**Algebra Project Ideas**

**Topic 1:** Basic Category Theory by Tom Leinster

**Project:** The student will learn basic category theory through the study of a range of mathematical structures and their relationships. The student will explore fundamental concepts such as objects, morphisms, functors, natural transformations, limits, colimits, and representable functors. The specific focus will be on understanding how different mathematical objects are connected through these categorical structures and how these connections can be used to solve problems in various branches of mathematics.

**Keywords:** Category theory, functors, natural transformations, Grothendieck, injective, surjective, isomorphism.

**Suggested Prerequisites:** Math 301 and Math 331 are useful, and some knowledge of set theory, linear algebra, and topology for referencing examples.

**Topic 2:** Elliptic Curves by Jean-Pierre Serre

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** calculus, computations, special functions, general function.

**Suggested Prerequisites:** Project Mark 10 and Mark 231 are useful, and some knowledge of set theory, linear algebra, vector spaces, and linear maps for referencing examples.

**Topic 3:** Rational Points on Elliptic Curves by Joseph Silverman and John Tate

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L, and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** number theory, modular forms, fields, groups, proofs, notes, sample numbers.

**Suggested Prerequisites:** Number theory, modular forms, elliptic curves, modular forms, notes, modular arithmetic.

**Topic 4:** An Introduction to the Theory of Numbers by Niven

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L, and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** elliptic curve, groups, abelian, integer solutions, Fermat's last theorem, cryptography, elliptic cryptography, number theory, finite fields.

**Suggested Prerequisites:** Project Mark 10 and Mark 231 are useful, and some knowledge of set theory, linear algebra, vector spaces, and linear maps for referencing examples.

**Topic 5:** Classical Galois Theory by Jean-Pierre Serre

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L, and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** elliptic curve, groups, abelian, integer solutions, Fermat's last theorem, cryptography, elliptic cryptography, number theory, finite fields.

**Suggested Prerequisites:** Project Mark 10 and Mark 231 are useful, and some knowledge of set theory, linear algebra, vector spaces, and linear maps for referencing examples.

**Topic 6:** Algebra and Topology by John Rognes

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L, and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** algebra, algebraic topology, number theory, finite fields.

**Suggested Prerequisites:** Project Mark 10 and Mark 231 are useful, and some knowledge of set theory, linear algebra, vector spaces, and linear maps for referencing examples.

**Topic 7:** Topological Groups and Lie Groups by G. Mislin

**Project:** This project is designed for a younger undergrad who has a strong grasp of the 32L, 22L, and 22M material. Linear algebra we may need can be picked up along the way.

**Keywords:** algebra, algebraic topology, number theory, finite fields.

**Suggested Prerequisites:** Project Mark 10 and Mark 231 are useful, and some knowledge of set theory, linear algebra, vector spaces, and linear maps for referencing examples.