

## Master Class “Advanced methods of operations research – theory and applications to energy markets”

**Date:** July 3 – 4 and 6 – 7, 2017

**Venue:** DIW Berlin

**Instructors:** Jeremy Eckhause (RAND Corporation), Sauleh Siddiqui (Johns Hopkins University)

**Optional credit points:**

6 ECTS (upon approval of your institution), written exam & seminar paper, other arrangements possible, contact Alexander Zerrahn on this issue

**Apply:**

email to Alexander Zerrahn ([azerrahn@diw.de](mailto:azerrahn@diw.de)) until June 15 with *short* info on academic background

This one-week short course provides participants with selected state-of-the-art methods in OR for both academic and applied work. It covers integer programming, real options, complementarity problems, and multi-stage games. The instructors have long-standing experience in both applied as well as theoretical research and teaching at various institutions.

The course comprises both theory lectures and hands-on programming sessions in GAMS. Applications mainly focus on energy markets; methods are, however, go beyond the field and can be applied to various investment and planning problems (under uncertainty), or computational game theory.

The course targets Berlin-based researchers and graduate students interested in applied OR and IO, energy market analysis, and numerical methods for management science. Some previous knowledge in numerical optimization techniques and the software GAMS is desirable but no prerequisite. If there is demand, an introduction to GAMS will be given.

The course consists of two parts – Monday and Tuesday, led by Jeremy Eckhause; Wednesday and Thursday led by Sauleh Siddiqui. Both parts together can be taken for 6 ECTS (optional) or taken separately (without credit points).

### Schedule

Monday 3 July (Jeremy Eckhause, Dulles room)

9.00 – 12.30: Integer Programming (IP): Geometric aspects of IPs, Examples of IPs, Logic problems: Either-or, If-then formulations

14.00 – 17.30: IP Examples: piecewise approximations to nonlinear terms, Linearizing products of binary variables, Solving IPs using branch-and-bound, Solving 0-1 IPs using implicit enumeration, Formulating IPs, IPs applied to energy case studies

Tuesday 4 July (Jeremy Eckhause, Schmoller room)

9.00 – 12.30: Real Options: investment under uncertainty, fundamental concepts, illustrative examples

14.00 – 17.30: Real Options: modeling real options as Markov Decision process, in-class exercises using stochastic dynamic programming (SDP) models, applications to clean energy investment

Wednesday 5 July (Sauleh Siddiqui, Dulles room)

9.00 – 12.30: Optimality conditions for constrained problems: Karush-Kuhn-Tucker (KKT) conditions (will be seen as special case for mixed complementarity problems)

14.00 – 17.30: Definition of (mixed) complementarity problems and variational inequalities, producer duopoly, GAMS exercises

Thursday 6 July (Sauleh Siddiqui, Schmoller room)

9.00 – 12.30: Wardrop traffic equilibrium, spatial price equilibrium, small natural gas market equilibrium, MPECs

14.00 – 17.30: Nash Cournot games, GAMS exercise from Chapter 1 of Gabriel book; Discuss project options, form groups, etc.

Friday 7 July (Jeremy Eckhause, Sauleh Siddiqui, Friedensburg room)

9.00 – 12.30: Participants present their proposed projects to the class (10-15 minutes) per group; Exam Review: Format, Review problems, etc.

Monday 10 July (tentatively)

9.00 – 13.00: exam