

# Summer Undergraduate Research in Mathematics at UNI

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UNI Mathematics has funding for two undergraduate students to work on research projects under the direction of a faculty member during the summer of 2016. Each student will receive a stipend of \$3,000 and the research is to be conducted over an eight week period. Student researchers are required to present a poster on their work at the College of Natural Sciences poster session in August.

The program is open to all students with a declared major or minor in a program offered by the Math Department, and who will still be in residence (including student teaching) in the fall of 2016. Interested students must submit their application materials to the Math Department office in WRT 220 by 5 pm on March 4th, 2016.

A complete application consists of all of the following documents:

- Applicant Information Form, including names of references
- Unofficial transcript
- Letter of application

Your letter of application should be a short statement (one page or less) explaining why you are interested in doing research this summer and why the project(s) you listed appeal to you. You are also welcome to describe a project (other than one of those listed) that you would like to work on this summer with a faculty mentor in the Math Department.

A copy of the Applicant Information Form is available at

<http://www.uni.edu/theron/SURP/index.html>

For more information about the program, contact Prof. Theron Hitchman:

[theron.hitchman@uni.edu](mailto:theron.hitchman@uni.edu)

## Possible Research Projects:

This is a partial listing of possible research projects available to students in the summer of 2016. For more information on a particular project, contact the faculty member listed.

### **Project #1: 3D Printing for Mathematics Visualization** (Prof Hitchman and Prof Wood)

Abstract: We see plenty of three-dimensional objects in courses like multivariable calculus, topology, and differential geometry that have interesting properties but are tough to visualize. We will explore how to use 3D printing technology to create accurate models of such objects. This work may lead to producing materials for courses at UNI or a workshop for the Rod Library's new maker space. Some experience in geometry and/or programming may be required.

### **Project #2: Software for Educational Research Support** (Prof Feldhaus)

Abstract: The Learning Lab for Applied Manipulative Applications (LLAMA) is looking for a student researcher to perform a number of software development, data analysis, and data administrative duties. Specifically, the student will develop a protected database to hold information from classroom studies, develop scripts to mine relevant data from the database, assist the faculty researchers in creating research charts and graphs, and create a fully-functioning playback application that will use database information to reconstruct a participant session for further analysis.

Research at LLAMA focuses on the implementation and effectiveness of a new touch input framework and motion virtual manipulatives (MVMs). MVMs are a new toolset that transforms an ordinary classroom wall into an interactive manipulative space through the use of a projector, a motion camera and mathematics manipulative software developed by our research team. We believe in the importance of developing affordable software for use in the classroom and educational research setting.

### **Project #3: Generalized Trigonometric Functions (Prof Wood)**

Abstract: The classical trigonometric functions sine and cosine can be defined as the functions returning the coordinates of a point on the unit circle. We can generalize these functions to apply to curves other than the unit circle. This project will explore a class of these functions that parameterize "squircles," which look like squared-off circles. We will discover properties of these functions and apply them to find formulas for length, area, volume, and hyper-volume of some interesting mathematical objects. Applicants should have completed Calculus III and have experience with or willingness to learn a computer algebra system such as Mathematica or Sage.

### **Project #4: Geometry of Knots: Bridge Number (Prof Hitchman)**

Abstract: A *knot* is a loop of thread that winds around itself in space to get all tangled up, and then joins the two ends smoothly. We will study a geometric way to understand the complexity of knots called the *bridge number*. In particular, knots with bridge number 2 are well-understood, but those with bridge number 3 need attention. A willingness to play with computer modeling and some comfort with multivariable calculus is very helpful, but there are no specific prerequisites.

### **Project #5: *Choose your own adventure***

Have an idea for some summer research? Or a professor you would really like to work with? Suggest an idea for summer research and we can try to help you work out the details.

Contact Prof. Hitchman if you are unsure how to get started: [theron.hitchman@uni.edu](mailto:theron.hitchman@uni.edu)