**Independent Study Proposal**  
**Student**: Nick Tagliamonte  
**Instructor**: Professor Shi  
**Term**: Summer 2025 (May 15 – August 8)  
**Credits Requested**: 3

**Title**: Exploring the InterPlanetary File System (IPFS): A Systems and Research-Oriented Independent Study

**Overview**:  
The InterPlanetary File System (IPFS) is a content-addressed, peer-to-peer protocol for decentralized file storage and retrieval. Originally conceived as a more resilient and permanent replacement for HTTP, IPFS introduces a new model for how data is located, transferred, and persisted on the web. By decoupling file identity from location and distributing storage responsibilities across participating nodes, IPFS offers solutions to long-standing limitations in traditional web infrastructure: broken links, central points of failure, and inefficient redundancy.

This independent study aims to investigate IPFS from a systems engineering and distributed computing perspective through research, implementation, and experimentation. It will examine how IPFS works and its design, how it performs under stress, and what challenges remain unsolved. The goal is to develop an understanding of the technical and theoretical forces shaping decentralized file systems and the broader web3 ecosystem.

**Scope and Objectives**:  
The primary goal is to understand the architectural and operational foundations of IPFS through theoretical and applied perspectives. Topics will include:

* **Protocol Architecture**: Understanding how IPFS uses Merkle DAGs for content addressing, libp2p for peer communication, and Kademlia-based DHTs for routing and lookup.
* **Systems Behavior**: Investigating how IPFS handles peer discovery, data persistence, replication, and consistency in the absence of a central authority.
* **Performance and Fault Tolerance**: Evaluating IPFS under conditions such as node churn, limited bandwidth, and increased latency, with an focus on its resilience and scalability.
* **Security and Reliability**: Studying challenges like content tampering, availability, and spam or Sybil attacks, as well as defenses currently implemented in the protocol.
* **Contextual Research**: Reviewing academic and industry literature on decentralized storage systems and Web3 technologies to situate IPFS in its broader technical context. Stretch goal to identify a specific bottleneck or open problem in the IPFS stack to pursue in the future.

**Deliverables**:  
To synthesize research and demonstrate practical engagement with the technology, the study will produce the following:

* A **weekly log** capturing progress, technical notes, and reflections
* A **small-scale IPFS node cluster**, deployed and tested with various configurations and simulated network conditions
* A **prototype application** utilizing IPFS for decentralized file storage or data sharing
* A **final report or presentation** summarizing findings, architectural insights, and open questions or directions for future work