitions, Young diagrams, tableaux in the Seminar: Representation theory of the Symmetric group, Technische Universität Kaiserslautern, May 2022.

Ext and Tor Groups in the Seminar: Algebraic Geometry, Technische Universität Kaiserslautern, November 2021.

Topological groups, Annual Foundation School-I, May,2020.

On the various proofs for the infinitude of Primes, Visting Students Research Program, TIFR, Mumbai, July 2018.

Invited talks:

Group theory, Modern Algebra and competitive exams, Ramanarain Ruia Autonomous College, January 2022.

History of Mathematics, Shete's Institute of academics, Kalyan,Mumbai, India, July 2019.

Scope of Pure Mathematics , Shree Gajanan Vidyalaya, June 2018.

Extra curricular activites

Sports and Board games: Chess(1500+ (Rapid) on Chess.com and Table tennis(Entry level Player).
Instruments: Tabla(6+ years of Learning) and A beginner on Ukulele.
Media: Avid user of DSLR Camera. I have experience of handling DSLR cameras for 7,8 years and have worked part-time as a Photographer in my Bachelors for my college Magazine. I am well-versed in Photo and Video editing software like Photoshop, Premiere Pro, and DaVinci Resolve. I am also Currently working on developing my photography and culinary Website(To be launched soon).
Literature: I love reading books and writing poems and articles. Along with working as a Photographer for my college magazine in my Bachelors, I also worked as a columnist and wrote for my college magazine.

University of Mumbai

Shikshana Prasaraka Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

NO : 323216 622498

I Certify that

SANT AKSHAY MANOJ SONALI

Passed the Bachelor of Science (B.Sc.) (CBSGS)

Degree (Three Year Degree Course) Examination

held by the

RAMNARAIN RUIA AUTONOMOUS COLLEGE

in the month of MARCH-2018 and was placed in the

'O' Grade.

May 18, 2018

Examination Co-ordinator

Personal statement

My fascination with numbers began in childhood, sparked by their patterns and the magic in simple operations. A vivid early memory is understanding the commutative property of addition through visualising pencils in groups. This elementary concept unveiled the beauty of intuitive and visual proofs, marking the start of my lifelong pursuit of mathematical knowledge. Despite a late start in focusing on mathematics, my curiosity was always keen, particularly towards logical thinking and computing. A testament to this was passing the MS-CIT exam at the age of six, a feat recognised by local newspapers and television, being the youngest at that time to achieve so. My parents, recognising my potential, nurtured my interests with various books and puzzles, enriching my logical and analytical skills. However, the path to pursuing pure sciences, notably mathematics, was not straightforward in my region. I stumbled upon mathematical competitions like the Olympiads only in my post-school or early college years, missing earlier opportunities due to a lack of awareness and guidance. Moreover, my decision to pursue pure sciences, despite achieving over 88 percentage(out of 100) in my pre-university exams and being in the top 1 percent of my class, was often met with skepticism and ridicule. This societal bias towards traditional careers like engineering and medicine was discouraging. However, these experiences only strengthened my resolve. My commitment to mathematics, in the face of these obstacles, demonstrates not only my passion for the subject but also my determination to challenge and change the societal perceptions of the value of pure sciences.

My grandfather was a school teacher and a social worker. He established an education trust that led to the founding of 64 schools in my state, which was purely devoted to the education of poor students who could not afford the usual education. He was also a member of Parliament and contributed a lot towards primary education. He also taught Mathematics as a school teacher before he became part of the Government. Taking inspiration from him, I also decided to do something of this nature, focusing on pure sciences. As explained earlier, there is a massive lack of awareness of careers in pure sciences, especially in suburban areas like the region I come from. Thus, I started pursuing my Bachelor of Science and later specialised in Mathematics. My undergraduate studies at Ramnarain Ruia Autonomous College and the mentorship of Mr. Tambe Sir were pivotal. It was a life-changing moment for me when he recommended I read the biography of Srinivasa Ramanujan. Something just stuck with me, and I never looked back from doing mathematics. I can easily say that my true calling in mathematics came under the mentorship of Mr Tambe, who introduced me to the vast and intriguing world of mathematical problems, steering me towards pursuing a master's degree in Mathematics and, in general, motivated me to pursue research in Mathematics. A significant milestone in my mathematical journey was participating in the Madhava Mathematics Competition, akin to the Putnam Competition. My performance in this competition led to an invitation to a nurturing program at ISI Bangalore. This program was instrumental in exposing me to advanced topics like algebraic number theory, Galois theory, and commutative algebra at an earlier stage than most places in India, sparking a more profound interest in these fields.

This generated a lot of interest in me about mathematics, and I decided not to restrict myself to setting dreams and to look beyond them. This led me to take part in competitive exams like the IIT-JAM and TIFR entrance exams, where I secured a rank in the top 200 and top 70, respectively, from all over India. Consequently, following my undergraduate studies, I secured admission to the Indian Institute of Technology, Gandhinagar. Additionally, I was accepted into the ALGANT Program at Regensburg University. Unfortunately, due to unforeseen health issues within my family and the subsequent financial burden, I had to make the difficult decision to discontinue my studies there. This period was a testament to my belief that health and family take precedence, yet it did not dampen my mathematical aspirations. During this challenging period, I continued to seek educational opportunities while supporting my family. My determination to pursue a career in Mathematics never wavered. Throughout my academic journey, I've faced significant challenges, including societal bias and systemic hurdles. Despite securing a top 200 rank in the IIT-JAM exam, a testament to my academic abilities, I encountered the complexities of India's reservation system. This was particularly evident when candidates with ranks below 600 were preferred over me in prestigious institutes due to caste system, a scenario that highlighted the intricate balance between affirmative action and individual merit.

I am grateful to Prof. Shripad Garge from IIT Bombay for offering me the chance to engage in a reading project on Commutative algebra and Algebraic geometry. His guidance was pivotal, and his recommendation led me to participate in the Annual Foundation School-I, conducted online during the COVID pandemic. This experience enriched my understanding of Algebra, Complex Analysis, and Topology. During my studies in commutative algebra, I extensively engaged with the works of Atiyah Macdonald and David Eisenbud. These texts, which remain among my favourites, sparked my curiosity to explore further related mathematical fields. My deep dive into algebraic geometry and modular forms was primarily guided by the writings of Diamond and Shurman, alongside the quintessential Hartshorne, a staple for any student in this domain. In November 2020, I was granted the wonderful opportunity to enroll in the Master's program at RPTU Kaiserslautern, a journey that began in April 2021. This opportunity was not just about pursuing higher education; it came with the added benefit of a scholarship and a valuable part-time role as a student research assistant under Dr. Böhm, where I mainly worked on the OSCAR Package to implement some of things from Commutative Algebra and Algebraic

geometry in Computer Algebra systems.

A notable highlight of my academic endeavour has been a reading course under the tutelage of Prof. Claus Fieker and Dr Jeroen Hanselman, centred on the book "The First Course in Modular Forms." This course has significantly enhanced my understanding of various mathematical disciplines, particularly in Modular Forms, Abelian Varieties, and Galois Representations. Complementing this, I have also been exploring sections of the seminal paper by Andrew Wiles and James Taylor on Fermat's Last Theorem, a work that has always captivated me. My Master's thesis, which is a significant focus of my current academic efforts, is designed to introduce and elaborate on the foundational theories related to the Modularity theorem. The goal is to outline the critical components of this theorem, discuss their theory in depth and establish its connection to Fermat's Last Theorem.

In addition to this endeavor, I investigated various aspects of Modular curves in-depth. This includes computing their genus, elliptic points, cusp forms, models, Jacobians, and conductors. Most of these computations are done manually, with a clear and comprehensive explanation of the underlying mathematical or algorithmic principles when computer assistance is used. The past few months have been an incredibly enriching and challenging period, particularly marked by my study of Diamond and Shurman's book. The book's approach, which leaves significant gaps in proofs and exercises for the reader to fill, required me to build a robust foundation in areas such as Modular Forms and Galois Representations, subjects I hadn't previously studied in depth. Additionally, deciphering parts of Wiles' paper, especially the sections on deformation theory and Gorenstein and complete intersection conditions, was a complex but ultimately rewarding task. Understanding Wiles' Criterion was a moment of fulfillment, as it connected back to my longstanding aspiration to comprehend the proof of this groundbreaking theorem since I began my serious pursuit of mathematics. As my thesis nears completion, with its submission due next month, I am in the process of making final corrections and additions. This phase of my academic journey has been both demanding and exhilarating, pushing me to explore new frontiers in mathematics and apply my learning to complex and challenging problems.

My academic interests are deeply rooted in Number Theory and Arithmetic Geometry, with a specific focus on elliptic curves. This encompasses exploring various aspects such as the Birch and Swinnerton-Dyer (BSD) Conjecture and their intricate connections to Modular Forms. Additionally, my interest extends to Algebraic Geometry and the Langlands Program. These areas represent the core of my mathematical pursuits. I also had the privilege of attending several conferences in April and September in Bonn, which were pivotal in broadening my understanding and exposure to contemporary mathematical discussions. Notably, at the Max Planck Institute Bonn, I delivered a speed talk where I discussed an arithmetic function. This function's study, particularly its zeroes, could potentially forge a link to the twin prime conjecture—an area that captivates my interest. While I am extremely fascinated by Analytic Number Theory, I must admit that my exposure to this field has been somewhat limited. My engagement has been primarily through self-studying Prof. Maynard's notes, supplemented by my background in Modular Forms.

I am deeply enthusiastic about the opportunity to pursue a PhD in Number Theory and Arithmetic Geometry at the University of Bristol. My profound interest in these fields is further heightened by the prospect of working under the guidance of esteemed academics such as Prof. Tim Dokchitser, Prof. Andrew Booker and Dr.Celine Maistret. Their pioneering research in these areas resonates with my own academic pursuits and aspirations.

Last year, I explored PhD opportunities in both the US and UK, and was privileged to receive a couple of offers. However, I deferred my plans to September 2024 due to personal health challenges, which further delayed the time to complete my Master's thesis. This interlude allowed me to reassess my academic goals, leading me to the realization that my interests have evolved, aligning more closely with the research themes at the University of Bristol.

The collaborative and innovative environment at the University of Bristol is particularly appealing. I am excited about the prospect of contributing to the ongoing projects led by Prof. Dokchitser and Dr. Maistret, whose work in the areas of algebraic number theory, arithmetic geometry, and their interdisciplinary applications, offer a rich experience of learning and exploration.

My commitment to mathematics has been unwavering, even through challenging times, and I am eager to bring my resilience, passion, and dedication to your esteemed PhD program. I am confident that the University of Bristol will provide the ideal environment for me to thrive and make meaningful contributions to the field of Number Theory and Arithmetic Geometry. Joining your program would be a pivotal step in my academic journey, allowing me to delve deeper into the complexities of mathematics and emerge as a significant contributor to the field.

Thank you for your time and kind consideration.

Research statement

1 Research Interests

My academic interests are deeply rooted in Number Theory, with a specific focus on **elliptic curves**, **diophantine equations** and **modular forms**. This encompasses exploring various aspects such as the Birch and Swinnerton-Dyer (BSD) Conjecture, Modularity of elliptic curves over Number fields and facilitating computations for practical purposes by working on the computational aspect as well. Additionally, my interest extends to Algebraic Geometry and the Langlands Program. These areas represent the core of my mathematical pursuits.

2 Academic work so far

A notable highlight of my academic endeavour has been a reading course under the tutelage of Prof. Claus Fieker and Dr Jeroen Hanselman, centred on the book "The First Course in Modular Forms., [DS05]." This course has significantly enhanced my understanding of various mathematical disciplines, particularly in elliptic curves, Modular Forms, Abelian Varieties, and Galois Representations. Complementing this, I have also been exploring sections of the seminal works by Andrew Wiles and James Taylor on Fermat's Last Theorem [WT95], [TW95], a work that has always captivated me. My Master's thesis, which is a significant focus of my current academic efforts, is designed to introduce and elaborate on the foundational theories related to the Modularity theorem. The goal is to outline the critical components of this theorem, discuss their theory in depth and establish its connection to Fermat's Last Theorem.

In addition to this endeavor, I investigated various aspects of Modular curves in-depth. This includes computing their genus, elliptic points, cusp forms, models, Jacobians, and conductors. Most of these computations are done manually, with a clear and comprehensive explanation of the underlying mathematical or algorithmic principles when computer assistance is used. The past few months have been an incredibly enriching and challenging period, particularly marked by my study of Diamond and Shurman's book. The book's approach, which leaves significant gaps in proofs and exercises for the reader to fill, required me to build a robust foundation in areas such as Modular Forms and Galois Representations, subjects I hadn't previously studied in depth. Additionally, deciphering parts of Wiles' paper, especially the sections on deformation theory and Gorenstein and complete intersection conditions, was a complex but ultimately rewarding task. Understanding Wiles' Criterion was a moment of fulfillment, as it connected back to my longstanding aspiration to comprehend the proof of this groundbreaking theorem since I began my serious pursuit of mathematics. This phase of my academic journey has been both demanding and exhilarating, pushing me to explore new frontiers in mathematics and apply my learning to complex and challenging problems.

I also had the privilege of attending several conferences in April and September in Bonn, which were pivotal in broadening my understanding and exposure to contemporary mathematical discussions. Notably, at the Max Planck Institute Bonn, I delivered a speed talk where I discussed an arithmetic function. This function's study, particularly its zeroes, could potentially forge a link to the twin prime conjecture, an area that captivates my interest. While I am extremely fascinated by Analytic Number Theory, I must admit that my exposure to this field has been somewhat limited. My engagement has been primarily through self-studying Prof. Maynard's notes, supplemented by my background in Modular Forms.

2.1 Some computations: An highlight of Master's thesis work

Consider a positive integer M that divides N. In Serge Lang's work, [Lan95]), a connection is established between the space of modular forms of level M, denoted $S_2(M)$, and the space $S_2(\Gamma_0(N))$. For each divisor d of N/M, there's a degeneracy map $\beta_{M,d}$. This map takes a modular form f in $S_2(M)$ and maps it to $S_2(\Gamma_0(N))$ by transforming $f(q)$ to $f(q^d)$, effectively changing the level of the modular form. The Newspace $S_2(\Gamma_0(N))_{\text{new}}$ is the orthogonal complement of spaces created by all $\beta_{M,d}$ maps.

According to Atkin and Lehner's foundational work, $S_2(\Gamma_0(N))$ decomposes as:

$$S_2(\Gamma_0(N)) = \bigoplus_{\substack{M|N \\ d|N/M}} \beta_{M,d}(S_2(M)_{\text{new}}).$$

To calculate $S_2(\Gamma_0(N))$, we find $S_2(M)_{\text{new}}$ for each divisor M of N, considering images under degeneracy maps.

Using Magma, we define modular symbols of level 38, finding its cuspidal subspace and new form decomposition. The command series used is:

```
M := ModularSymbols(38);
M_cusp := CuspidalSubspace(M);
M_dec := NewformDecomposition(M_cusp);
```

We get the output as follows:

$$f_1 = q - q^2 + q^3 + q^4 - q^6 - q^7 - q^8 - 2q^9 + O(q^{10}) \tag{1}$$
$$f_2 = q + q^2 - q^3 + q^4 - 4q^5 - q^6 + 3q^7 + q^8 - 2q^9 + O(q^{10}) \tag{2}$$
$$g_1 = q - 2q^3 - 2q^4 + 3q^5 - q^7 + q^9 + O(q^{10}) \tag{3}$$

Note that , f_1, f_2 are newforms of level 38 with trivial character and g_1 is a newform of level 19 with trivial character. These align with LMFDB data for the Modular curve $X_0(38)$.

Considering two functions g_1 and $g_2(z) = g_1(2z)$, we prove their linear independence through their q-expansions. The absence of odd powers in g_2's expansion, as it's defined as $g_1(2z)$, is key. The only solution to the equation $c_1 g_1 + c_2 g_2 = 0$ is $c_1 = c_2 = 0$, confirming their independence. The dimension of the newspace is 2, with g_1 and g_2 generating the old space in $S_2(38)$. Thus, f_1, f_2, g_1, g_2 form a basis of $S_2(38)$. g_2 is an image of g_1 under a degeneracy map with $M = 19, d = 2$.

Definition 2.1.1
For each newform $f \in \mathcal{S}_2(\Gamma_0(M_f))$, let

$$A'_f = \mathrm{J}_0(M_f)/I_f\, \mathrm{J}_0(M_f).$$

This is another Abelian variety associated with f.

We have the following thereom:

Theorem 2.1.2 (Isogeneous decomposition)
There is an isomorphism

$$A'_f \xrightarrow{\sim} V_f^{\wedge}/\Lambda'_f \quad \text{where } \Lambda'_f = \mathrm{H}_1(X_0(M_f), \mathbb{Z})|_{V_f}$$

and an isogeny

$$\mathrm{J}_0(N) \longrightarrow \bigoplus_f \left(A'_f\right)^{m_f}$$

where the sum is taken over the equivalence classes of newforms $f \in \mathcal{S}_2\left(\Gamma_0\left(M_f\right)\right)$.

Returning to our computations, the isogenous decomposition of $J_0(38)$ involves newforms from levels 19 and 38, as $S_2(2)$ is trivial. This leads to the conclusion:

$$J_0(38) \cong A'_{f_1} \bigoplus A'_{f_2} \bigoplus (A'_{g_1})^2,$$

where (A'_{g_1}) appears with multiplicity 2 due to the two divisors of 19.

Another application of our computations is that we can compute a model for the modular curve $X_0(38)$. Let $\omega_1, \ldots, \omega_4$ be a basis for the space differential 1-forms $\Omega^1_{\text{hol}}(X_0(38))$. As the canonical divisor is very ample (and $X_0(38)$ can be shown to be non-hyperelliptic), the induced map

$$\begin{aligned} \varphi : C &\to \mathbb{P}^{g-1} \\ P &\mapsto [\omega_1(P) : \cdots : \omega_g(P)]. \end{aligned}$$

will embed C into P^3.

Note that there exists an isomorphism between the space of weight 2 cusp forms $\mathcal{S}_2(\Gamma_0(38))$, $\Omega^1_{\text{hol}}(X_0(38))$. As any non-hyperelliptic genus 4 curve can be written down as a complete intersection of a cubic and a quadric (see, e.g. Example 5.5.2 from [Har77]), finding these kinds of relations between the f_i will give us an equation of the curve. (This method was cleverly used by Galbraith in [Gal].)

As per our computations, we have $f_1(\tau), f_2(\tau)$ newforms of level 38 and $g_1(\tau), g_1(2\tau)$, g_1 being newform of level 19.

We can just plug in the following commands in Magma:

```
M := ModularSymbols(38);
M_cusp := CuspidalSubspace(M);
M_dec := NewformDecomposition(M_cusp);
Relations(CuspidalSubspace(ModularForms(Gamma0(38))), 3, 20);
Relations(CuspidalSubspace(ModularForms(Gamma0(38))), 2, 20);
```

To get the relations of degree 2 and degree 3:

Degree 3: $a^2*c - a*b^2 - a*b*d - a*d^2 - b^2*c - b^2*d - b*c*d - b*d^2 - c^3 - 2*c^2*d - 2*c*d^2 - d^3$,

$a^2*d + a*d^2 - b^3 + 3*b^2*c + 2*b^2*d - 3*b*c^2 - 4*b*c*d - 2*b*d^2 + c^3 + 2*c^2*d + 2*c*d^2 + d^3$,

a*b*c - $b^3 - b^2*d - b*c^2 - b*c*d - b*d^2, a*c^2 - b^2*c - b*c*d - c^3 - c^2*d - c*d^2, a*c*d - b^2*d - b*d^2 - c^2*d - c*d^2 - d^3$

Degree 2: $a*c - b^2 - b*d - c^2 - c*d - d^2$

A quick check in Magma shows that the curve given by:

$$\begin{aligned} x^2w + xw^2 - y^3 + 3y^2z + 2y^2w - 3yz^2 - 4yzw - 2yw^2 + z^3 + 2z^2w + 2zw^2 + w^3, \\ xz - y^2 - yw - z^2 - zw - w^2 \end{aligned}$$

defines a curve of genus 4 which has bad reduction at the primes 19 and 2. This aligns with the properties of the modular curve $X_0(38)$.

3 Why Bristol?

Embarking on a PhD journey in Number Theory at the University of Bristol represents an exciting convergence of a vibrant city life and a rich academic landscape. Bristol, with its lively cultural scene and historical depth, offers a stimulating backdrop that's crucial for maintaining a well-rounded, productive lifestyle during my studies. The

University of Bristol, known for its excellence in Number Theory research, aligns perfectly with my academic aspirations. Its collaborative environment, backed by top-notch facilities, sets the stage for groundbreaking research. The university of Bristol's dedication to fostering a strong academic community is a significant draw. Regular seminars and workshops provide invaluable opportunities for engaging in intellectual discourse, sharing ideas, and building networks vital to a thriving academic career. My enthusiasm for joining Bristol is further fueled by the opportunity to work under the guidance of esteemed academics like Prof. Tim Dokchitser and Dr. Celine Maistret. Their pioneering work in Number Theory and, or Arithmetic Geometry deeply resonates with my research interests. Besides, I also find a lot of interest in the works of Prof. Andrew Booker. His Mathematical style of using computational tools to tackle problems in various branches of Number theory.

After considering offers from a couple of institutions in the US and UK, the alignment of Bristol's research themes with my evolving academic focus became clear, especially after a period of introspection brought on by personal health challenges.

The University of Bristol's collaborative and forward-thinking approach makes it an ideal setting for nurturing my unwavering commitment to mathematics. I am keen to immerse myself in ongoing projects, contributing to and learning from these enriching experiences. My confidence in the University of Bristol as the ideal place for my academic growth and contribution to Number Theory and Arithmetic Geometry is strong. Joining this PhD program would be a pivotal step in my academic journey, allowing me to delve into mathematical complexities and position myself as a significant contributor in the field.

4 Goals for my doctoral research

I do not yet have the specific research problem in my mind. In the available projects listed on the University of Bristol, Professor Tim Dokchitser says, "Most of the things that I do rely heavily on computers and computational algebra systems. I use computer experiments a lot to formulate and to test conjectures, and to get inspiration about their proofs as well". This is something I exactly want to do in my Doctoral studies and may be even for whole of my life, which makes,a compelling case to apply to the University of Bristol. I am fascinated by Numbers and computers. Given an opportunity, I would be happy to discuss the availablity of projects and problems and get started working on the same.

I appreciate your consideration of my application and look forward to the possibility of contributing to the vibrant academic community at Bristol.

References

[DS05] F. Diamond and J. Shurman. *A First Course in Modular Forms.* Graduate Texts in Mathematics. Springer, 2005.

[Gal] Steven Galbraith. *Equations for modular curves.* PhD thesis. Available online: https://www.math.auckland.ac.nz/ sgal018/thesis.pdf.

[Har77] R. Hartshorne. *Algebraic Geometry*, volume 52 of *Graduate Texts in Math.* Springer-Verlag, New York, Berlin, Heidelberg, 1977.

[Lan95] Serge Lang. *Introduction to Modular Forms.* Springer-Verlag, Berlin, 1995.

[TW95] Richard Taylor and Andrew Wiles. Ring theoretic properties of certain hecke algebras. *Annals of Mathematics*, 141:553–572, 1995.

[WT95] Andrew Wiles and Richard Taylor. Modular elliptic curves and fermat's last theorem. *Annals of Mathematics*, pages 443–551, 1995.

(AFFILIATED TO UNIVERSITY OF MUMBAI)
INDIA

TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **BSc (SEM-I to VI)** in the following academic year.

GRADES	MARKS	GRADES POINTS	SGPA/ CGPA
O	70 & Above	7	7 & Above
A	60 to 69.99	6	6 to 6.99
B	55 to 59.99	5	5 to 5.99
C	50 to 54.99	4	4 to 4.99
D	45 to 49.99	3	3 to 3.99
E	40 to 44.99	2	2 to 2.99
F (Fail)	39.99 & Below	1	1 to 1.99

Note : Consider 1 Grade point is equal to zero for CG calculation of failed student/s in the concerned course/s.

SEMESTER	SGPA	GRADE
I	7.00	O
II	7.00	O
III	7.00	O
IV	7.00	O
V	7.00	O
VI	7.00	O
FINAL GRADE	7.00	O

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019.

UNIVERSITY OF MUMBAI
INDIA
TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **F.Y.BSc (SEMESTER-I)** in the following academic year.

F.Y.BSc (SEMESTER-I) : Month & Year Of Examination October - 2015
EXAM.SEAT NO : C - 5809

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
USFC 101	FOUNDATION COURE-I	16	02	O	07	14
USPH 101	PHYSICS-I	16	02	O	07	14
USPH 102	PHYSICS-II	16	02	O	07	14
USPHP 1	PHYSICS PRACTICAL	16	02	O	07	14
USMT 101	MATHEMATICS-I	16	03	O	07	21
USMT 102	MATHEMATICS-II	16	03	O	07	21
USST 101	STATISTICS-I	16	02	O	07	14
USST 102	STATISTICS-II	16	02	O	07	14
USSTP 1	STATISTICS PRACTICAL	16	02	O	07	14
	TOTAL	**16**	**20**	**---**	**---**	**140**
SGPA : 7.00				**Grade: O**		
Remark : PASS						**NOV 2015.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019

UNIVERSITY OF MUMBAI
INDIA
TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **F.Y.BSc (SEMESTER-II)** in the following academic year.

F.Y.BSc (SEMESTER-II) : Month & Year Of Examination March - 2016
EXAM.SEAT NO : C - 5809

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
USFC 201	FOUNDATION COURE-I	16	02	O	07	14
USPH 201	PHYSICS-I	16	02	O	07	14
USPH 202	PHYSICS-II	16	02	O	07	14
USPHP 2	PHYSICS PRACTICAL	16	02	O	07	14
USMT 201	MATHEMATICS-I	16	03	O	07	21
USMT 202	MATHEMATICS-II	16	03	O	07	21
USST 201	STATISTICS-I	16	02	O	07	14
USST 202	STATISTICS-II	16	02	O	07	14
USSTP 2	STATISTICS PRACTICAL	16	02	O	07	14
	TOTAL	**16**	**20**	**---**	**---**	**140**
SGPA : 7.00				**Grade: O**		
Remark : PASS						**APRIL 2016.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019.

UNIVERSITY OF MUMBAI
INDIA
TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **S.Y.BSc (SEMESTER-III)** in the following academic year.

S.Y.BSc (SEMESTER-III) : Month & Year Of Examination Dec-2016
EXAM.SEAT NO.: C – 6865 (ADD. EXAM)

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
UAFC 301	FOUNDATION COURE-II	16	02	O	07	14
USMT 301	MATHEMATICS-I	16	03	O	07	21
USMT 302	MATHEMATICS-II	16	03	O	07	21
USMT 303	MATHEMATICS-III	16	03	O	07	21
USST 301	STATISTICS-I	16	02	O	07	14
USST 302	STATISTICS-II	16	02	O	07	14
USST 303	STATISTICS-III	16	02	O	07	14
USSTP 3	STATISTICS PRACTICAL	16	03	O	07	21
TOTAL		**16**	**20**	**---**	**---**	**140**
SGPA : 7.00				**Grade: O**		
Remark : PASS						**FEB 2017.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnaraln Ruia Autonomous College,
Matunga, Mumbai - 400019

UNIVERSITY OF MUMBAI
INDIA
TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **S.Y.BSc (SEMESTER-IV)** in the following academic year.

S.Y.BSc (SEMESTER-IV) : Month & Year Of Examination April-2017
EXAM.SEAT NO.: C - 6865

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
USFC 401	FOUNDATION COURE-II	16	02	O	07	14
USMT 401	MATHEMATICS-I	16	03	O	07	21
USMT 402	MATHEMATICS-II	16	03	O	07	21
USMT 403	MATHEMATICS-III	16	03	O	07	21
USST 401	STATISTICS-I	16	02	O	07	14
USST 402	STATISTICS-II	16	02	O	07	14
USST 403	STATISTICS-III	16	02	O	07	14
USSTP 4	STATISTICS PRACTICAL	16	03	O	07	21
	TOTAL	**16**	**20**	**---**	**---**	**130**
SGPA : 7.00				**Grade: O**		
Remark : PASS						**APR 2017.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019

(AFFILIATED TO UNIVERSITY OF MUMBAI)
INDIA

TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **BSc (SEMESTER-V)** in the following academic year.

BSc (SEMESTER-V) : Month & Year Of Examination October-2017
EXAM.SEAT NO.: 53508

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
MATHEMATICS						
RUSMAT 501	INTEGRAL CALCULUS	16	2.5	O	07	17.5
RUSMAT 502	LINEAR ALGEBRA	16	2.5	O	07	17.5
RUSMAT 503	TOPOLOGY OF METRIC SPACES	16	2.5	O	07	17.5
RUSMAT 504	GRAPH THEORY	16	2.5	O	07	17.5
RUSMATP 501	PRACTICAL OF RUSMAT501+RUSMAT502	16	3.0	O	07	21.0
RUSMATP 502	PRACTICAL OF RUSMAT503+RUSMAT504	16	3.0	O	07	21.0
RUSACMAT 501	APPLIED COMPONENT COMPUTER PROGRAMMING AND SYSTEM ANALYSIS-I	16	2.0	O	07	14.0
RUSACMATP 501	PRACTICAL OF RUSACMAT501	16	2.0	O	07	14.0
TOTAL		**16**	**20**	**---**	**---**	**140**
CGPA : 7.00			**Grade: O**			
Remark : SUCCESSFUL						**DEC 2017.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019

(AFFILIATED TO UNIVERSITY OF MUMBAI)
INDIA

TRANSCRIPT

This is to Certify that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this College and he has completed **BSc (SEMESTER-VI)** in the following academic year.

BSc (SEMESTER-VI) : Month & Year Of Examination March-2018
EXAM.SEAT NO.: 622498

THEORY

Course code	Course Title	Weeks Per Semester	Credits Earned (C)	Grade	Grade Points (G)	C x G
MATHEMATICS						
RUSMAT 601	REAL AND COMPLEX ANALYSIS	16	2.5	O	07	17.5
RUSMAT 602	ALGEBRA	16	2.5	O	07	17.5
RUSMAT 603	METRIC TOPOLOGY	16	2.5	O	07	17.5
RUSMAT 604	GRAPH THEORY	16	2.5	O	07	17.5
RUSMATP 601	PRACTICAL OF RUSMAT601+RUSMAT602	16	3.0	O	07	21.0
RUSMATP 602	PRACTICAL OF RUSMAT603+RUSMAT604	16	3.0	O	07	21.0
RUSACMAT 601	COMPUTER PROGRAMMING AND SYSTEM ANALYSIS-II	16	2.0	O	07	14.0
RUSACMATP 601	PRACTICAL OF RUSACMAT601	16	2.0	O	07	14.0
TOTAL		**16**	**20**	**---**	**---**	**140**
CGPA : 7.00			**Grade: O**			
Remark : SUCCESSFUL						**MAY 2018.**

THE MEDIUM OF INSTRUCTION WAS IN ENGLISH.
DATE : 25 OCT 2018

RAMNARAIN RUIA AUTONOMOUS COLLEGE 1937 MUMBAI-19

I/C Registrar
Ramnarain Ruia Autonomous College,
Matunga, Mumbai - 400019.

Date : 25/10/2018

To Whomsoever it May Concern

This is to inform you that **Mr. SANT AKSHAY MANOJ SONALI** was a bonafide student of this college . He had appeared for FYBSc, SYBSc & TYBSc (Mathematics) (Sem-I to Sem-VI) Credit System University of Mumbai examination in the academic year 2015 to 2018 and obtained 4843 marks out of 5100 marks. He has secured 94.96% which has been calculated on the basis of his FYBSc, SYBSc & TYBSc Semester I to VI marks

Year	Semester	Marks Out of	Obtain	SGPA	Grade	Percentage
FYBSc	I	900	818	7.00	O	90.89%
	II	900	822	7.00	O	91.34%
SYBSc	III	850	812	7.00	O	95.53%
	IV	850	829	7.00	O	97.53%
TYBSc	V	800	791	7.00	O	98.87%
	VI	800	771	7.00	O	96.37%
Aggregate	-	5100	4843	7.00	O	94.96%

PRINCIPAL
RAMNARAIN RUIA COLLEGE
MATUNGA, MUMBAI - 400 019

Transcripts

This file contains compilation of Postgraduate and undergraduate transcripts.
Note: Page 2 and 3 of this document are the latest official transcripts of my Masters degree but are in German language. I had requested latest official English transcripts but the person responsible for the same is away due to the health reasons and now due to holiday reasons. Nevertheless, I was advised to use the English version available on the official website of our University. This is Page 4 of this document. I had requested the department for the official English transcripts at the begining of January, this year. Page 5 and Page 6 are official transcripts in English with all the notes at the end of Page 6. This will certainly help as to compare latest version which is in German as opposed to the English version.

I will nevertheless mention important things in case if there are still some doubts.
Modul/Kurs: This means Module/Course names.
LP: This means credit points
Third column mentions the name of professors with whom I have taken the course and given the exam.

Page 6 also mentions refrence for understanding grades. 1.0 to 1.5 means very good and 1.6-2.5 means good.

Rheinland-Pfälzische
Technische Universität
Kaiserslautern
Landau

Master Transcript

Akshay Sant

Studiengang: **Mathematics International (Master)**
Vertiefung: Algebra und Zahlentheorie

Mat.-Nr.: **420212**
Geb.Datum: **19.04.1998**
Geburtsort: **Kalyan, Mumbai, Indien**

Bisher wurden folgende Studien- und Prüfungsleistungen erbracht[1]:

Modul/Kurs	Note	Prüfer*in/Betreuer*in	LP
Sommersemester 2021			
Character Theory of Finite Groups; p-adic Numbers	1,3#	Prof. Dr. Malle	9
Algebraic Number Theory	1,7	Prof. Dr. Fieker	9
Plane Algebraic Curves	1,0	Dr. Eder	4,5
Deutsch als Fremdsprache (Niveau B-2.1)	3,3*	Krier	6
Summe Leistungspunkte (LP)			**28,5**
Wintersemester 2021/22			
Commutative Algebra	1,3#	Prof. Dr. Thiel	9
Computer Algebra	1,0	Dr. Böhm	9
Cohomology of Groups	1,0	Jun. Prof. Dr. Lassueur	9
Plane Curve Singularities	1,0	Dr. Böhm	4,5
Seminar Topics in Algebra and Geometry	BE*	Prof. Dr. Schulze	3
Summe Leistungspunkte (LP)			**34,5**
Sommersemester 2022			
Cryptography	1,3	Dr. Kunte	9
Übung Functional Analysis	BE*	Prof. Dr. Grothaus	3
Regression and Time Series Analysis	2,7	Prof. Dr. Redenbach	9
Seminar Representation Theory of the Symmetric Group	BE*	Prof. Dr. Malle	3
Summe Leistungspunkte (LP)			**24**

(Fortsetzung auf Seite 2)

E-Mail: dekanat@math.rptu.de
Tel.: +49 (0)631/205-2251

(Siegel)

Prüfungsamt Mathematik
Ausstelldatum: **27.06.2023**

Modul/Kurs	Note	Prüfer*in/Betreuer*in	LP
Wintersemester 2022/23			
Algorithmic Number Theory	1,3	Prof. Dr. Fieker	9
Reading Course Modular Forms and Abelian Varieties	BE*	Prof. Dr. Fieker, Dr. Hanselman	12
Summe Leistungspunkte (LP)			21
Leistungspunkte insgesamt			**108**

Des Weiteren liegen folgende Meldungen zu Prüfungen vor:

Modul/Kurs	Datum	LP
Sommersemester 2023		
Functional Analysis		(6)
Quadratic Number Fields*		(3)
Riemannian Surfaces*		(3)
Summe Leistungspunkte (LP)		(12)

Thema der Masterarbeit ist: "Modularity and Fermat's Last Theorem".

Abgabefrist ist der 22. November 2023.

Zum Bestehen der Masterprüfung fehlt nur noch die Masterarbeit (30 LP) und die gemeldete Prüfung zu "Functional Analysis" (6 LP).

(Siegel)

Dr. habil. Christoph Lossen
(Geschäftsführer Fachbereich Mathematik)

* Studien- bzw. Zusatzleistung, das Erbringen als benotete Leistung ist freiwillig.

Diese Leistungen wurden im Rahmen der Auflagen zur Zulassung zum Masterstudium erbracht.

[1] Aufgeführt sind sowohl alle bestandenen als auch alle nicht bestandenen Prüfungsleistungen.

Noten: 1,0 – 1,5: sehr gut, 1,6 – 2,5: gut, 2,6 – 3,5: befriedigend, 3,6 – 4,0: ausreichend, 5,0: nicht ausreichend (nicht bestanden)
NE: nicht erschienen, NFA: nicht fristgerecht angetreten, BE: bestanden.

E-Mail: dekanat@math.rptu.de
Tel.: +49 (0)631/205-2251

Prüfungsamt Mathematik
Ausstelldatum: 27.06.2023

Degree: [88] Master's degree program: [706] Mathematics International Specialization: [ ]								
Exam no.	Exam text	semester	grade	status	bonus	note	Attempt	Exam date
6001	Application for approval submitted	Summer semester 21		passed	0		1	June 4, 2021
88499	German as a foreign language	Summer semester 21	3.3	passed	6		1	September 6, 2021
	Additional text: *"German as a foreign language (level B-2.1)"*							
9998	**Total points account**	**Summer semester 23**			**87**			
1100	**pads**	**WiSe 21/22**	**0.0**	**passed**	**0**			
84120	Commutative algebra	WiSe 21/22	1.3	passed	9		1	February 21, 2022
84133	Character Theory of Finite Groups; p-adic Numbers	WiSe 21/22	1.3	passed	9		1	October 28, 2021
2000	**Pure mathematics**	**WiSe 21/22**		**passed**	**18**			
84112	Plan Algebraic Curves	Summer semester 21	1.0	passed	4.5		1	September 22, 2021
86170	Computer algebra	WiSe 21/22	1.0	passed	9		1	April 22, 2022
86356	Plan Curve Singularities	WiSe 21/22	1.0	passed	4.5		1	May 4, 2022
3000	**Applied Mathematics**	**Summer semester 22**		**Account**	**18**			
84160	Cryptography	Summer semester 22	1.3	passed	9		1	September 28, 2022
84330	Regression and Time Series Analysis	Summer semester 22	2.7	passed	9		1	September 23, 2022
4000	**Study focus**	**Summer semester 23**		**passed**	**39**			
84130	Algorithmic Number Theory	WiSe 22/23	1.3	passed	9		1	April 18, 2023
86117	Algebraic Number Theory	WiSe 21/22	1.7	passed	9		1	October 6, 2021
86156	Cohomology of Groups	WiSe 21/22	1.0	passed	9		1	April 26, 2022
88112	Reading Course 12	Summer semester 23	0.0	passed	12		1	
	Additional text: *"Reading Course Modular Forms and Abelian Varieties"*							
5000	**Seminars**	**Summer semester 22**		**passed**	**6**			
87110	Seminar (Algebra and ZT)	Summer semester 22	0.0	passed	3		1	
	Additional text: *"Seminar Representation Theory of the Symmetric Group"*							
87120	Seminar (Algebraic Geometry)	WiSe 21/22	0.0	passed	3		1	
	Additional text: *"Seminar "Topics in Algebra and Geometry""*							
6000	**Non-mathematical elective**	**Summer semester 21**		**passed**	**6**			
88499	German as a foreign language	Summer semester 21	3.3	passed	6		1	September 6, 2021
	Additional text: *"German as a foreign language (level B-2.1)"*							

Rheinland-Pfälzische
Technische Universität
Kaiserslautern
Landau

Academic Record

Akshay Sant

Course of Study: **Mathematics International (Master)**
Specialisation: Algebra and Number Theory

Student Id: **420212**
Birth Date: **19.04.1998**
Birth Place: **Kalyan, Mumbai, India**

So far, the following achievements were accomplished[1]:

Study Achievement (Subject/Title of Course)	Grade	Examiner/Supervisor	CP
Summer Term 2021			
Character Theory of Finite Groups; p-adic Numbers	1.3#	Prof. Dr. Malle	9
Plane Algebraic Curves	1.0	Dr. Eder	4.5
Algebraic Number Theory	1.7	Prof. Dr. Fieker	9
German as a Foreign Language (Level B-2.1)	3.3*	Krier	6
Credit Points			28.5
Winter Term 2021/22			
Commutative Algebra	1.3#	Prof. Dr. Thiel	9
Computer Algebra	1.0	Dr. Böhm	9
Cohomology of Groups	1.0	Jun. Prof. Dr. Lassueur	9
Plane Curve Singularities	1.0	Dr. Böhm	4.5
Seminar Topics in Algebra and Geometry	passed*	Prof. Dr. Schulze	3
Credit Points			34.5
Summer Term 2022			
Cryptography	1.3	Dr. Kunte	9
Regression and Time Series Analysis	2.7	Prof. Dr. Redenbach	9
Exercise Class Functional Analysis	passed*	Prof. Dr. Grothaus	3
Seminar Representation Theory of the Symmetric Group	passed*	Prof. Dr. Malle	3
Credit Points			24
Aggregate credit points (ECTS)			**87**

(Continued on Page 2)

E-Mail: dekanat@math.rptu.de
Phone: +49 (0)631/205-2251

Examination Office Mathematics
Date: **05.01.2023**

Moreover, the student has registered for the following exams:

Subject/Title of Course	Date	CP
Winter Term 2022/23		
Elliptic Functions and Elliptic Curves		(3)
Algebraic Geometry		(9)
Algorithmic Number Theory		(9)
Functional Analysis		(6)
PDE: An Introduction		(3)
Credit Points		(30)

(Seal)

Administrative Director of the Examination Office

* These achievements are not considered for the results and the aggregate mark.

\# These achievements were part of the additional requirements for being admitted to the master's programme.

[1] All exams taken (including the failed exams) are listed.

Grades: 1.0 – 1.5: very good, 1.6 – 2.5: good, 2.6 – 3.5: satisfactory, 3.6 – 4.0: sufficient, 5.0: not sufficient (not passed)
NE: did not appear, NFA: not registered in time, Rep.: Repetition

Topics studied in the past 2 years:

Here, I state the topics/courses I have studied/taken with a brief explanation of the content. For the exams I have, taken I will also mention the grades next to the courses. I have attended some courses just for gaining knowledge and some exams didn't fit in the exam plan as my university has a strict plan about credits coming some divisions of Mathematics.

For german grading system, 1.0 and 1.3 translate to Very good grades and are two of the highest grades, next 1.7, 2.0, 2.3 are considered good and 2.7, 3.0,3.3 are considered average.

1) **Commutative Algebra(1.3)**:
Basic revision of Ring theory, Spectrum of a ring, Zariski topology, the Galois connection between closed subsets and radical ideals, Theory of Modules, Localization, Integrality, Nullstellensatz, Noetherian rings and modules, Artinian modules and rings, Krull's principal ideal theorem, Regular sequences, Dedekind domains and Primary decomposition.

2) **Plane Algebraic curves(1.0)** :
Affine and projective curves, Intersection multiplicities, Bezout's theorem, Functions and divisors on a curve, Elliptic curves and The Riemann-Roch theorem.

3) **Character theory of Finite groups(1.3)**:
Linear representations and characters Character tables, orthogonality relations Burnside's theorem, Restriction, induction, inflation, tensor products, Clifford theory.

4) **P-adic numbers(1.3)**:
Basic theory of valuations, complete valued fields, p-adic analysis, Algebraic extensions of $\mathbb{Q}_p$, The Newton polygon, Ramified and unramified extensions of $\mathbb{Q}_p$.

5) **Algebraic Number theory(1.7)** :
Quadratic forms over $\mathbb{Q}_p$ and $\mathbb{Q}$, Theory of local and global fields, Krasner's lemma, classification of unramified, totally ramified and tamely ramified extensions, Weil differentials, Adeles, Riemann-Roch theorem, Algebraic codes.

6) **Computer Algebra(1.0)**:
Monomial orderings, division with remainder, normal forms, standard bases, Bucherger's and Mora's algorithm, Ideal and module membership, radical membership, intersections, quotient, saturation, elimination, Smith normal form, Free resolutions, Hilbert's Syzygy Theorem, Primary decomposition, Hilbert series, Hilbert polynomial, Dimension theory, Noether normalization.

7) **Plane Curve Singularities(1.0)**:
Parametrization of plane curves, Puiseux series, Newton polygons, value semigroups, characteristic exponents, resolution of plane curve singularities.

8) **Cohomology of Groups(1.0)**:
Semidirect products of groups, Presentations of groups, Homological algebra, Homology and cohomology of groups, Cohomology and group extensions,The Schur multiplier and central extensions, Projective representations.

9) **Cryptography(1.3)**:
Cryptosystems, Stream and block ciphers, Frequency analysis, Modern ciphers, Factorization of large numbers, RSA, Primality tests, Discrete logarithm, Diffie-Hellman key exchange, ElGamal encryption, hash functions, signature, Elliptic curve cryptography (ECC), Attack on the discrete logarithm problem, Factorization algorithms (e.g. quadratic sieve, Lenstra).

10) **Algorithmic Number theory(1.3)**:
Free $\mathbb{Z}-$modules, Orders and computation of Maximal order in a number field, Lattices and Minkowski Theory, Dedekind domains and the class group and computation of the class group and the Number field sieve.

11) **Algebraic Geometry**:(Could not take the exam due to health reasons and then the exam wasn't offered and wasn't also needed to take the exam as the credit requirements for Masters degree were already met)
Affine Varieties, The Zariski Topology, The Sheaf of Regular Functions, Morphisms, Varietie, Projective Varieties I: Topology, Projective Varieties II: Ringed Spaces, Grassmannians, Birational Maps and Blowing Up, Smooth Varieties, The 27 Lines on a Smooth Cubic Surface, Schemes, Sheaves of Modules, Quasi-coherent Sheaves, Differentials, Cohomology of Sheaves.

Following are some of the extra courses I attended without taking exams:
Quadratic Number fields,
Riemann surfaces,
Class field theory.

I have also taken following **seminars** during my postgraduate studies and gave a talk in both of them:
Seminar on Algebraic geometry, Cohen-Macaulay Rings
Seminar: Representation theory of finite Symmetric groups.

IELTS™

Test Report Form

ACADEMIC

NOTE *Admission to undergraduate and post graduate courses should be based on the ACADEMIC Reading and Writing Modules. GENERAL TRAINING Reading and Writing Modules are* ***not*** *designed to test the full range of language skills required for academic purposes. It is recommended that the candidate's language ability as indicated in this Test Report Form be re-assessed* ***after two years*** *from the date of the test.*

Centre Number	IN001	Date	15/SEP/2018	Candidate Number	195690

Candidate Details

Family Name	SANT
First Name	AKSHAY MANOJ
Candidate ID	L4800945
Date of Birth	19/04/1998
Sex (M/F)	M
Scheme Code	Private Candidate
Country or Region of Origin	
Country of Nationality	INDIA
First Language	MARATHI

Test Results

Listening	Reading	Writing	Speaking	Overall Band Score	CEFR Level
7.5	6.5	6.5	6.5	7.0	C1

Administrator Comments

Centre stamp

Validation stamp

Administrator's Signature

Date 28/09/2018

Test Report Form Number 18IN195690SANA001A

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Department of Mathematics

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Department of Mathematics
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Phone +49 (0) 631 205 3927
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Kaiserslautern
11.01.2023

Certification

This is to certify that **Mr. Akshay Sant**, born on 19 April 1998 in Kalyan / India, is a full-time student in the Master Programme "Mathematics International".

The language of instruction in the Master Programme "Mathematics International" at RPTU Kaiserslautern-Landau is English.

Yours faithfully,

(Dr. Falk Triebsch)

Rheinland-Pfälzische Technische Universität 25 Kaiserslautern-Landau

Rheinland-Pfälzische
Technische Universität
Kaiserslautern
Landau

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Selection Committee PhD Programme
University of Bristol

Kaiserslautern
January 4, 2024

Recommendation letter Akshay Sant

To whom it may concern,

It is my pleasure to recommend Akshay Sant for a PhD position at the University of Bristol. Akshay finished writing his Master thesis supervised by me and Prof. Dr. Claus Fieker on the topic of Modularity and the proof of Fermat's Last Theorem.

I met Akshay in early 2022 when he was interested in doing a reading course on the Langlands program. He was looking for someone to supervise him on this topic and as we didn't have a real expert on the topic. Professor Fieker suggested that I could supervise a reading course on the Modularity Theorem, which could serve as a light introduction to the concepts behind the Langlands program.

Since then I have had frequent discussions with Akshay about the topics of Elliptic curves, modular curves, Jacobians and modular forms and I've co-supervised the Master thesis he is almost finished with.

Akshay is a very curious and polite person who is extremely interested in all kinds of mathematics. He is very motivated to understand difficult material and is not afraid to ask questions if he doesn't understand something completely. He has also showed initiative by attending lectures, conferences and workshops on his own accord to further increase his knowledge of arithmetic geometry.

As I haven't supervised any other Master theses yet I can only compare Akshay to Master students I have taught exercise classes in algebraic geometry and number theory to. The sample size would be about 20 students. Of these I'd say Akshay is in the top 15%.

Akshay has a good grasp of English. He might phrase things a bit oddly from time to time, which most likely has to do with him speaking Indian English, but it is never difficult to understand what he means.

Based on my interactions with Akshay I believe he would make for an excellent PhD

student and I can therefore recommend him for this position.

Yours sincerely,

Dr. Jeroen Hanselman

Fachbereich Mathematik

Rheinland-Pfälzische Technische Universität Kaiserslautern Landau

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E-Mail malle@mathematik.uni-kl.de

To whom it may concern

Kaiserslautern
01.12.2023

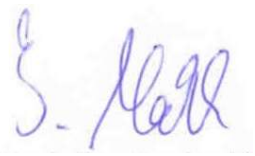
Unser Zeichen
Ma/Mee

Letter of Reference for Akshay Sant

Akshay Sant is currently studying mathematics at our department in Kaiserslautern. He will soon submit his thesis written under the supervision of Jeroen Hanselmann in the area of number theory.

I know Mr. Sant from a number of courses he attended and one seminar. In the courses on “p -Adic Numbers" and on “Character Theory" he also took the oral exam with me (with the grade “very good"), while in the course on “Algebraic Number Theory" he had already taken the exam with my colleague beforehand. Presently he is following my course on “Modular Representation Theory". In all of these courses he caught my attention by his vivid interest and by the questions he asked which showed his quick understanding and his ability to see connections to other areas. In my seminar on the “Representation Theory of Symmetric Groups" he gave a very well prepared and presented talk.

It is my impression that Mr. Sant is very keen to learn and to do interesting mathematics. He certainly is among the best students I have had here in my courses here in Kaiserslautern. Even though I did not supervise any thesis or research work of his, I consider him to be a suitable candidate for your PhD programme.



Prof. Dr. Gunter Malle

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dr-claus-fieker

Kaiserslautern
January 5, 2024

Akshay Sant

To whom it might concern

this is to support the application of Akshay Sant to the PhD programme in mathematics for the University of Bristol.

I know Akshay as an extremely motivated and gifted student from several of my lectures (number theory) and, more recently a reading course. Since in Kaiserslautern the student numbers are quite low, currently, numerical ranking is hard, but I would put him into the top 10%.

His topic for his MSc thesis is the proof of Fermat's last theorem and he devoted the last semester to careful background studies (the reading course) in preparation for his thesis.

Akshay is a hard and careful worker who always participated well in class. He does not shy away from hard material, but puts the necessary time in to master it.

I would not hesitate to accept him as a PhD student myself, however, his interests in arithmetic geometry are much better met in Bonn (and currently I cannot offer any positions).

In summary: to fully support his application - Akshay will be a good PhD student!

Greetings

Prof. Dr. Claus Fieker