2020 Issue 01

SUTD Honours And Research Programme (SHARP) Newsletter

Innovating Research with Design

WELCOME MESSAGE

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Dear Reader,

It is my pleasure to welcome you to the first issue of the SHARP newsletter. With this news outlet, we aim to give you an idea of the exciting things happening in the programme. In this particular issue, we will interview some of our students regarding their life as SHARP students, the experience they had during the first year, and the projects they plan to do in the future. We also interviewed incoming students to find out what attracted them to us.

Without further ado, enjoy this newsletter and be ready for more exciting newsletters to come, filled with the great work and experiences of our students.

As always, stay SHARP!

Scan to find out more about SHARP

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

WHAT IS SHARP?

Launched in 2019, SHARP is a premier special programme offered by SUTD for students who are intellectually curious and interested in pursuing a research-oriented pathway and future career.

Scan to find out more about SHARP

Key Highlights of SHARP:

1. Take advanced classes during the three Freshmore terms as pre-research training
2. Conduct research as an undergraduate research assistant and earn a stipend
3. Gain overseas exposure through funded summer programme, research internship, visits to top research centres, and presentation of research paper at overseas conferences

THROUGH THE LENS OF SHARP STUDENTS

Jia Shuyi, Class of 2022

What is a typical week like for you?

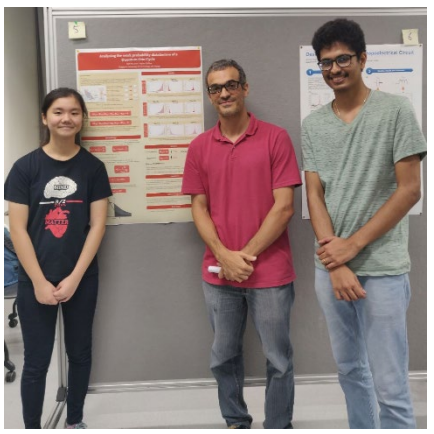
Shuyi: Every week, we have a 2.5-hour advanced lesson (known as Honours session) and I spend an additional two to five hours on SHARP assignments, which is manageable throughout most of the terms. Content-wise, the Honours sessions do not overlap with our Freshmore subjects. However, I had several "Aha!" moments throughout my first year, when I connect the dots between different concepts presented in both. Every term, the Honours sessions end off with a project. As deadlines usually snowball towards the end, burning the midnight oil is not uncommon. I form study groups with my SHARP classmates, which allow us to gain a better understanding of the concepts and also motivate each other.

Koh Hui Juan, Class of 2022

How have the Honours Sessions helped you identify your research interests?

Hui Juan: Firstly, they have allowed us to explore various topics in different fields. When the professors share their research experiences, it helps us to think about the topics that we might be interested in. It also allows us to make an informed decision when selecting research projects to work on. For instance, I developed an interest in Quantum Cryptography and even went on to work on a related Undergraduate Research Opportunities Programme (UROP) project with other SHARP students. It was surprising as I have never expected myself to work on topics other than healthcare, which I am very interested in.

Furthermore, the Honours Sessions impart us with research skills. In Term 1, we ran simulations and computations. In Term 2, we worked on a group project and made a poster. In Term 3, we conducted lab experiments, analysed scientific articles and attempted to write an abstract.



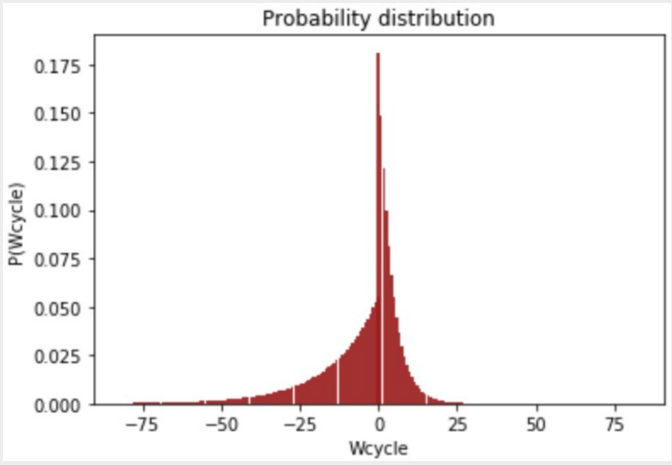
From left to right:
Hui Juan, Prof. Dario and Shyam

How was it working on the Physics project during the Term 2 Honours session?

Hui Juan: I did a project on Quantum Heat Engine (see project description in page 03), with Prof. Dario Poletti, and a fellow classmate Shyam Sridhar. The project extended from Prof. Poletti's lessons on "Introduction to Statistical Physics". The theoretical knowledge I gained from this project was also rather relevant to one of our Term 3 Freshmore courses "Engineering in the Physical World", and hence helped me to better cope with the subject. Overall, the opportunity to work on a research project, making a poster, presenting it and gaining feedback from other professors was definitely a rewarding experience.

Term 2 Honours Session – Hui Juan's Physics Project

Project Title: **Analyzing the work probability distribution of a Quantum Otto Cycle**
Group Member: **Koh Hui Juan, Shyam Sridhar**
Project Supervisor: **Prof. Dario Poletti**



Problem: The Otto cycle is a typical engine cycle used currently nowadays. How different does it perform at a scale so small that *quantum* effects are relevant?

Findings: We showed that the output is probabilistic, i.e. the engine produces an output that can be different at each time. In the figure we show the probability of the work produced in a cycle W_{cycle}. On average W_{cycle} is negative (i.e. work done by the system), but there is non-zero probability that the engine produces positive work (i.e. the engine is doing the opposite of what you would like). Note also that there is a small probability that the output is very large and negative, which corresponds to extremely high work done by the engine, even larger than the Carnot limit.

Methodology: These results were obtained by numerical simulations for the energy exchanges of a single atom in a contracting and expanding harmonic potential (which mimics the role of the piston), and two ideal heat baths (which mimic the heat transferred by burning petrol or releasing the gas).

What research project will you embark on next term?

Hui Juan: Next term, I am doing a SHARP-UROP project on "Computational Design of Luminescent Materials for Bioimaging and Biosensing Applications" with Prof. Liu Xiaogang from Science, Mathematics and Technology (SMT). I have always had a keen interest in healthcare sector research and one of the topics taught in Term 3 SHARP Honours session, "The Diabetes Pandemic: A Global Healthcare Problem of the 21st Century", reaffirmed that.

This SHARP-UROP project intrigued me as it integrates and applies various topics into one research. It exploits the advancement of technology to run chemical calculations, eventually applying the results for a biological innovation that is used in the healthcare sector.

On top of this, one of the Term 3 Freshmore subjects, "Introduction to Biology", covered the topics of cancer cells and the use of fluorescence to detect cells. Hence, I believe that this SHARP-UROP project would be very exciting as it allows me to use the concept that was previously taught during Biology class and see how the theoretical knowledge is relevant in real-life scenarios.

WHY SHARP? HEAR FROM AN INCOMING STUDENT

Tran Nguyen Bao Long
Victoria Junior College alumnus
SUTD Class of 2023

SHARP opens up many research opportunities in both Singapore and overseas. For instance, I can pursue my research interests in an overseas research internship. I believe the Honours sessions will introduce me to new and exciting research topics, and let me gain more insights into what I am truly passionate about and to focus on in the future. Without SHARP, I think I will have less exposure to available research opportunities and topics, and may end up doing something I do not truly enjoy.

What do you hope to gain from SHARP?

I am looking forward to the multi-disciplinary curriculum that allows me to apply concepts from other fields to what I am working on. Future problems will require more complex solutions that will not be possible to solve using knowledge from a single field. I also hope to present my research thesis one day and learn from prominent scientists at overseas conferences.

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