Abstract
PhD Research Proposal: Networking in Graph Theory

The study of networks through the lens of graph theory has emerged as a foundational approach for understanding complex systems in diverse fields such as computer science, telecommunications, social sciences, and biology. This research proposes a rigorous investigation into the structural and algorithmic aspects of graph theory as they relate to networking, with an emphasis on enhancing the robustness, efficiency, and scalability of networked systems.

The central aim is to explore how key graph-theoretic concepts — including connectivity, graph flows, network decomposition, and spectral properties — can inform the design, analysis, and optimization of real-world networks. Particular focus will be placed on (i) developing new theoretical models that accurately capture dynamic and heterogeneous network topologies; (ii) deriving extremal and probabilistic bounds on parameters such as network resilience, fault tolerance, and communication efficiency; and (iii) designing efficient algorithms for network routing, clustering, and fault detection based on structural graph invariants.

This interdisciplinary research will bridge deep theoretical insights with practical applications, contributing to both pure graph theory and applied network science. The expected outcomes include novel theorems and structural characterizations, computational methods for network analysis, and validated applications in areas such as wireless communication, distributed computing, and complex networked infrastructures. By advancing the mathematical foundations of networking through graph theory, the project aims to provide robust tools and frameworks that meet the growing demands of modern interconnected systems.