Project title: Extremal Properties of k-Partite Graphs of Large Girth, $k = 2, 3$

Project Description: Extremal graph theory is a branch of graph theory that is interested in studying the following scenario: Suppose $\mathcal{G}$ is a family of graphs, P a property and $\mu(G)$ an invariant for each $G \in \mathcal{G}$. We wish to determine a value m such that whenever $\mu(G) > m$ for $G \in \mathcal{G}$, then G has property P. Those graphs $G \in \mathcal{G}$ for which $\mu(G) = m$ and G does **not** have property P are said to be the extremal graphs with respect to property P and invariant $\mu(G)$. For example, suppose $\mathcal{G}$ is the family of simple graphs on n vertices, n a positive integer. Moreover, suppose P is the property that "G contains a cycle," $G \in \mathcal{G}$ and the invariant $\mu(G)$ is the number of edges of G, $\mu(G) = e(G)$. Then $m = n - 1$ (the number of edges a graph on n vertices can possess and still not contain a cycle) and the extremal graphs are trees on n vertices.

Consider all k-partite simple graphs ($k = 2, 3$) on a finite set of vertices. The objective of this project is to explore bounds on the number of edges that k-partite graphs can have and still be of large girth. That is, what is the maximum number of edges a bipartite or tripartite graph can have and avoid cycles of length n ($n = 3, 4, 5, \ldots$)?