Institut für Thermodynamik
Prof. Dr.-Ing. Jürgen Köhler
Department of Mechanical Engineering
Technical University Braunschweig / Germany

Lectures

Thermodynamics (Koehler, G, L/E 3/2, WS, 6 CP): Balances and conservation laws, thermodynamic relations, fundamental equations and equations of state, heat and work interactions, equilibrium criteria, ideal gas, properties of real substances, thermodynamic processes, moist air processes.

Heat and Mass Transfer (Koehler, G, L/E 2/2, SS, 4 CP): Heat exchanger, steady state and transient heat transfer, convective heat transfer with/ without phase change, radiation of black/real bodies, diffusion.

Thermodynamics of Mixtures (Koehler, G, L/E 2/1, WS, 5 CP): Basics of multicomponent systems (Gibbs fundamental and Gibbs-Duhem's equation, Legendre transformation, equilibrium conditions and stability); properties of mixtures; thermodynamic models; phase diagrams; chemical reactions.

Thermodynamics and Statistics (Koehler, E, L/E 2/1, SS, 5 CP): Balances and conservation laws (mass, momentum, energy, entropy), thermodynamic relations (Euler, Gibbs-Duhem, Maxwell), fundamental equations and equations of state, heat and work interactions, equilibrium criteria, ideal gas, properties of real substances, statistical thermodynamics.

Object-Oriented Methods in Thermal Science (Koehler/Tegethoff, E, L/E 2/2, WS / SS, 5 CP): Intensive course C++ (classes, inheritance, polymorphism, container types). Object-oriented modeling of simple energy systems on the basis of the first law of thermodynamics. Object-oriented formulation of heat transport mechanisms (conduction, convection, radiation, contact, enthalpy flow). Transient and steady state systems. GUI programming with QT.

Molecular Simulation (Koehler/Raabe, G, L/E 2/0, WS, 5 CP): Basics of statistical mechanics and molecular modelling; introduction to Monte Carlo and molecular dynamics, simulation in various ensembles; simulation structure.

Mobile Air Conditioning (Koehler/Specht, G, L/E 2/0, WS, 5 CP): HVAC systems in cars, historical background, refrigeration processes, e.g., Evans-Perkins cycle, absorption cycle, gas cycle, air conditioning and heat pump systems, refrigerants (conventional and alternatives like CO2, 152a, Blend H, DP1), components, e.g., heat exchangers, expansions valves, compressors, control units.

Modeling of Thermal Systems in Modelica (Koehler/Tegethoff/Richter, L/E 2/1,WS/SS): Formulation of hybrid differential algebraic equation (DAE) systems with the modeling language Modelica, solving DAE systems, polymophism, examples:polymorph model library for refrigeration cycles, lumped capacities, heat exchangers

Thermodynamics in Chemical Process Simulations (Broecker, G, L/E 2/0, WS, 5 CP): Applications of thermodynamics in process simulations; thermodynamic modeling of devices and processes; empirical and physical models for properties of pure substances; models of real mixtures; models of chemical reactions and their kinetics.

Environmental Protection Processes I, II (Hempel, Koehler, Kosyna, Leithner, Scholl, Schwedes, G, L/E 2/0 + 2/0, WS + SS, 5 + 5 CP): Climate protection, production-integrated environment protection, measurement techniques, methods for off-gas and air cleaning: particulate and gaseous impurities, transport of environmentally sensitive products, energy conservation, water and waste water, noise protection, recycling, waste treatment and deposition, legislation: authorities and procedures

Numerical Simulation (CFD) (Koehler, Kosyna, Leithner, Scholl, G, L/E 2/1, WS, 5 CP): Application examples, balance equations, discretisation methods: finite differences, finite elements, finite volume; solution methods for algebraic equations; turbulence models, heat and mass transfer, chemical reactions, phase change; multiphase flow; commercial tools; exercise in grid generation and flow simulation

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Research

Thermophysical Properties

- simulation of VLE (vapor-liquid equilibrium) and LLE with various EOS, mixing rules and g^E-models
- experimental investigation of VLE and VLLE at low temperatures
- Monte Carlo and molecular dynamic simulations of thermophysical properties
- determination of ab initio interaction energies

Thermal systems

- analysis and investigation of A/C systems for climate control in automobiles and residential buildings
- transient and steady-state system simulations, development and application of own simulation tools for the computation of various energy, refrigeration and A/C systems as well as modeling based on commercial software (Modelica),
- detailed steady-state and transient object oriented modeling (C++, Modelica) of components for thermal systems (compressor, HX, receiver, expansion devices, etc. for various refrigerants)
- experimental analysis of mobile and stationary A/C and heat pump cycles using alternative refrigerants (CO_2)
- optimization of heat supply systems (comfort heating and hot water) for lowest energy residential buildings based on the CO_2 heat pump system (including solar-thermal coupling)
- theoretical and experimental studies of enhanced systems like ejector cycles or two stage high performance A/C and heat pumps operating in the transcritical mode (CO_2 based)

Heat and Mass Transfer

- experimental analysis of fluid flow and heat transfer in complex geometries utilizing laser optical visualization methods (PIV, LDA) as well as IR-thermography and ammonia absorption method (determination of local heat transfer coefficients)
- CFD simulations of various heat exchanger geometries (Fluent, Star CD)
- high-speed visualization of temperature distribution in technical applications (e.g. automobile breaks)
- investigation of the influence of local turbulence on heat transfer properties

Equipment

Thermophysical Properties

- VL(L)E apparatus for the investigation of phase equilibria (p < 10MPa, T = 100 - 300K)
- codes for the computation of VLE and LLE with various EOS, mixing rules and g^E-models
- various codes for molecular simulations of thermophysical properties at equilibrium

Thermal Systems

- compressor test facility (indicator diagram measurements, especially for CO_2)
- calorimetric test chamber for A/C and heat pump measurements
- test facilities for A/C components (HX, receiver, expansion device, etc.)
- own simulation platform designed for computation of thermal systems
- Dymola / Modelica

Heat and Mass Transfer

- Particle Image Velocimetry (PIV) and Laser Doppler Anemometry (LDA)
- high-resolution high-speed thermo camera
- Fluent, Star CD, Centaur

Contact

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