TTK4130 Modeling and Simulation – Reading list

Textbooks: "Modeling and Simulation for Automatic Control", O. Egeland and J.T. Gravdahl, 2002. (E&G)
"Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", P. Fritzson, 2011. (F)

Exercises and presentations prepared for lectures (at blackboard) are also curriculum.

Topic	Chapter	Key issues
Modeling, and model representation	F: 1, E&G: 1.1 – 1.3, 2.1 – 2.2	Modeling and Simulation. State-space models, linearization, transfer functions.
Principles of object-oriented modeling Modelica	F: 2	How should models be interconnected? Principles of object-oriented modeling languages. Modelica/Dymola.
Energy-based methods and passivity	E&G: 2.3 – 2.4	Energy functions, passivity, positive real transfer functions, storage functions, interconnection of passive systems.
Electromechanical systems	E&G: 3.1 – 3.6	DC-motor (with constant field), gears, elastic transmissions, deadzone. Transfer functions.
Hydraulic motors	E&G: 4.1 – 4.4 (4.2.2/4.2.3 more central than the rest.)	Valves, regularization, four-way valves, motor models.
Transmission lines.	E&G: 4.5 – 4.6	Principles in the different approaches to solving the transmission line PDEs.
Friction	E&G: 5	Viscous friction, Coloumb friction, static friction, Stribeck effect. Problems with discontinuity. Dynamic friction models (Dahl, LuGre).
Rigid body dynamics	E&G: 6.1 – 6.9 (detailed knowledge of quaternions not required), 6.12 – 6.13, 7.1 – 7.7, 8.1 – 8.2	Vectors, dyadics. The rotation matrix and its representations (Euler angles, angle-axis, Euler parameters). Angular velocity and the kinematic differential equations. Rigid body kinematics. Newton-Euler equations of motions, angular momentum, inertia dyadic/matrix, kinetic energy of a rigid body. Generalized coordinates, forces of constraints, d'Alembert's principle. Lagrange's equation of motion.
Balance laws	E&G: 10.4, 11.1 – 11.4 Presentations for Lecture 21 and 22	Balance laws for process modeling. Mass balance (differential and integral form, multicomponent systems), momentum balance, energy balance.
Numerical solution of ordinary differential equations	E&G: 14.1 – 14.8, 14.11 (Understand principles of multistep methods), 14.12 (What is a DAE problem? What is the differential index, how to reduce the index of a DAE system?).	Order, local error, stability function, linear test system. Explicit Runge-Kutta methods, Implicit Runge-Kutta methods. Butcher arrays. Stability regions. Stiffs systems and Aliasing, and A- and L-stability. Padé approximations and Runge-Kutta methods. Automatic adjustment of step sizes. Event detection. Principle behind multistep solvers (Adams, BDF). DAE system, reduce differential to index 1 DAE system.