Department of Mathematics

February 18, 2019

UNDERGRADUATE MATH SEMINAR on hiatus this week

There is a break in the undergraduate math seminar series in deference to the Union College **Founders Day** keynote address. According to the Union College website, "Noted economist, scholar and educator **Catharine Bond Hill** will deliver the keynote address at Founders Day, **Thursday, February 21, at 1:00 PM in Memorial Chapel**. The event commemorates the 224th anniversary of the College's charter. Hill's talk will center on coeducation at Union, which will celebrate the 50th anniversary of admitting women in 2020.

Math and Physics Clubs to Host Dinner and Discussion with Professors, by Emily Rosenlof '20

On **Wednesday, February 20** at **6:00pm** in **Sorum House**, the Math Club will be co-hosting a **Dinner & Discussion event** with the Physics Club! **Professors Jeff Jauregui** and **Brenda Johnson** from the Math Department, along with **Professor Jef Wagner** from the Physics Department, have agreed to come and speak at the event regarding the overlaps between math and physics. It will be a great event and dinner will be served!

Professors Jeff Jauregui, Brenda Johnson, and Jef Wagner to discuss math and physics

Math Professors Awarded NSF Grants

Two professors in the Math Department, **Professors Ellen Gasparovic** and **Jeff Hatley** were recently awarded grants to fund math conferences that they will be helping to organize.

- Professor Gasparovic's grant is for the project entitled, "Second Workshop for Women in Computational Topology (WinCompTop 2)."
- Professor Hatley will be part of a group receiving funding for the next three years of Upstate NY Number Theory Conference meetings, with the 2021 meeting to be held at Union College.

Congratulations – and good luck organizing the conferences!

Spring Petitioning Process Continues through Tuesday, February 19

If you have not done so already, don't forget to petition for your spring term courses! As a reminder, the following math courses are petition courses: Math 130, 224, 332, and 448.

HRUMC – Saturday, March 23, 2019 at Smith College: Sign-up Now!

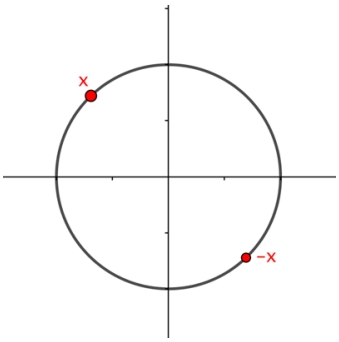
Interested in attending HRUMC? If you would like to go to this year's HRUMC, please email **Professor Paul Friedman** (friedmap@union.edu). Transportation to/from the conference might be limited, but we will do our best to accommodate all interested students. (There is **no charge** for attending the conference, and breakfast and lunch will be provided at the conference.)

Maths in a minute: Equal temperatures

The following article, by Marianne Freiberger, is taken from *Plus*, an internet magazine that she edits. See https://plus.maths.org.

At every given point in time there are two points on the equator of the Earth that have the same temperature.

How do we know this? Well, here's a proof. Let's look at the equatorial plane which slices through the Earth at the equator. The equator is a circle which lies in that plane, and we can choose a coordinate system on the plane so that the point (0,0) lies at the centre of the equator. For each point *x* on the equatorial circle there is a point *-x* which lies diametrically opposite *x.*



Now each point *x* on the equator comes with a temperature *t(x)*. We can assume that the function *t,* which allocates a temperature to each point, is continuous. That's because temperature doesn't suddenly jump up or down as you move around on the Earth.

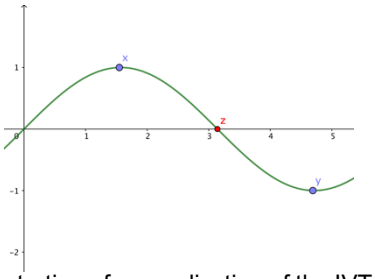


Illustration of an application of the IVT: If *t(x)>0* and *t(y)*<0 and *t* is continuous, then there is a point *z* between *x* and *y* such that *t(z)=0*.

Now consider the function ***f(x) = t(x)-t(-x)***. It is also continuous. If this function is equal to 0 for some point *x*, then we are done because if *f(x) = t(x)-t(-x)=0*, then *t(x)= t(-x)*, so the temperature at *x* is the same as the temperature at *-x*.

If *f(x)* isn't equal to 0 anywhere, then let's assume (without loss of generality) that there is a point *x* at which *f(x)>0,* so *f(x) = t(x)-t(-x)>0*. This implies that *f(-x) = t(-x)-t(x)=-f(x)<0*.

There is a result, called the Intermediate Value Theorem, which [allows one to conclude that] if a continuous function is greater than 0 at some point of its domain and less than 0 at another, then it must equal 0 at some point in between the two.

Thus, since *f(-x)<0* and *f(x)>0*, there must be a point *y* on the circle such that *f(y)=0*. So *f(y) = t(y)-t(-y)=0* which means that *t(y)=t(-y)*. So the temperature at the point *y* is the same as the temperature at the point *-y!*

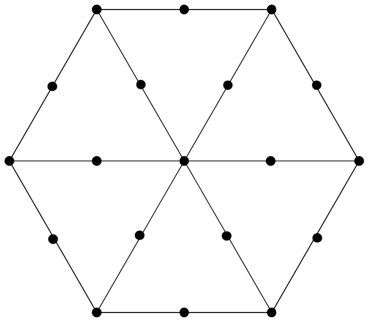
The result actually holds for any circle on the Earth, not just the equator. In fact, the result is the one-dimensional case of the **Borsuk-Ulam Theorem**, which says that for any continuous function *t* from the circle to the real numbers there is a point *x* such that *t(x)=t(-x).*

The more general version of the Borsuk-Ulam Theorem says that for any continuous function *t* from the *n*-sphere to the set of *n*-tuples of real numbers there is a point *x* such that *t(x)=t(-x).* [An application of this tells us there is always a pair of diametrically opposed points on Earth with the same temperature AND barometric pressure – pretty cool!]

Problem(s) of the Newsletter – February 18, 2019

Last week's problem: Congratulations to **Khoa Ngo The '22** for solving last week's problem. A solution is posted at the newsletter sites in Bailey.

This week's problem: Label the 19 dots in the hexagon with the numbers 1 to 19 so that each set of three dots that lie along a straight line segment add to 22. Have fun!



Professor Friedman (friedmap@union.edu) will accept solutions until midnight Friday, February 22.