Prof. Kostya Turitsyn (Assistant Professor, MIT)

"Computational toolbox for stability of future power systems"

Abstract. Power system is the largest, and arguably the most complex machine ever built by humans. Due to inherent nature of power flows it lacks global stability and is naturally "fragile". Large enough disturbances may cause the loss of stability and trigger the cascading failures resulting in major blackouts. Aggressive introduction of renewable generation increases the overall stress of the system, so the stability constraints will likely become the main barrier for transition to clean energy sources. Despite many decades of research, stability assessment is still the computational bottleneck in power grid operation process.

The talk will consist of three parts. After a gentle introduction to power system stability and computational challenges the discussion will focus on a recently proposed Lyapunov Function Family technique for assessment of transient stability of power systems. This technique will be shown to be applicable to design of the so-called special protection systems and identification of the possible remedial actions executed during the emergencies. Despite its effectiveness in simple models, the approach can not be yet applied to a whole spectrum of power system models, and is generally poorly scalable. A number of possible strategies will be proposed to tackle these challenges.

The final part of the talk will introduce an emerging technology of low voltage ad hoc DC microgrids that are a viable solution for providing electricity to 1 billion people in the world currently lacking access to power. By design, these microgrids have to be modular and maintain stability for arbitrary network topology. Furthermore, power dispatch has to be coordinated in a decentralized manner. A simple set of design criteria will be proposed that guarantees stability for arbitrary interconnection. The talk will conclude with the discussion of a simple decentralized control strategy that ensures economic optimality and its performance verified via numerical simulations.

Bio. Konstantin (Kostya) Turitsyn received his Ph.D. degree in physics from Landau Institute for Theoretical Physics, Moscow, in 2007. Currently, he holds an Assistant Professor position in the Mechanical Engineering Department at Massachusetts Institute of Technology (MIT), Cambridge. Before joining MIT, he was Kadanoff-Rice fellow in University of Chicago and Oppenheimer fellow at Los Alamos National Laboratory. His research interests encompass a broad range of problems related to development of novel mathematical tools for analysis of large-scale nonlinear and stochastic systems. These tools have been applied to problems arising in different domains, most importantly in the fields of statistical physics, optics, fluid mechanics and more recently power systems.