2044. Thermodynamics Software

Programming with open-source software, PYTHON, in energy applications.

- Introduction to Python programming:
  - Installation of Python and programming
  - Basic types of variables
  - Basic language structures
- Programming in Python:
  - Essential libraries (numpy, matplotlib, scipy, openpyxl, pandas, pytorch, etc.)
  - Connecting to external files (excel, text, csv)
  - Calling other languages within Python (C++, Fortran, Julia)
  - Connecting with repositories (github, google colab)
- Creating beginner applications:
  - Simple mathematical problems (e.g., finding prime numbers, solving simple equations)
  - Codes for solving:
  - Newton-Raphson
  - Levenberg-Marquardt
  - Bezier curves
  - Fourier transformations
  - Solving Ordinary Differential Equations
- Introduction to thermodynamics with Python:
  - IAPWS in Python
  - Creating a water vapor chart (Mollier type) via Python (matplotlib)
  - Assignment: given the state equation for R134a, create the corresponding chart
- Lesson 5 – Solving Thermodynamic Problems:
  - Rankine cycle with reheating
  - Plotting on a chart
  - Complete performance analysis

Absorption engines. Description of H_2O-LiBr units, creation of computational codes, modeling their behavior. Extension of applications to double-effect units and to modern cogeneration installations. Stirling engines: Introduction. Types of engines (A, B, C). Power engines. Refrigeration engines. Crankshaft engines (CSEs) and free-piston engines (FPSEs). Solar systems (Dish-Stirling). Low-temperature differential engines. Cogeneration. Reduced-emission engines. Isothermal and adiabatic analysis. Thermal losses. Application of these analyses to thermal engines like GPU-3 and Ford-Philips 4-215 and the refrigeration engine PPG-102. Generalized and specific state equations. Calculation of thermal and thermodynamic properties of real gases. Thermodynamics of compressible gases. Chemical potential. Fugacity of pure gases and binary mixtures. State equations of binary mixtures. Free surface

phenomena and their thermodynamics. Computational code for thermodynamic properties of water-steam. Examples of modeling power and refrigeration systems. Cogeneration plants for power, heating, and cooling. Open cycle units with solid and liquid desiccant materials. Geothermal heat pumps and ground source heat exchangers. Examples of modeling solar thermal collectors, both flat and parabolic trough type, as well as photovoltaic systems. Modeling of solar cooling systems.
Methodology for calculating thermal and cooling loads of a residence. Optimization of building energy efficiency. Nearly zero-energy buildings.

E. Koronaki, (G. Antonakos, N. Komninos)