

Personal details

Personal details

First / given name Ayesha
Second given name
Third given name
Surname/family name Bennett
Date of birth 08 January 2002
Preferred first/given name Ayesha
Previous surname
Country of birth England
Legal nationality British National
Dual nationality
Country of residence United Kingdom
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 England
Postcode LS8 2JB
Address Line 1 11 Oakwood Drive
Address Line 2
City Leeds
County West Yorkshire
Telephone 07921950471

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 England
Postcode NW1 8PT
Address Line 1 39 Castle Road
Address Line 2
City London
County
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 Full Time
programme?

Qualifications

Qualifications

Institution	Qualification	Type	Subject	Actual/predicted	Grade	Start date	End date
University College London (UCL)	Master's Degree (PG)	Academic Qualification	Mathematics	Predicted	1st	26/Sep/2020	01/Jul/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? Yes

What is your first language?

Did you study at school/university where you were taught in English?

For how many years?

Have you sat a relevant English language test?

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

UKVI number (if applicable)

Date of IELTS test

IELTS listening score

IELTS reading score

IELTS writing score

IELTS speaking score

IELTS total score

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 University College London, Gower St, London WC1E 6BT

Job title and main duties Transition Mentor at UCL. I am responsible for mentoring First Year Mathematics students at UCL, and their first point of contact for their academic and social challenges.

Full time/Part time Part time

Date of Appointment 01 September 2023

End date (if applicable) 18 December 2023

Previous employment 1

Employer name and address My Tutor, Online

Job title and main duties Tutor. I am currently working as an online tutor as part of the online platform My Tutor since 2021. I teach Maths, Physics and English. I devise and adapt bespoke lesson plans for each tutee, and have a wide experience with varied age groups.

Full time/Part time Part time

Date of Appointment 01 February 2021

End date (if applicable)

Previous employment 2

Employer name and address University of British Columbia, Vancouver, BC V6T 1Z4, Canada

Job title and main duties Undergraduate Teaching Assistant During my year abroad (2022), I worked as an Undergraduate Teaching Assistant at University British Columbia. I was responsible for grading (and providing feedback) on homework sets of First Year Mathematics students.

Full time/Part time Part time

Date of Appointment 01 September 2022

End date (if applicable) 19 December 2022

Previous employment 3

Employer name and address Aire Logic/Nightglass, Aire Street, Leeds LS1 4HT.

Job title and main duties Software Engineer Intern. Coding experience in JSON, XML/XPath and building APIs. Adopting Agile methodology to distribute tasks and leading the team as Scrum Master to improve the roster system for junior doctors.

Full time/Part time Part time

Date of Appointment 01 July 2021

End date (if applicable) 16 August 2021

Other Experience

Do you have any other relevant work experience to support your application? No

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 Henna Koivisalo

Proposed supervisor 1 Oleksiy Klurman

Proposed project title Topics in Geometric Measure Theory, Number Theory and Fractal Geometry
(max 150 chars)

Passport and visa

Visa required

Do you require a visa to study in the UK? No

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?

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 Rod

Surname Halburd

Position Professor of Mathematics

Institution/Company University College London

Email address r.halburd@ucl.ac.uk

Country England

Referee 2

Do you have a second reference to upload? No

Type of reference Academic

Referee title Professor

Forename Malabika

Surname Pramanik

Position Professor of Mathematics

Institution/Company University of British Columbia

Email address malabika@math.ubc.ca

Country Canada

Funding

Funding 1

What is your likely source of funding? Engineering and Physical Sciences Research Council

Please give the name of your scholarship or Studentship

Please specify

Percentage from this source 100

Is this funding already secured? No

Funding 2

What is your likely source of funding? Other

Please give the name of your scholarship or Studentship

Please specify I would like to be considered for Heilbronn Doctoral Partnership (in addition to all other available funding sources)

Percentage from this source 100

Is this funding already secured? No

Funding 3

What is your likely source of funding? University of Bristol scholarship

Please give the name of your scholarship or Studentship

Please specify

Percentage from this source 100

Is this funding already secured? No

Other funding

I would like to be considered for other funding opportunities Yes

Documents

Document type	File name
Degree certificate	Letter of Student Status.pdf
Personal statement	Bristol Personal Statement.pdf
Transcript	Official UCL Transcript.pdf
Curriculum vitae	Anonymous CV.pdf
References	Ayesha_Bennett_2023_Signed.pdf
Research proposal	Bristol Research Statement.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 significant 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.

Higher Education

2020-present: Mathematics MSci (4-year integrated Masters), University College London (UCL).

- Graduating Summer 2024; predicted grade: First Class.
- Current Average (after 3 years): 84%. (notable course grades: above 90% in eight modules - 99% Graph Theory, 92% Harmonic Analysis, 97% Modern Differential Geometry).

2022-2023: Study Abroad Student, Department of Mathematics, University British Columbia.

- Selected from a competitive application process to study at University British Columbia.
- Recipient of the Turing scholarship (£3500) after a competitive application process.
- Completed a research project "On Khinchin's Theorem in the theory of Continued Fractions" spanning both number theory and measure theory, supervised by Professor Pramanik.
- Delivered an extensive presentation of my research project within the Harmonic Analysis and Fractal Geometry PhD seminar program.

Secondary Education

2018-2020: Roundhay Sixth Form, Leeds.

- A Levels in English Literature, Mathematics, Physics and Further Mathematics. All Grade A* (the highest grade).
- Recipient of the Class of 2020 Outstanding Achievement award.

2011-2018: Roundhay High School, Leeds.

- GCSEs in English Literature, English Language, Mathematics, Physics, Chemistry, Biology, Spanish, History, Geography. All Level 9 (the highest grade). This was achieved by only 732 students nationally, out of more than half a million students taking GCSEs in 2018.
- AQA Level 1/2 Certificate in Further Mathematics. A* with Distinction (the highest grade).

Work Experience

2018 (June): Shadowed a barrister at Park Square Chambers, Leeds LS1 2LW.

- Participated in formal court procedures that required strict etiquette such as sitting alongside the defending barrister.
- Worked with both a Circuit and a District Judge.
- Edited closing statements that were subsequently read out in court.

Internships

2021 (July-August): Aire Logic/Nightglass, Aire Street, Leeds LS1 4HT.

- Coding experience in JSON and XML/XPath and building program interfaces (APIs).
- Adopting Agile methodology to distribute tasks, and leading the team as Scrum Master.
- Collaborating with two separate organisations and five other interns on a project to improve the roster system for junior doctors.

2019 (July): Environmental Systems Research Institute (ESRI) UK, Aylesbury HP21 7QG.

- Software experience using ArcGIS.
- Presenting an individual project to a board from the company, demonstrating how mapping the locations in Mary Shelley's novel *Frankenstein* made evident structures of gender and social inequalities that were otherwise hidden.

Employment and Volunteering

2023 (September-present): Transition mentor at UCL, London

- Responsible for mentoring First Year Mathematics students at UCL.
- First point of contact for their academic and social challenges.

2023 (July-August): GOTOCO <https://www.go-to.co/> International Participant, Poland.

- Working to achieve the TESOL certificate (to teach English as a foreign language).
- One to one speaking sessions with children.
- Responsible for the full-time safety of children aged 11-18.

2022 (September-December): Undergraduate Teaching Assistant, University British Columbia.

- Responsible for grading (and providing feedback) on homework sets of First Year Mathematics students.

2020 (March-present): My Tutor. Online Tutor in Maths, Physics and English.

- Devising and adapting bespoke lesson plans for each tutee. Wide experience with varied age groups and requirements from age 7-18 (A Level).
- Crafting detailed lesson reports for parents of tutees when requested.
- Experience of both face to face and online tutoring.

2019-2021 (August): Mi Sports Summer Camp, London and Rounders Summer Camp, Leeds.

- Leading sporting and team building activities for children aged 2-13.
- Supervising children with special needs or specific dietary requirements.

2018 (May) and 2017 (September): Roundhay High School, Leeds.

- Volunteering in English Department, helping disadvantaged children develop literacy skills.

Other Achievements

- UCL Women's Football Club First Team (UCLWFC) Captain for the 2021/22 season.
- Committee member and First Team player for UCLWFC (2020-22).
- Involved in university-based projects (e.g ThisGirlCan) to encourage women into sports.
- Represented my High School and Sixth Form in sports including football, hockey, tennis, badminton, rounders, athletics, and netball.
- Finalist on The Big Deal, a national team-based Dragon's Den style competition (2016).
- Selected to discuss the impact of period poverty on girls in the UK on national television -- the ITV Calendar program (2019)
- Play the clarinet, recorder, and piano to varying grades.
- Achieved Bronze, Silver and Gold Duke of Edinburgh awards.

**Term address**

39 Castle Road
London
NW1 8PT
United Kingdom

22 December 2023

Home address

11 Oakwood Drive
Leeds
LS8 2JB

STATEMENT OF STUDENT STATUS

This is to confirm that the student's current status at UCL is as follows:

Student Number:	20009507
Full Name as registered:	Ms Ayesha Oonagh Velani Bennett
Qualification:	Master in Science
Programme of Study:	MSci Mathematics
Department:	Mathematics
Student Status:	Enrolled
Previous Mode of Attendance:	Full-time
Start Date of Programme:	28/Sep/2020
Expected Date of Completion:	07/Jun/2024
Date of birth:	08/Jan/2002
Gender:	Female
Nationality:	British National

Any address details quoted on this statement have been provided by the student and have not been checked by UCL.

Students registered on a full-time basis are expected to devote approximately 35 hours per week to their studies and to attend the course for periods of at least 24 weeks in the year. Students registered on a part-time basis are permitted to be in attendance for a maximum of 15 hours per week.

All UCL programmes are taught in English. Assessment is in English unless the purpose of the assessment is to test ability in another language.



This information was true at the time of production.

From childhood onwards I have viewed Mathematics as a powerful tool helping me understand the world. It allowed me to formulate logical arguments, and challenge statements that seemed undeniably true. I well remember tracing a pen around a Mobius strip and realizing that not every object must have an inside and outside. Equally well, I remember being astonished by the simplicity, beauty and power underpinning the idea (of contradiction) showing that there is no largest number. This is often my particular example when trying to explain to a non-mathematician that Mathematics is not simply about solving complicated equations (the perception of most people who struggled with Mathematics) but instead about elegant ideas.

While at school I was selected to participate in Mathematical challenges organised by UKMT and Leeds University. In addition, I participated in classes offered to state school students by the outreach team at Leeds University. These experiences developed my appreciation of the subject and subsequently I took the opportunity to attend public lectures at the Royal Institute, further extending my knowledge. Ideally I would like employment that challenges me on a daily basis, and uses the Mathematics and research-led skills that I will develop over the course of my PhD. The internships I have undertaken relied on analytic and research driven thinking, and I found that extremely stimulating.

At both UCL and UBC I have actively participated in student life, academically, socially and through playing sports. At UCL I was Captain of the Women's Football Club First Team (UCLWFC) for the 2021/22 season. In this role I organised referees for home games, finances for First Team players and training sessions. I take every opportunity to raise awareness about still prevalent institutionalised misogyny, and used my platform in the committee to do so. For example, I participated in university-based projects (e.g ThisGirlCan) to encourage women into sports, building on my longstanding interest in this area. Between the ages of 14 and 15 I played for a boys' football team and was very aware of how girls and women are excluded from the game. At age 15 I became the first ever female to play in a local five-a-side team which had never previously included girls or women in its fifty-year history. My participation opened conversations about prejudices in football, and helped dismantle stereotypes – evidence for this is that the team now regularly and enthusiastically includes female players. The change has positively impacted all the players. I would very much like to continue playing sports at Bristol and continue to develop my experiences in this

way. Having to fight for my place as a woman footballer has equipped me well as a woman

mathematician and has given me confidence that I deserve to be treated as an equal in whatever endeavour I undertake.

I try to support students from underrepresented groups outside of sports too, recognising that exclusion takes multiple (and sometimes invisible) forms. In High School, I was selected to discuss the impact of period poverty on girls in the UK on national television -- the ITV Calendar program (2019). I also volunteered in the English Department, helping disadvantaged children develop literacy skills. As a mixed race person in a very diverse (though often divided) school I was able to cut across expectations of all kinds, something that taught me that living and working in a diverse and accepting place is extremely important to me.

I value travel and mixing with people from a range of other cultures and countries. I have traveled widely both as a child and independently as an adult. I spent a month at an École Maternelle (nursery school) in Lille, France, when I was four. I have visited India to spend time with my father's family and Australia to visit members of my mother's family. In the summer of 2023 (July-August) I volunteered as part of GOTOCO <https://www.go-to.co/> as an International Participant in Poland. This involved being responsible for the full-time safety of children aged 11-18 for three weeks, while carrying out one on one speaking sessions to teach English. I am now working to achieve the TESOL certificate (to teach English as a foreign language).

I trust that the above gives a good sense of the personal values and interests that underwrite my academic aspirations.

My primary objective is to undertake a PhD in Mathematics, either with the prospect of a future academic career or in an area in which my research experience can be a valuable tool. Bristol's reputation and the strengths of its faculty members and programme appeal to me greatly; study there will equip me for the future.

I am now finishing my final year of a four-year integrated Masters (MSci) at University College London, choosing modules in Number Theory, Algebra and Analysis where possible. My appreciation and enjoyment of Mathematics has continued to grow over the course of my degree. This was particularly honed in my third year, as a study abroad student. I had a very positive experience at the University of British Columbia (2022-2023), marking a significant step in my mathematical education. I took graduate level courses which truly fascinated me, especially in Measure Theory under the instruction of Professor Young-Heon Kim and Harmonic Analysis under the instruction of Professor Josh Zahl. I also took the opportunity to undergo a supervised research project, under the guidance of Professor Malabika Pramanik. We met on a weekly basis, discussing my progress and consolidating and planning the next steps in the project. This gave me insight into what the process of research might be like at a more advanced level, something I found inspiring. I was awarded a final mark of 96%. This project spanned both Number Theory and Measure Theory and had two main goals:

- (i) Improve Khinchin's theorem (Theorem 35 in his book 'Continued Fractions') concerning the distribution of partial quotients in the continued fraction expansion for almost every (with respect to Lebesgue measure) real number, from an asymptotic statement to one with an essentially best possible error term.
- (ii) Obtain analogues of Khinchin's theorem for naturally occurring number theoretic sets of measure zero such as subsets of badly approximable numbers. More specifically, one considers the fractal sets $B(N)$ of real numbers with partial quotients bounded above by N (an integer >1) and then attempts to establish an analogue of Khinchin's theorem with respect to 'fractal' measures (such as Bernoulli measures) supported on $B(N)$.

In addition to the project, I participated in Professor Pramanik's seminar for PhD students with research interests in Harmonic Analysis and Fractal Geometry. In this setting, each student took turns presenting their current research to the group and discussing any sticking points. I found this a very engaging and helpful way to learn, though it was initially daunting. I presented my findings from my research project to the group and found the experience invaluable especially because it fostered collaborative thought. The project deepened my interest in Fractal Geometry and Number Theory.

In my final year project at UCL, I am studying complex dynamical systems with Professor Rod Halburd, beginning by digesting Sullivan's non-wandering domain theorem, and then focusing primarily on the fractal measure and dimension theory of Julia sets associated with rational maps. I am particularly interested in studying Cantor-type Julia sets, the construction of Sullivan's conformal measure and the characterization of dimension as the critical exponent of a Poincaré series. This project has continued to develop my academic independence, and expose me to various aspects of

research. For example, I was a fully funded invitee at the One Day Holomorphic Dynamics conference at the University of Nottingham (06/11/23). Prof Halburd has encouraged me to participate at the conference "On Geometric Complexity of Julia Sets - V" to be held at the Stefan Banach International Mathematical Centre (21-26/07/24). I hope to attend (subject to success in accessing funding).

These two projects have been the highlights of my study to date. They are the key catalysts for my desire to undertake doctoral research.

Even with my limited experience, I find research-led learning extremely fulfilling. In terms of PhD research, I am interested in working on problems that lie on the interface between geometric measure theory, dynamical systems and number theory. The programme at Bristol would allow me to continue consolidating a firm understanding of the key concepts in these areas. In particular, it would enable me to work within dynamic research groups (Ergodic Theory, Dynamical Systems & Statistical Mechanics and Number Theory), with leading figures such as Dr Henna Koivusalo and Dr Oleksiy Klurman. I have named both as proposed supervisors on the Application Form. They have either close or adjacent alignments with my intellectual interests. I am particularly engaged by the prospect of interacting with, and learning from, more than one research group.

I have been in contact with Dr Koivusalo. We had an extremely fruitful conversation in which we discussed what a PhD would look like under her supervision. She outlined two potential doctoral projects for which she has clear and exciting research directions in mind. The first rests on Marstrand's Projection Theorem, which loosely speaking tells us that the Hausdorff dimension of the orthogonal projection of a Borel set K onto $L(\theta)$, a line passing through the origin at 'angle' θ , is maximal for Lebesgue almost all θ . However, it is difficult to characterise the angles that are atypical; i.e. those that belong to the exceptional Lebesgue measure zero set. In particular, it would be highly desirable to establish a Marstrand-type theorem in which the angles are restricted to naturally occurring measure zero sets such as badly approximable numbers. The second potential project focuses on the interactions between the theory of cut and project sets and Diophantine Approximation. The former plays a key role in modelling aperiodically ordered physical quasicrystals. I am excited at the prospect of being involved in research with potential physical applications. I am interested in both of the suggested projects. Nevertheless, Dr Koivusalo assured me that I would have autonomy over the direction of research.

As well as being enthused by research, I also enjoy teaching and currently work as a Transition mentor at UCL. I am responsible for mentoring First Year Mathematics students, and I am their first point of contact for their academic and social challenges.

During my year abroad (2022), I worked as an Undergraduate Teaching Assistant at UBC. I was responsible for grading (and providing feedback) on homework sets of First Year Mathematics students.

Since 2021 have been working as an online tutor for the platform My Tutor, teaching Maths, Physics and English and I devising bespoke lesson plans.

I am accustomed to teamwork, something demonstrated by my internship experience, which used mathematical skills. In 2021 (July-August) I worked at the technology consultancy firm Aire Logic, representing the client Nightglass. This collaboration with two separate organisations and five other interns aimed to improve the roster system for junior doctors in the NHS (National Health System). I gained coding experience in JSON and XML/XPath and building program interfaces (APIs). I used Agile methodology to distribute tasks, and lead the team as Scrum Master.

In 2019 (July), I was an intern at Environmental Systems Research Institute (ESRI). I gained software experience using ArcGIS and applied it to another area of personal interest. My final, formal, presentation to the senior team showed how mapping geographical locations in Mary Shelley's Frankenstein revealed gendered and social inequalities that were otherwise harder to perceive.

Academic Transcript

Personal Information

Student: Ayesha Oonagh Velani Bennett
Date of Birth: 8th January 2002 University Reference: 20009507/1
HESA Reference: 2011490095074

Programme Information

Teaching Institution: University College London Language of Instruction: English
Programme of Study: MSci Mathematics
Qualification Sought: Master in Science FHEQ Level: 7
Mode of Attendance: Full-time

Module Information

Academic Year	Module Code	Module Title	UCL Credit Awarded	ECTS Credit Awarded	Result Mark	Grade	Attempts Completed
2020/21	MATH0003	Analysis 1	15.00	7.50	90.00	P	1
	MATH0004	Analysis 2	15.00	7.50	80.53	P	1
	MATH0005	Algebra 1	15.00	7.50	94.73	P	1
	MATH0006	Algebra 2	15.00	7.50	89.20	P	1
	MATH0008	Applied Mathematics 1	15.00	7.50	84.33	P	1
	MATH0009	Newtonian Mechanics	15.00	7.50	75.90	P	1
	MATH0010	Mathematical Methods 1	15.00	7.50	96.25	P	1
	MATH0011	Mathematical Methods 2	15.00	7.50	92.63	P	1
	MATH0013	Analysis 3: Complex Analysis	15.00	7.50	70.78	P	1
	MATH0014	Algebra 3: Further Linear Algebra	15.00	7.50	88.10	P	1
2021/22	MATH0015	Fluid Mechanics	15.00	7.50	71.75	P	1
	MATH0016	Mathematical Methods 3	15.00	7.50	67.10	P	1
	MATH0034	Number Theory	15.00	7.50	72.65	P	1
	MATH0051	Analysis 4: Real Analysis	15.00	7.50	75.30	P	1
	MATH0052	Geometry and Groups	15.00	7.50	61.99	P	1
	MATH0053	Algebra 4: Groups and Rings	15.00	7.50	83.10	P	1
	MAPF0002	MAPS Study Abroad Module A	30.00	15.00	84.00	P	1
	MAPF0005	MAPS Study Abroad Module F	30.00	15.00	84.00	P	1
	MAPF0006	MAPS Study Abroad Module B	30.00	15.00	84.00	P	1
	MAPF0007	MAPS Study Abroad Module C	30.00	15.00	84.00	P	1
2022/23	MATH0023	Algebraic Topology					
	MATH0030	Mathematical Ecology					
	MATH0036	Elliptic Curves					
	MATH0073	Representation Theory					
	MATH0083	Prime Numbers and their Distribution					
	MATH0084	Project in Mathematics					
2023/24	MATH0109	Theorem Proving in Lean					
Total credits gained:			360	180			

University Reference: 20009507/1

END OF TRANSCRIPT





Department of Mathematics
 Room 121, Mathematics Building
 1984 Mathematics Road
 Vancouver, BC Canada V6T 1Z2

Phone: (604)822-2855
 Email : malabika@math.ubc.ca

December 14, 2023

Dear Admissions Committee:

It is a pleasure to write a letter of recommendation in support of Ms. Ayesha Bennett's application to the mathematics graduate program at your university. I was Ayesha's supervisor in a research-oriented reading course in Spring 2023, when she was an exchange student at the University of British Columbia (UBC) in Vancouver. I will base this letter on Ayesha's work during this period. Her grade of 96/100 (A+) in the course falls far short of capturing her consistently stellar performance over the term.

Ayesha already had a plan in mind when she approached me for a reading course. She wanted to learn about continued fractions, specifically their measure-theoretic and number-theoretic properties. An earlier project in number theory followed by a course in harmonic analysis had sparked her interest in exploring topics at their interface. The course plan consisted of two parts:

1. Read Khinchin's book titled "Continued fractions", with the goal of reaching the classical theorem regarding the distribution of partial quotients with respect to Lebesgue measure (Theorem 35 of the book). Specifically, the result says the following: let $f : \mathbb{N} \rightarrow \mathbb{R}$ be any non-negative function with the property

$$f(r) < Cr^{\frac{1}{2}-\delta} \text{ for some } C, \delta > 0. \quad (1)$$

Then for Lebesgue almost every $x \in (0, 1)$,

$$\lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n f(a_k) = \frac{1}{\ln 2} \sum_{r=1}^{\infty} f(r) \ln \left(1 + \frac{1}{r(r+2)} \right). \quad (2)$$

Here $a_k = a_k(x)$ denotes the k^{th} coefficient or partial quotient in the continued fraction expansion of $x = [a_0 : a_1, a_2, \dots]$:

$$x = a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \dots}}$$

2. Understand the inner workings of the proof of the above result well enough to tackle finer questions regarding Lebesgue-null sets of numbers whose partial quotients have special properties.

Ayesha was very clear about her expectations from the course. She did not just want to gather some fundamental material on an interesting topic (which is what many reading courses tend to be), her real objective was to try out ideas that would constitute original research. I thought the plan was ambitious, but she had an infectious energy and enthusiasm that convinced me to give it a try.

Ayesha's performance in the course exceeded my wildest imagination. At the initial stages, she prepared detailed notes and questions based on her reading of the book, which she presented during our weekly meetings. But it was soon clear that she was ready to bring her own insights into the project. The first question she asked was about the error bound implicit in the relation (2). She recognized the average on the left side of the equality in (2) as a potential application ground for a sharp large deviation inequality, such as Harman's lemma. Halfway through the course, she had proved the following stronger result: for any non-negative function $f : \mathbb{N} \rightarrow \mathbb{R}$ with the (more general than (1)) property

$$\sum_{r=1}^{\infty} \frac{(f(r))^2}{r^2} < \infty, \quad (3)$$

the following relation holds for Lebesgue almost every x ,

$$\frac{1}{N} \sum_{k=1}^N f(a_k) = \frac{1}{\ln 2} \sum_{r=1}^{\infty} f(r) \ln \left(1 + \frac{1}{r(r+2)} \right) + O_{\varepsilon} \left(N^{-\frac{1}{2}} \log^{\frac{3}{2}+\varepsilon} N \right). \quad (4)$$

Ayesha was the sole architect of the project. She formulated the question, explored the literature on large deviations based on some references that I provided and applied Harman's lemma to provide a rigorous answer the question that she posed. It was an intensely satisfying experience for both of us.

Ayesha's next step, related to item 2 above, was to study the set $\mathcal{B} \subseteq [0, 1]$ of badly approximable numbers. A number $x \in \mathcal{B}$ is characterized by the property that the sequence of partial quotients $\{a_k(x) : k \geq 1\}$ is bounded. One can realize \mathcal{B} as a union:

$$\mathcal{B} = \bigcup_{N=2}^{\infty} \mathcal{F}_N \quad \text{where } \mathcal{F}_N := \{x = [0 : a_1, a_2, \dots] \in (0, 1) : a_k \leq N \text{ for all } k \geq 1\}.$$

The set \mathcal{B} is Lebesgue-null, and its measure-theoretic properties are still being explored for their deep connections with diophantine approximation. An important result of Kaufman shows that $\mathcal{F}_N \subseteq \mathcal{B}$ supports a measure with power decay for all $N \geq 3$. Studying this paper with a view to possible generalizations was the second part of Ayesha's course. She excelled in this part as well. She had not yet taken a formal course in measure theory when she tackled Kaufman's paper - a formidable challenge since it meant frequent back-tracking to pick up background material before understanding certain parts of the work. Nevertheless, by the end of the course, she had a solid enough understanding of the main ideas that she was able to construct, on her own, a measure on \mathcal{F}_N using a random mechanism! She was trying to quantify the rate of decay of its Fourier transform when the term ended.

Ayesha's end-of-term report read like a professional technical report or a master's essay in terms of its mathematical precision and expository quality. She prepared a survey of preliminary material in geometric measure theory and Cantor-like sets naturally occurring number theory to provide necessary background before launching into the results directly connected with her work. I do hope she shares a writing sample as part of her application dossier to demonstrate her presentation standards. I have seen this level of clarity in mature graduate students, but never from a third-year undergraduate. It was truly impressive.

Ayesha's level of engagement went beyond the confines of the reading course. She forged genuine collaborations with members of my research group. She joined a graduate-level student-led seminar that my students and postdocs were organizing that fall, and created a learning group on the connections between continued fractions and normal numbers. The latter was one of the focus areas of the seminar during that term. She gave two seminar talks on her work from the reading course; they were clear, well-articulated and well-received by the seminar audience, resulting in a lively creative exchange. She has a natural ability to field questions, even from an advanced peer group, and a flair for crafting examples on the fly to substantiate or refute impromptu claims. But she later confided that she wanted to do even better in this regard. She holds herself to exceptionally high standards!

In summary, Ayesha functions more as an independent researcher rather than as an undergraduate student interested in advanced mathematics applying to a graduate program. I think very highly of her innovative talents and her self-motivation, and have no doubt that she will be a star and a solid citizen in any department of her choice. Academia in general and STEM fields in particular need more people like her, who through their commitment and charisma, shape public perception of our field and continue to attract talented young people with diverse voices to our discipline. I wish her every success in her academic journey.

Sincerely,

Malabika Pramanik

Malabika Pramanik
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University of British Columbia
and
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15 December 2023

Recommendation Letter for **Ms Ayesha Bennett**

To whom it may concern,

It is my pleasure to write this recommendation letter to support the application of Ms Ayesha Bennett.

I am a professor of Mathematics at University College London. Ayesha is currently in the fourth and final year of our MSci in Mathematics programme. I am her supervisor for her final year project, which concerns the iteration of rational maps on the Riemann sphere. I was also Ayesha's lecturer for MATH0010 Mathematical Methods 1 in her first year. She achieved a phenomenal overall mark of more than 96% in that module.

The mathematics programmes at UCL have some of the very highest entry requirements in the UK. Students are required to achieve the highest possible grades of A* in Mathematics and in Further Mathematics and to achieve at least an A in another academic subject.

Based on the latest marks I have, which are from the end of her third year, Ayesha was in the top 5% of our cohort of about 390 students across all mathematics programmes in her year. Needless to say, she is well on target to achieve a first class honours degree. She is also one of the most impressive project students I have ever supervised. Not only is she very smart and diligent, but she has established a great habit of trying to come up with slightly different proofs of lemmas and theorems arising in her project, often introducing new ideas, which is very refreshing.

She has had an interest in pursuing research for quite a few years now. She spent a year abroad on exchange with the University of British Columbia. I have introduced her to a number of colleagues from different universities and they have been impressed with her attitude. She is naturally intellectually curious, which is an essential quality for any budding PhD student.

Ayesha's hard work and natural ability are reflected in the results from his modules to date. She has only two modules with a result less than first class.

I give you my strong recommendation without reservation. Ayesha is the type of student I would have accepted myself as a PhD student. Please do not hesitate to contact me if you have any questions.

Sincerely,

A handwritten signature in blue ink, reading "R. Halburd". The signature is written in a cursive style with a long, sweeping underline.

Rod HALBURD, Professor of Mathematics