MITMECHE

Colloquium

Mechanical Engineering Lecture in Mechanics

Fragility and Resilience of modern power systems

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Power system is the largest, and arguably the most complex machine ever built. Due to the physics of power flows it lacks global stability and is naturally "fragile". Large enough disturbances may result in loss of stability and trigger a cascade of failures leading to major blackout. Aggressive introduction of renewable generation around the world increases the overall stress on the systems, and stability/resilience constraints are becoming the key barrier for integrating more clean energy sources. At the same time, advances in GPS assisted real-time sensing and fast power electronic actuations offers unique opportunities for redesigning both normal and emergency control architectures in power systems.

In this talk I will introduce novel computational tools for both analysis and control of modern power grids. The first half will primarily focus on the problem of transient stability of large scale transmission power grids. I will discuss novel approaches to characterization of attraction basins for systems lacking global stability, and introduce new strategies for designing remedial action schemes that can save the system from collapse. In the second half, the same problem will be addressed in the context of the rural electrification of poorest regions of India and Africa where 1 billion of people still lack power access. I will introduce the concept of modular low voltage ad hoc microgrids and discuss the stability related challenges. Brayton-Moser potential theory will be used to derive design specifications allowing for ad hoc interconnection of individual components that guarantee transient stability of the overall systems.

The talk will finish with an overview of open problems and opportunities.