A cyber-physical system (CPS) is a networked embedded computing system with tight integration of computational and physical components.

Networked computing devices in a CPS communicate with one another and interact with the physical world via sensors and actuators. CPS has ubiquitous applications from smart buildings to medical devices to automobiles. The increasing demand for dependable and robust CPSs has raised new challenges in their design methodologies. From self-driving cars to multi-robotic coordination systems to synthetic regulatory anticancer therapies, safety and robustness have become desired features. Achieving a high confidence in these properties requires rigorous analysis across many facets of the design process. Because a CPS typically displays hybrid behavior of interacting discrete-time and continuous-time dynamics. Formal methods, in principle, can deliver provable guarantees by identifying design flaws that conventional simulation methods fail to find, which may lead to catastrophic consequences.

This course provides an introduction to the principles of CPS design, specification, modeling, and analysis. These principles draw from a diverse set of sub-disciplines, including model-based design, concurrency theory, distributed algorithms, formal methods for specification and verification, control theory, and hybrid systems.