

Undergraduate Research Opportunities Programme in Science (UROPS)  
Research Project Proposal Form

Project No /Academic Yr:

Lecturer: Helmer Aslaksen, [aslaksen@math.nus.edu.sg](mailto:aslaksen@math.nus.edu.sg)

Department of Mathematics, S14 #02-11, 6874 2746

Project Title: Indian Calendars

Suitable for: 4MC or 8MC

Objectives:

The Indian calendar is the most complicated calendar in the world. In addition to leap months (like the Chinese calendar), it can also skip months. It has leap days, but it can also skip days. It is based on the sidereal year and month, rather than the tropical year and the synodic month like all other calendars. There are also several regional variations.

The goal of this project is to understand the relationship between the different Indian calendars in use and to create a convenient web site for conversion.

Methods / Techniques used:

You will need to learn a bit of astronomy, and you will have to do some programming in Java, Mathematica or Lisp.

Relevance:

Have you always wanted to know how to compute when Deepavali is celebrated? Or why people from different parts of India celebrate New Year on different days? Then this is the project for you!

Field of Research:

Astronomy.

Pre-requisite of student:

Interest in astronomy and programming.

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Project Title: The Discovery of Kepler's Laws

Suitable for: 4MC or 8MC

Objectives:

We will start by trying to understand the article "How Did Kepler Discover His First Two Laws" by Curtis Wilson.

Methods / Techniques used:

Astronomy and geometry.

Relevance:

You will learn a lot about astronomy and the history of science.

Field of Research:

Astronomy and geometry.

Pre-requisite of student:

Interest in astronomy and geometry.

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Project Title: The Mathematics of the Astrolabe

Suitable for: 4MC or 8MC

Objectives:

The astrolabe is an ancient astronomical instrument. The Asian Civilisations Museum has a nice Persian astrolabe. I want to do a talk for the museum about how it works. I would like you to create a web page with nice graphics.

Methods / Techniques used:

Astronomy and geometry.

Relevance:

You will see how mathematics can help you understand the world around you.

Field of Research:

Astronomy and geometry.

Pre-requisite of student:

Interest in astronomy and geometry.

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Project Title: Stellated Polyhedra

Suitable for: 4MC or 8MC

Objectives:

We will study the stellations of the icosahedron. We will try to both understand the theory and build models. The main reference is the book "The Fifty-nine Icosahedra" by H.S.M. Coxeter and al.

Methods / Techniques used:

Geometry.

Relevance:

You will learn about a beautiful mathematical topic.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.

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Project Title: Visualizing Polytopes in Four Dimensions

Suitable for: 4MC or 8MC

Objectives:

The goal of the project is to explain the model of the 120-cell <http://www.math.nus.edu.sg/aslaksen/polyhedra/>. The main reference is the book Beyond the Third Dimension by Thomas F. Banchoff.

Methods / Techniques used:

Geometry.

Relevance:

You will learn about an interesting area of mathematics.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.

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Project Title: Tilings and Patterns

Suitable for: 4MC or 8MC

Objectives:

The main reference is the book Tilings and Patterns by Grunbaum and Shephard. We will try to do as many of the exercises as possible.

Methods / Techniques used:

Geometry.

Relevance:

You will see how mathematics can help you appreciate the world around you.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.

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Project Title: Symmetry Groups in Chinese Art

Suitable for: 4MC or 8MC

Objectives:

We will try to determine which of the 17 wallpaper groups have been used in Chinese art. The main reference is the book "Symmetries of Culture" by Washburn and Crowe.

Methods / Techniques used:

Geometry.

Relevance:

You will see how mathematics can help you appreciate the world around you.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.

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Department/Office Room No: Dept of Mathematics, S14 #02-11 Tel No: 874 2746

Project Title: Penrose Tiles

Suitable for: 4MC or 8MC

Objectives:

We will study Penrose tiles and other non-periodic tessellations. We will start with the book "Penrose tiles to trapdoor ciphers" by Martin Gardner.

Methods / Techniques used:

Geometry.

Relevance:

You will learn about a beautiful mathematical topic.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.



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Project Title: Perspective in Painting

Suitable for: 4MC or 8MC

Objectives:

Many books have recently appeared that suggest that Vermeer and other painters used optical instruments to help them with the perspective in their paintings. We will summarize these new results, using Vermeer's Camera: The Truth Behind the Masterpieces by Philip Steadman, Secret Knowledge: Rediscovering the lost techniques of the old masters by David Hockney and [www.artandoptics.com](http://www.artandoptics.com).

Methods / Techniques used:

Geometry.

Relevance:

You will learn about a beautiful mathematical topic.

Field of Research:

Geometry.

Pre-requisite of student:

Interest in geometry.