**Project work – Fall 2014**

**Supervisor: Professor Bjarne Foss**

This note includes additional information on project work proposals. All projects can be continued in a Master thesis project. Further, all projects has a co-supervisor who is a current PhD-student or a postdoc researcher. Some of the projects will be run in cooperation with external companies.

**1. Optimal control - Integration of control and experiment design for optimal adaptive control**

Adaptive controllers for unknown systems often suffer from insufficient information gathered during operation, due to little variation in a system’s outputs and the control inputs. While little variation in these signals can be a good thing when it corresponds to meeting a control goal, it can paradoxically lead to poor control or even instabilities since the controller in this case does not learn enough about the system. A solution to this is to design a controller that intelligently perturbs the system so that more information can be gathered from the response, while trying to minimize the reduction in control performance, effectively experimenting with the system while controlling it.

The goal of this project is to use ideas from model predictive control and estimation to find good adaptive control strategies that achieve these specifications. Other techniques can be used depending on the student’s interests and background. The problem requires strong skills in optimization and nonlinear programming (NLP), parameter estimation/system identification, adaptive control, and systems theory. Recommended courses include TTK4135 Optimization and Control and TTK4215 System Identification and Adaptive Control.

Co-supervisor: PhD student Tor Aksel Heirung.

**2. Stochastic optimization – Applied to oil and gas systems**

When optimizing the performance of a system, model parameters are often uncertain. For the objective function, this can be handled by considering the expected value. For the constraints, chance constraints can be used, meaning that the constraints must be met with a certain probability. If the uncertainty is Gaussian and the model linear, a deterministic equivalent of the chance constraint can be found, resulting in a Second Order Cone Programming problem. When these requirements are not met, deterministic equivalents are very difficult to find, and approximations are often used.

The application will be optimization of oil and gas systems, where an important problem is to maximize oil production while honoring all operational and safety-related constraints.

Co-supervisor: PhD student Kristian Hanssen

**3. Energy analysis in flow networks**

Optimization in multiphase flow networks may include the need for energy balances to model temperatures since gas flow rates depend on temperature. This may be done in different ways, using detailed or simplified models. In this work we study the suitable formulations for optimization applications. The application will be taken from oil and gas systems.

Co-supervisor: PhD student Bjarne Grimstad

**4. Rate estimation of multiphase flow with moving horizon estimators**

Current work on the use of simple models with a moving horizon estimator for rate estimation in multiphase flow, is promising. In this work we extend current results by using dynamic models instead of steady-state models. The student will in addition to Matlab use the state-of-the-art multiphase flow simulator OLGA.

Co-supervisor: PhD student Bjarne Grimstad

**5. MPC - Nonlinear MPC applied to oil reservoir simulation**

When producing from underground oil reservoirs about 50% of all the oil is left over! This has many reasons; thus maximizing recovery is a complicated task. In this work we explore the use of MPC to increase recovery by adjusting injection and production rates, or well pressures, in an optimal manner. This work continues current research and it includes the use of simple reservoir models and advanced optimization techniques. The Matlab MRST toolbox will be an important testing and implementation platform.

Co-supervisor: PhD student Andres Codas

**6. MPC - Constraint handling for Nonlinear Model Predictive Control applied to Oil Reservoir Production Optimization**

When producing from underground oil reservoirs about 50% of all the oil is left over! This has many reasons; thus maximizing recovery is a complicated task. In this work we explore how nonlinear constraints can be included without deteriorating computational performance. This will be done by using a multiple shooting techniques where the optimization interval is divided into smaller parts, which can be handled in parallel. This work continues current research and it includes the use of simple reservoir models and advanced optimization techniques. The Matlab MRST toolbox will be an important testing and implementation platform.

Co-supervisor: PhD student Andres Codas

**7. MPC - Fault-tolerant MPC for active mitigation of actuation faults in process systems**

MPC applications need to be monitored since alternative faults may occur. Faults may for instance include the loss of measurements. In this work we study alternative approaches for detecting and mitigating such faults. The work will be done in cooperation with Cybernetica AS.

Co-supervisor: Postdoc researcher Brage Knudsen

**8. Optimization in electric power producing system by use of decomposition techniques**

This work studies optimization of energy systems, more specifically electric power producers and the emission-constrained unit commitment problem. These problems may be large, thus there is a need to decompose them in order to solve them efficiently. This can be done by Lagrange relaxation, which will be the focus of this study.

Co-supervisor: Postdoc researcher Brage Knudsen