# Martin Skilleter

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## EDUCATION

- Bachelor of Philosophy – Science (Honours) — 2021
  - Australian National University
  - Major: Mathematics
  - Thesis: Deligne-Lusztig theory and character sheaves
  - GPA: 7.00 (out of 7.00)
- Queensland Certificate of Education
  - Brisbane Grammar School
  - ATAR: 99.90

## AWARDS and COMMENDATIONS

- **Scholarships**
  - (i) National University Scholarship ($12,500 per annum for 4 years) — 2018-2021
  - (ii) College of Engineering & Computer Science Research & Development Excellence Scholarship ($5,000)
  - (iii) Bachelor of Mathematical Sciences Relocation Grant ($1,000)
  - (iv) Mathematical Sciences Institute Honours Scholarship ($5,000) — 2021
- Dean's Science Education Commendation Award — 2019 / 2020
- Chancellor's Letter of Commendation — 2018 / 2019 / 2020
- Cockle Prize for Dux of Mathematics — 2017
- General Merit Award

## PREVIOUS EXPERIENCE and LEADERSHIP ROLES

- Demonstrator for MATH1005, MATH1013, MATH1014, MATH1115, MATH2322 at the Australian National University — 2019-2021
- President of ANU Mathematics Society — 2020
- Secretary of Undergraduate Student Research Society (formerly PhB Society)
- Summer Research Scholar — 2019 / 2020
- First-year Drop-In Mentor
- Sponsorship Officer for ANU Mathematics Society
- Peer-Assisted Learning Mentor for MATH1005, MATH1116 — 2019
- Internship – Data Analyst at *LGIAsuper* — 2018 / 2019
- Internship – Junior Quality Assurance Officer at *Fugro Roames Pty Ltd* — 2015 / 2016

**PREVIOUS RESEARCH and SPECIAL TOPICS**

| Project Title | Description | Supervisor |
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| Crystals: Combinatorial Algorithms and Tensor Categories | In this lecture course, we developed the theory of monoidal categories, with a focus on braided and coboundary monoidal categories. We also studied the induced actions by the braid and cactus groups, with a focus towards constructing interesting examples of these actions.<br><br>To motivate the definition of a crystal, we defined reflection groups and root systems before proving various results, such as the classification of irreducible finite real reflection groups.<br><br>In the final part of the course, we constructed crystals and used combinatorial algorithms to compute their various properties, with a focus on the crystals of semistandard tableaux for the $(GL_n)$ root datum. More precisely, we studied the RSK algorithm, the Schützenberger involution and the Littlewood-Richardson coefficients. | Dr. Noah White |
| Algebraic & Analytic Number Theory | This reading course was devoted to various topics in modern number theory. The first half was devoted to algebraic number theory and various standard results, such as the Kummer-Dedekind theorem, Minkowski's bound and methods of computing the class group. We then spent some time analysing techniques specific to Galois extensions of number fields.<br><br>For the second half, we transitioned into analytic number theory, proving results such as the prime number theorem and the analytic class number formula. I gave a lecture proving the Chebotarev density theorem, as well as Frobenius' theorem and the Dirichlet density theorem (which can be derived as corollaries). | Dr. Amnon Neeman |
| Riemann Surfaces | This lecture course developed much of the important theory for Riemann surfaces, including the uniformization theorem, the existence of meromorphic functions on any compact Riemann surface, the classification of elliptic curves and more. | Dr. Ian Le |

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| | As a personal project, I wrote a short paper demonstrating the equivalence of the Čech, de Rham and Dolbeault cohomologies on any complex manifold. I then used this to give an alternate proof of the existence of meromorphic functions on compact Riemann surfaces, different from the one seen in lectures. | |
| 3-Manifolds | This course was a broad survey of many topics in 3-manifold theory, including Heegaard decompositions, surgery, Morse theory and more. It was intended to provide an introduction to many different areas, with the goal that students might have the language to research any interesting topics further.<br><br>As a personal project, I gave a talk and wrote a short paper about the construction of Khovanov homology for knots. I also proved that it was invariant under the first and second Reidemeister moves. | Dr. Joan Licata |
| Fourier Analysis on Number Fields | This reading course developed the background necessary to understand Tate's seminal thesis, which used techniques from representation theory to prove the meromorphic continuation of zeta functions on locally compact abelian groups. | Dr. Uri Onn |
| Foundations of Algebraic Geometry | This reading course followed Ravi Vakil's *The Rising Sea: Foundations of Algebraic Geometry* to develop the theory of sheaves and schemes. The first half focused on the equivalence between rings and affine schemes, while the second was built around quasicoherent sheaves, line bundles and sheaf cohomology. | Dr. Anand Deopurkar |
| Vector Bundles and K-Theory | This course developed the theory of vector bundles on a topological space, defining topological $K$-theory and showing its applications.<br><br>As a personal project, I constructed an alternate $K$-theory for analytic objects called $C^*$-algebras. I also proved the Serre-Swan theorem, which shows that topological $K$-theory is a special case of operator $K$-theory of $C^*$-algebras. | Dr. Vigleik Angeltveit |
| Computational Algebraic Geometry | This course gave a computational approach to modern algebraic geometry, developing algorithms and showing their applications using the language Macaulay2. | Dr. Martin Helmer |

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| | As a personal project, I studied the invariant theory of finite matrix groups, culminating with the Chevalley-Todd-Shephard Theorem. This theory has direct applications to the representation theory of finite groups of Lie type. | |
| Perverse Sheaves & Deligne-Lusztig Theory | This formal lecture course was divided into two sections. In the perverse sheaves component, we developed the theory of derived categories and $t$-structures on a triangulated category. We used this to study perverse sheaves and the perverse $t$-structure induced by a perversity function.<br><br>The Deligne-Lusztig component was devoted to various classifications for characters on finite reductive groups, including parabolic induction and Deligne-Lusztig induction. | Dr. Asilata Bapat & Dr. Uri Onn |
| Applications of Persistent Homology to Identifying Bridges in Graphs | I used techniques from the field of persistent homology to develop an algorithm to identify bridges in graphs. This algorithm has applications in identifying diffusers of malicious information through social media. | Dr. Katharine Turner |
| Differential Geometry and de Rham Cohomology | I followed the text *Calculus on Manifolds* by Michael Spivak to learn the elementary theory of differential geometry. Ben Andrews provided resources to extend the project into the topics of Riemannian metrics and de Rham Cohomology. | Dr. Ben Andrews |
| The Implementation of Inner Product Spaces in Lean | I investigated the mathematical theory of inner product spaces and Hilbert spaces in the context of implementing this theory in the interactive theorem proving language Lean. I developed the rudimentary theory, including implementing the axioms of an inner product space, and proceeded to prove results such as the Jordan von Neumann Theorem, the Orthogonal Decomposition Theorem and the Riesz-Representation Theorem. | Prof. Scott Morrison |