Abstracts for talks

1. Title: *Harris Graphs – an introduction*

Speaker: Douglas Shaw

Affiliation: UNI

Abstract: Harris Graphs are tough, Eulerian, non-Hamiltonian graphs. They can be found by undergraduates in an hour, but not in fifteen minutes. All of these terms will be defined, and an amazing illustrative teaching story will be told.

2. Title: *The Geometry of the Hyperelliptic Torelli Group*

Speaker: Tatsunari Watanabe

Affiliation: ERAU-Prescott

Abstract. In this talk, I will introduce the hyperelliptic mapping class group and the hyper-elliptic Torelli group and discuss some major open problems related to them. These groups are infinite-index subgroups of the mapping class group of a compact oriented topological surface of genus $g \geq 2$. The mapping class groups have been extensively studied in areas such as topology, differential geometry, algebraic geometry, and algebraic topology. For example, some important applications of the mapping class groups and Torelli groups appear in the study of algebraic curves using the Teichm¨uller theory. The hyperelliptic mapping class group and hyperelliptic Torelli group are important tools for studying the moduli space of smooth projective hyperelliptic curves and the universal hyperelliptic curve over it. For example, some algebraic information of the moduli space is captured in the Lie algebra structure of the relative completion of the hyperelliptic mapping class group. This Lie algebra is closely related to the hyperelliptic Torelli group.

3. Title: *Matrices with Perron-Frobenius Properties*

Speaker: Daniel B Szyld

Affiliation: Temple University

Non-nilpotent nonnegative matrices have a positive dominant eigenvalue that corresponds to a nonnegative eigenvector. This property is called the PerronFrobenius property. General matrices with a Perron-Frobenius property are studied, i.e., matrices which have a positive dominant eigenvalue, with the corresponding eigenvector being positive or non-negative. We concentrate on matrices which are not necessarily non-negative, and whose powers are not necessarily non-negative. Several characterizations of matrices having Perron-Frobenius properties are presented, including some depending on spectral, combinatorial, and geometric characteristics. We also study generalizations of M-matrices, i.e., matrices of the form $sI - B$ with B having a Perron-Frobenius property, and whose spectral radius is no larger than s.

4. Title: *Tetrahedra: Tilings and Scissors-Congruence*

Speaker: Anas Chentouf

Affiliation: MIT

Abstract: In this talk, I will discuss some problems relating to tetrahedra: when does a tetrahedron tile? And when is it scissors-congruent to a cube? The discussion will encompass necessary and sufficient conditions, as well recent results regarding the two questions

5. Title: *A Low-Cost Algorithm to Determine Orbital Trajectories within Cislunar Region*

Speaker: Sirani Perera

Affiliation: ERAU - Daytona

Abstract: As traffic within the Cislunar region continues to grow, there is an escalating demand for efficient techniques to propagate trajectories in the circular restricted three-body problem (CR3BP). It is crucial to employ analytical algorithms that are both computationally inexpensive and feasible to effectively generate satellite trajectories within the Cislunar domain and accurately describe periodic orbits in the CR3BP.
In this talk, we introduce a technique that leverages interpolation incorporating boundary conditions to determine orbital trajectories. We propose a low-cost algorithm for tracking orbital motion in the three-body problem. Once the algorithm is obtained, it is applied to relevant Cislunar trajectories. We show that the proposed algorithm achieves approximately a 50% improvement in time complexity compared to existing iterative techniques.

6. Title: *Uniform exponential growth of Lie algebras and their associated universal enveloping algebras*

Speaker: Christopher Briggs

Affiliation: ERAU - Prescott

Abstract: In this talk, we discuss the relationship between the growth of a Lie algebra of exponential growth and its universal enveloping algebra. In particular, we prove that the universal enveloping algebra has exponential growth if and only if the Lie algebra does. We also prove that uniform exponential growth of the universal enveloping algebra implies uniform exponential growth of the Lie algebra, and conversely if the Lie algebra is graded by the natural numbers.

7. Title: *Geometric Analysis Under Ricci Curvature Bounds*

Speaker: Shoo Seto

Affiliation: CSU-Fullerton

Abstract: In this talk, we will introduce the notion of Ricci curvature on a Riemannian manifold. Most famously, the Ricci curvature appears in Einstein's field equations: $\mathrm{Ric}_{ij} - 1/2Rg_{ij} + \Lambda g_{\mathrm{ij}} = \kappa T_{ij}$, where Ric_{ij} is the Ricci curvature tensor, g_{ij} the metric tensor, $R = \mathrm{Tr}(\mathrm{Ric}_{ij})$ is the scalar curvature, Λ and κ are some constant and T_{ij} the stress-energy tensor. We will briefly discuss how the Ricci curvature determines the geometry and also survey some results from geometric PDE's where the Ricci curvature plays a crucial role.

8. Title: *Rotation Operations on the Errera Map and its Variations – Part 1*

Speaker: Weiguo Xie

Affiliation: University of Minnesota Duluth

A Kempe chain in a colored graph is a maximal connected component containing at most two colors. Kempe chains have played an important role historically in the study of the Four Color Problem. Irving Kittell explored a set of Kempe chain operations which would form a group on a minimal counterexample of the Four Color Theorem. These operations can also be used to obtain a coloring of a plane graph from a partial coloring. We will study one of these operations, denoted α, as well as a historical map known as the Errera map. The operation α is known to generate a group on some partial colorings of the Errera map; we determine all such colorings, as well as show how to systematically color all such partial colorings. We then extend this to a related family of graphs.

9. Title: *On Finite Rings and Their Groups of Units*

Speaker: Yasuyuki Hirano

Affiliation: Hiroshima Institute of Technology

Abstract: A finite ring is an associative ring consisting of only finitely many elements. Let R denote a finite ring with identity. The group of units in R is denoted by $R^\times$. For a set S, we denote the number of elements in S by $|S|$. In this paper, we analyze the structure of a finite ring R in relation to the number $|R| / |R^\times|$. We also study conditions for $R^\times$ to be a simple group.

10. Title: *DSR-graphs and group algebras*

Speaker: Tsunekazu Nishinaka

Affiliation: University of Hyogo, Japan

Abstract: In this talk, we first introduce two types of graphs which come from originally two edge colored graphs. One is here called an SR-graph, and another is called a DSR-graph. Next, we will see applications of SR-graphs and DSR-graphs to group algebras of non-Noetherian groups and consider the primitivity and non-amenability for those algebras. Finally, we will announce recent progress in my study for the amenability problem of Thompson's group F.

11. Title: *Introduction to Fully Prime Rings*

Speaker: Hisaya Tsutsui

Affiliation: ERAU - Prescott

Abstract: A ring in which every ideal is prime is called a fully prime ring. A commutative fully prime ring is either 0 or a field. The endomorphism ring of a vector filed over a division ring is an example of a fully prime ring with nonzero ideals unless the dimension is finite. A ring is fully prime if and only if every ideal is idempotent and the set of ideals is linearly ordered. In this talk, we introduce known structure of fully prime rings and discuss most recent development of the study.

12. Title: *Universal localization at semiprime Goldie ideals*

Speaker: John A. Beachy

Affiliation: Northern Illinois University

Abstract: My talk will mostly be expository, in an effort to call attention to the method of noncommutative localization introduced by P. M. Cohn (in 1973). Given a prime ideal P of a Noetherian ring R, he constructed the ring universal with respect to inverting the set of matrices inverted by the canonical mapping from R to the classical ring of quotients of R/P. This ring always exists, but the definition via a universal property seems to only provide information about the "top" of the localized ring, while it remains difficult to even determine the kernel of the localizing homomorphism. I would note that Cohn's construction reduces to the Ore localization when the prime ideal is localizable, and it turns out to be closely related to the localization defined earlier by Alfred Goldie (in 1967). On the other hand, it seems to be on the opposite end of some spectrum involving the torsion theoretic localization. There are many "known" unknowns, along with what is surely a large number of "unknown" unknowns. I still have hope that Cohn's method can provide a language that will help in extending commutative results involving localization to the noncommutative case.

13. Title: *Rotation Operations on the Errera Map and its Variations – Part 2*

Speaker: Andrew Bowling

Affiliation: University of Minnesota Duluth

Abstract: A Kempe chain in a colored graph is a maximal connected component containing at most two colors. Kempe chains have played an important role historically in the study of the Four-Color Problem. Irving Kittell explored a set of Kempe chain operations which would generate a group on a minimal counterexample of the Four-Color Theorem. These operations can also be used to obtain a coloring of a plane graph from a partial coloring. We will study one of these operations, denoted α, as well as a historical map known as the Errera map. The operation α is known to generate a group on some partial colorings of the Errera map; we determine all such colorings, as well as show how to systematically color all such partial colorings. We then extend this to a related family of graphs.

14. Title: *On certain algebraic structures associated with Lie (super)algebras*

Speaker: Noriaki Kamiya

Affiliation: University of Aizu, Japan

Abstract: This talk is to deal with a certain survey and to several examples of triple systems, furthermore to describe a history of Jordan river in nonassociative algebras from the author's viewpoint. Also, we will speak a correspondence with Lie (or Jordan) structures and symmetric spaces with complex structure.

15. Title: *Semi-Implicit Time Integration for Partial Differential Equations and The Method of Regularized Stokeslets*

Speaker: Benjamin Stager

Affiliation: Tulane University

Abstract: Many processes found in science and engineering are governed by dynamical systems described by ordinary and partial differential equations. These systems are often complex and do not admit closed form solutions. Therefore, numerical methods called time integrators are required for finding solutions. In this thesis we study the efficiency of various integrators for solving three partial differential equations: the heat equation, the viscous Burgers' equation, and Stokes equations (specifically the time integration of velocity field produced by method of regularized Stokeslets). A time integrator's efficiency is quantified by analyzing the amount of computational time required to approximate the solution at a given accuracy. This thesis has three primary components. First, we will discuss implicit and explicit integrators for solving linear PDEs. Second, we will present implicit-explicit and exponential integrators for solving semi-linear PDEs. Lastly, we propose to use a semi-linear time integrator for solving initial value problems arising from the Stokes equations. We find that a semi-implicit integrator can take larger timesteps when modeling stiff springs.

16. Title: *Reverse Orthogonal Polynomials*

Speaker: Steven H. Weintraub

Affiliation: Lehigh University

Abstract: Let $\mathscr{P}$ be the vector space of all polynomials equipped with an inner product. We may apply the Gram-Schmidt procedure to the ordered basis $\{1,\ x,\ x^2,...\}$. of $\mathscr{P}$, with suitable normalization, to obtain orthogonal polynomials $\{F_0(x),\ F_1(x),\ F_2(x),...\}$. This is a classical construction. Instead, for any fixed *n*, we begin with the vector space $\mathscr{P}_n$ of polynomials of degree at most *n*, with the restriction of the same inner product, and apply the Gram-Schmidt procedure to the ordered basis $\{x^n, x^{n-1},\ ...,1\}$. of $\mathscr{P}_n$, with suitable normalization, to obtain orthogonal polynomials $\{\overset{\leftarrow n}{F}_n(x),\ \overset{\leftarrow n}{F}_{n-1}(x),\ ...,\ \overset{\leftarrow n}{F}_0(x)\}$. Since we are applying the Gram-Schmidt procedure in reverse order, we call these reverse orthogonal polynomials. We discuss the reverse orthogonal polynomials, with particular emphasis on the reverse Legendre polynomials and the reverse Chebyshev polynomials of the first and second kinds.