# FACULTY CONTRIBUTED SESSIONS

**MAA EPaDel/NJ Section Meeting -- Villanova University**
**12 November 2016**

## 1:20 Driscoll 244 **Wing Hong Tony Wong** (Kutztown University of PA)

*A two-person graph coloring game*

**Abstract**: In this two-person graph coloring game, Alice and Barbara take turns to color the vertices of a given graph. Alice uses color A and Barbara uses color B, so that no neighbors of a colored vertex may share the same color. The first player who is unable to color a vertex loses the game. In this project, we determine which player has a winning strategy on certain types of graphs, such as paths, cycles, and some grids. We also prove some general assertions about all graphs. Furthermore, we discover that this game is closely related to other games introduced by John Conway and Richard Guy. This project is a joint work with Diego Manzano-Ruiz, a freshman at Kutztown University Eric Stachura, Haverford College, Haverford, PA.

## 1:36 Driscoll 244 **Iwan Praton** (Franklin and Marshall College, PA)

*Minimal tilings of the unit square*

**Abstract**: Tile a unit square using n smaller squares (which can be of the same size). Let S denote the sum of the side lengths of the n small squares. For example, if n=9 and the tiling uses 9 identical squares of side length 1/3, then S=3. Is there a tiling where S is bigger? smaller? Determining how large S could be for a given n seems hard (it is basically an Erdos problem), but the related problem of determining how small S could be turns out to be easier. I will discuss the solution to this question, which involves only elementary undergraduate mathematics.

## 1:52 Driscoll 244 **Robert Search** (Centenary University, NJ)

*Mathematics and Astronomy*

**Abstract**: The purpose of this presentation is to examine how knowledge of astronomy can enhance college-level learning situations involving mathematics. The fundamental symbiosis between mathematics and astronomy was established early in the 17th century when Johannes Kepler deduced the 3 basic laws of planetary motion. This mutually harmonious relationship between these sciences has been reinforced repeatedly in history. In the early 20th century, for example, astronomer Arthur Eddington used photographic evidence from a 1919 solar eclipse to verify Einstein's mathematical theory of relativity. This study was conducted in 5 undergraduate mathematics classes over the course of 2 years. An introductory course in ordinary differential

equations, taught in Spring Semester 2013, involved 4 students. A similar course in Spring Semester 2014 involved 6 students and a Summer 2015 Astronomy course involved 8 students. The students were asked to use Kepler's astronomical evidence to deduce mathematical laws normally encountered on an undergraduate level. They were also asked to examine the elementary mathematical aspects involved in a theoretical trajectory to the planet Neptune. The summer astronomy class was asked to draw mathematical conclusions about large numbers from the recent discoveries concerning the dwarf planet Pluto. The evidence consists primarily of videotaped PowerPoint presentations conducted by the students in both differential equations classes, along with interviews and tests given in all the classes. All presentations were transcribed and examined to determine the effect of astronomy as a generator of student understanding of mathematics. An analysis of the data indicated two findings: definite student interest in a subject previously unknown to most of them and a desire to make the mathematical connection to celestial phenomena.

### 2:08 Driscoll 244 **Garth Isaak** (Lehigh University, PA)

*Multiset Poker*

**Abstract**: A multiset poker hand allows repeated cards. In multiset poker every such hand is equally likely. We present a new bijection
that is more amenable for physical playing with cards than the standard multiset bijection and has some other nice properties. We also discuss some new notation that simplifies determining poker probabilities for regular poker, other variants such as dealing with replacement and multiple decks that have multiset hands as well as multiset poker with arbitrary numbers of suits, ranks and hand size.

### 2:24 Driscoll 244 **John T. Saccoman** (Seton Hall University, NJ)

*A Survey of Laplacian Integral Graphs and Multigraphs*

**Abstract**: The number of spanning trees in a graph or multigraph are an important measure of vulnerability to disconnection by edge failure. The eigenvalues of the Laplacian matrix associated with the graph or multigraph are used to compute the number of spanning trees. We say that a graph is a split graph if its node set can be partitioned into a clique and an independent set. A split graph G is a threshold graph if, for all pairs of nodes $u$ and $v$ in G, $N(u)-\{v\} \subseteq N(v)-\{u\}$ whenever $deg(u) \leq deg(v)$. We present some infinite families of graphs and multigraphs of these types, or nearly of these types, whose Laplacian eigenvalues are all integers.

### 1:20 Driscoll 246 **Rommel G. Regis** (St. Joseph's University, PA)

*An Introduction to Continuous Multi-Objective Optimization*

**Abstract**: Many practical optimization problems involve multiple conflicting objectives to be optimized. However, multi-objective optimization is hardly treated in standard calculus and optimization textbooks. The main goal of multi-objective optimization is to identify Pareto optimal solutions, which are solutions that cannot be improved in any of the objective functions without worsening another objective function. This talk will present some of the basic terminology and results in multi-objective optimization. It will also briefly review some of the classical and widely used approaches in solving continuous multi-objective optimization problems. In addition, it will present some theoretical results that guarantee the convergence of stochastic search methods to Pareto optimal solutions. This talk will be accessible to students with a background in multivariable calculus, linear algebra and probability.

## 1:36 Driscoll 246 **Eric Stachura** (Haverford College, Haverford, PA)

*Metamaterial Lens Design*

**Abstract**: .We prove how to design a lens that focuses monochromatic radiation from a light source into a given point when the lens is constructed out of an exotic material known as a Metamaterial (meta = $\mu\varepsilon\tau\alpha$ = ``beyond" in Greek). Such materials do not exist naturally, but have been constructed in the laboratory in the early 2000's. The research on the behavior of these materials has been extremely active in recent years, especially for applications to invisibility cloaking and the development of a ``superlens", which can in principle image objects at the smallest scales. In this talk I will discuss the precise construction of the lens; i.e., given one surface of the lens, we construct the second surface explicitly, and show that most of the time the slab has a non-rectangular geometry, even if the given surface is planar. Most of the mathematics involved should be understandable to calculus students.

## 1:52 Driscoll 246 **Chung Wong** (The College of New Jersey)

*Asymptotics of Fouier coefficients of Spectral Density Functions in Two Variables*

**Abstract**: We look at the asymptotic of the Fourier coefficients of spectral density functions along different directions in two variables. We use theories developed by Geronimo and Woerdeman for directions in the second and fourth quadrants. For the first and third quadrants, we use theories by Pemantle and Wilson.

The one variable Bernstein-Szegő moment problem asks when does a given finite list of complex numbers from the Fourier coefficients of the spectral density function of a stable polynomial. Szegő proved in 1919 that it is possible if and only if the Toeplitz matrix formed by these numbers is positive definite. Bernstein later proved in 1930 a real line analog of the problem. The two variable version of the problem was proven by Geronimo and Woerdeman in 2004. Related problems arise from the studies of the moment problem in higher dimensions. Of particular interest is to determine any relations between the Fourier coefficients and the coefficients of the stable

polynomial. In this presentation, I will briefly describe one of such relations, which focus on the asymptotics of the Fourier coefficients and the different methods used to prove it.

## 2:08 Driscoll 246 **Baoling Ma** (Millersville University of PA)

**Coauthors:** Azmy S. Ackleh, Ross A. Chiquet, Tingting Tang, Hal Caswell, Amy Veprauskas, and Natalia Sidorovskaia

*Analysis of Lethal and Sublethal Impacts of Environmental Disasters on Sperm Whales using the Stochastic Modeling Approach*

**Abstract**: The Deepwater Horizon (DWH) oil rig explosion in April of 2010 has encouraged substantial research efforts to better understand how such environmental disasters affect the resilience of the Gulf of Mexico (GoM) ecosystem. This talk is focused on how such disasters affect the dynamics and persistence of marine mammal populations in the Northern GoM under certain assumptions. Matrix population models are developed to study the lethal and sublethal impacts of such environmental disasters on the GoM sperm whales. We investigate how reductions in the survival probabilities and in fecundity affect the sperm whale population. We show that a reduction of as little as 0.81% in adult survival and double that in immature survival could reduce the asymptotic growth rate below one, which indicates population decline. Meanwhile, it would take a 34% reduction in the fecundity to have the same effect. We then investigate the long term effect of such an environmental disaster on the population of sperm whales in the GoM. We also inspect the effects of demographic stochasticity on the recovery probabilities and the recovery time of the population.

## 2:24 Driscoll 246 **Michael Yatauro** (Penn State University, Brandywine)

*Network Reliability and Binary Strings*

**Abstract**: We define a network model involving failure of edges and endpoints which is dependent on a specified parameter. If the network is defined by a path, then the vulnerability of the network within this model can be studied using a specific set of binary strings. We define those strings and present a recursive formula for counting them.

Let $G$ be a finite simple graph. Consider a model in which edges of $G$ fail independently, and when an edge fails we remove it from $G$ along with the incident vertices (this is sometimes called an *edge explosion*). We say that a set of edges $F$ is a *failure set* of $G$ if after all edges of $F$ fail, the components of the induced subgraph each contain at most $k-1$ vertices, for some prescribed $k>0$. If the edges fail with probability $\rho$, then the *unreliability* of $G$, denoted $U_k(G,\rho)$, is the probability that a randomly selected set of edges is a failure set. Let $P_n$ be the path on $n$ vertices. For any fixed value of $k$, we will demonstrate how counting appropriate binary strings allows us to generate a recursive formula on $n$ for $U_k(P_n,\rho)$.