Program

2010 Governor's Institute in Mathematical Sciences

June 20 - 25, 2010

Approximately 30 top Vermont mathematics students from grades 9-12 will participate in the **2010 UVM / GIV Mathematical Sciences Institute, June 20 - 25, 2010**. Participants will explore topics such as chaos, fractals, robotics, mathematical games and mathematical problem solving. Students will visit NRG to investigate production, research and development at the company.

Chaos, Fractals, and the Mathematics of Prediction
"Chaotic" is a term used to describe mathematical behavior that appears random, but may in fact be produced by a very simple equation. The "butterfly effect," whereby a butterfly flaps its wings in Brazil and causes a tornado in Texas two weeks later, is a metaphor for the implications of chaos in the Earth's atmosphere. This course will introduce students to the difficulties associated with modeling chaotic physical phenomena using bifurcation diagrams and fractals, drawing upon examples from the fields of astronomy, biology, physics, and atmospheric science. This course is taught by Chris Danforth of the UVM Mathematics Department.

Evolutionary Robotics
Building a robot is hard work: it requires an understanding of physics, biology, math, mechanical and electrical engineering, and computer science. So rather than build a robot by hand, could we get a computer to build a robot for us? In this course we explore how we can use computer programs known as `evolutionary algorithms' to create and compete virtual robots against one another, much like in Will Wright's 'Spore' computer game. Along the way, we'll learn much about biological evolution, computer simulation, and robotics. This course is taught by Josh Bongard of the UVM Computer Science Department.

Mathematics and the Arts
We tend to think of mathematics and science as rational disciplines, while the arts are those that speak to our senses and emotions. But the ancient Greeks considered math, science, and the arts together - all were reflections of the essential perfection of the universe. This course will explore some of the many connections between mathematics and the arts, and consider how these have changed from ancient times to the present. Some of the ideas we'll explore: Pythagoras and musical ratios, and how these relate to the mathematics of sound production; the symbolism of number and geometric shape in musical and visual compositions; mathematical perspective in drawing: how to achieve it, and how to recognize other approaches to perspective. This course is taught by Sheila Weaver of the UVM Department of Mathematics and Statistics.

Twenty Years of the Hubble Space Telescope
The Hubble Space Telescope was launched twenty years ago. From initial elation to depression when the mirror was soon discovered to be flawed, to elation again when the problem was fixed three years later, the Hubble has since become one of NASA's most successful missions. We will learn about the history of the telescope and see some of the successes that it has had. This course is taught by Bill Jefferys, Visiting Professor of the UVM Statistics Program.

What Color is my Hat?
A game show has three contestants and as they enter the stage either a red or a black hat is placed on their head. Each contestant can see the other contestant's hats, but not their own. No communication of any sort is allowed, except for an initial strategy session before the game begins. Once they have had a chance to look at the other hats, the contestants must guess the color of their own hats, or pass. The contestants share a $1,000,000 prize if at least one of the contestants guesses correctly and no contestants guess wrong and get nothing if even one contestant guesses wrong. In this session we will play this game and discuss some

strategies that may help our chances of winning. This course is taught by Jeff Dinitz of the UVM Department of Mathematics.

Problem Solving Strategies
One session is taught by Tony Trono, Director of GIV Math for many years and award-winning math team coach. Another session is taught by Felix Wu, alumnus of GIV, and Junior Counselor.

Rocket Science: The Mathematics of Projectile Motion
Knowing the initial velocity of a projectile, can we predict how high it will go and how far it will travel? What happens to the path of the projectile if we alter its initial speed and launch angle? We will investigate the mathematics of projectile motion using computer software and a bit of trigonometry, and test our predictions by launching our own projectiles in the form of toy rockets. This course is taught by Helen Read of the UVM Department of Mathematics.

Math game: Instant Insanity
Description: A popular Parker Brothers Game Company puzzle called Instant Insanity consists of four cubes where each cube's six faces are colored from four given colors. The object of the puzzle is to stack these cubes on top of one another in a tower four cubes tall so that each of the four colors appears on each side of the tower's four sides. Until you know some graph theory it will drive you crazy! This course is taught by John Schmitt of the Middlebury College Department of Mathematics.

Innovation and Invention
Many examples of mathematics applied to everyday technology, by inventor Carlton W. Sheldon of Quantum Dynamics, Inc., including: Hydrogen fuel production, solar powered vehicles, Corning's catalytic bricks, and more.

Bijective Proofs
The process of understanding something better often involves uncovering hidden connections. In combinatorics, this can amount to showing that two seemingly different collections of objects are the same. Without realizing it, one is just giving a single object two different names and two different descriptions. To prove the collections are the same one can just create a dictionary that converts one description to another in a way that pairs up the elements in the first collection with the elements in the second. This is a "bijection." We will give a few beautiful examples of this idea. This course is taught by Gregory Warrington of the UVM Department of Mathematics.

Power off the Grid
In this course we will discuss the elegant mathematics of electric energy, and then use the theory to build working electric machines. We will also discuss topics like the power grid (and why if fails in spectacular ways), renewable power, and smart grid. This course is taught by Paul Hines of the University of Vermont Department of Engineering.

Tour of NRG
Since 1982, NRG Systems has manufactured products to help their customers measure and understand the wind.They serve the wind energy industry exclusively, from wind farm developers and turbine manufacturers to electric utilities and research institutes, in more than 135 countries. Students will meet with an engineer at NRG.