Directed Reading in Homological Algebra, Mark Krusemeyer
Fall/Winter or Winter/Spring (circle one or both)
Prerequisite: Math 342 (Abstract Algebra I); some knowledge of topology may be helpful, but is not required.

Description: This is an opportunity for two people to delve deeply into material beyond the standard undergraduate curriculum, and to get substantial (weekly) experience in presenting that material at the blackboard. Homological algebra grew out of investigations in algebraic topology and has important applications there, but it has become a separate, highly abstract area of mathematics. The mathematical "language" of category theory, which it uses, is pervasive in much of modern mathematics. (Some results which require only this general framework and thus pop up in all sorts of different contexts are affectionately known as "(general) abstract nonsense" - you can find a Wikipedia article with this title!) The reading will probably cover substantial sections of MacLane's classic book *Homology*.

Directed Reading in Elliptic Functions and Modular Forms,
Mark Krusemeyer Fall/Winter or Winter/Spring (circle one or both)
Prerequisites: Math 261 or 361 (Functions of a Complex Variable/Complex Analysis, required); Math 342 (highly recommended). Experience with number theory may be helpful, but is not required.

Description: This is an opportunity for two people to delve deeply into material beyond the standard undergraduate curriculum, and to get substantial (weekly) experience in presenting that material at the blackboard. We will start by looking at elliptic functions, which are functions of a complex variable that have two independent periods - unlike trigonometric functions, which have only one. This will lead us to Eisenstein series, modular forms, the "classical" proof of the remarkable formula

$$\sigma_7(n) = \sigma_3(n) + 120 \sum_{k=1}^{n-1} \sigma_3(k)\sigma_3(n-k),$$

where $\sigma_r(n)$ denotes the sum of the r-th powers of the divisors of n, and more beautiful mathematics than we can possibly get through. Sources will likely include one or more of Apostol, *Modular Functions and Dirichlet Series in Number Theory*; Koblitz, *Introduction to Elliptic Curves and Modular Forms*; Serre, *A Course in Arithmetic* (chapter 7).