	Title of proposed project *	**Short description of proposed project, together with a book that could be used** *
1	Structure in combinatorial game theory	Combinatorial game theory is a branch of mathematics and theoretical computer science that typically studies sequential games with perfect information. Study has been largely confined to two-player games that have a position that the players take turns changing in defined ways or moves to achieve a defined winning condition. In this project, we will investigate the structural properties of a combinatorial game - the subtraction game. The material about subtraction games, which is scattered throughout the following pdf by Thomas Ferguson, will serve as suitable background. Text: Combinatorial games by Thomas Ferguson Prerequisite: None
2	Using wavelets in Image processing and Compression	A wavelet is a wave-like oscillation with an amplitude that begins at zero, increases or decreases and then returns to zero one or more times. Wavelets have inherent properties that make them useful for signal and image processing. Wavelets cannot only be described by a mathematical equation (for example the sine graph), they have connections to vectors in n-dimensional Euclidean space. This means we can study wavelets using fundamental ideas from linear algebra. This project is intended to explore the applications of wavelets in image processing, audio restoration or seismology. Text: Discovering wavelets by Edward Aboufadel and Steven Schlicker. Prerequisite: The reading will be self paced and only requires you to have taken a course in Linear algebra.
3	Some computations in linear algebra	This project will give the opportunity to use a computer program to solve problems in linear algebra. In particular, If you have taken a first course in linear algebra and you want to learn how to use a computer program to solve problems in linear algebra, then this reading course will help you towards your goal. We will read chapters 5-7 of David Austin's book. An online version of the text is found at: https://davidaustinm.github.io/ula/ula.html. We attempt to understand the Singular Value Decomposition (SVD) treated in chapter 7. If there is time, we will complete any of the following projects (i) 7.5.4 - Image compressing and denoising (ii) 7.5.5 - Analyzing Supreme Court cases) Text: Understanding Linear Algebra by David Austin Prerequisite: A first course in linear algebra

4	Quivers and related mathematical applications	A quiver is a storage for arrows used for fishing, hunting etc. But quivers have mathematical connotations as well – in fact, a quiver is a graph. An algebra is a "nice" mathematics object combining features of a group, a ring, and a vector space. To any quiver, we can associate an algebra. In this project, we will start with groups, rings, fields, vector spaces, and algebras. We will then look at how algebras arise from quivers considering interesting examples. We will read chapters I & II of the text. It will be self-paced, and we will go in the direction you're most interested in. Text: Elements of representation theory of associative algebras by *Ibrahim Assem, Daniel Simson, Andrzej Skowronski* Prerequisites: Linear Algebra + the first course of Abstract Algebra covering Group Theory and possibly some ring theory
5	Some group representation theory	Representation theory is an old and beautiful field that boils down to finding matrix solutions to equations. It connects abstract algebraic structures (such as groups) to matrix theory (linear algebra). In this project, we will start with a review of group theory and the theory of vector spaces and continue into Group Representation Theory. It will be self-paced, and extra topics could be introduced based on your interests. Text: "Representation Theory and Characters of Groups" by James and Liebeck Prerequisites: Linear Algebra + the first course of Abstract Algebra covering Group Theory
6	Applications of the Brouwer fixed point theorem	The Brouwer fixed point theorem states that any continuous map from an n-sphere to an n-Euclidean space maps a pair of antipodal points to the same spot. It has several applications in algebraic geometry and combinatorics. In this project, we will look at some topological and non-topological proof of the theorem and consider some interesting applications. Possible text: Any undergraduate text in topology Prerequisite: A first course in undergraduate analysis
7	Introduction to commutative algebra	In this project, we will look at basic notions and objects of study in commutative algebra- rings, ideals, factorization, localization and draw connects to some geometric objects. We will follow the text *Undergraduate commutative algebra* by Miles Reid. Possible Text: Undergraduate commutative algebra by Miles Reid. Prerequisite: a first course in linear/abstract algebra
8	Introduction to homological algebra	This project is a step-by-step guide to homological algebra approaching it from the perspectives of terms originating from algebraic topology. We will follow the text Introduction to homological algebra by Joseph Rotman Text: Introduction to homological algebra by Joseph Rotman Prerequisite: Linear algebra + a first course in abstract algebra

9	Zero divisor graphs of tri-diagonal matrices	Ring theory involves the study of zero divisors. In this project, we will consider the ring of 3 by 3 tri-diagonal matrices over a finite field, studying its zero divisors. We will be particularly interested in the zero-divisor graph of this ring. We will investigate properties such as Eulerian, planar, Hamiltonian, traceability of this graph. This project involves a lot of computations and possibly the use of some computer application software. The project will help you explore connections between noncommutative algebra and graph theory. **Text: We will read the paper "Structure in zero-divisor graphs of noncommutative rings" by S. Redmond.** **Prerequisite: Linear algebra+ first course in abstract algebra covering groups and rings.**