THERMAL PROBLEMS

Thermal problems are basically those caused by high or low temperatures, i.e., thermodynamic problems of how to reach and maintain those temperatures, materials problems of how to withstand them, heat transfer problems of energy dissipation, flow of energy due to a temperature difference, measuring thermal effects, etc.

Examples of thermal problems:

- Metabolic heat release. Living beings, and humans in particular, have to get rid of metabolic heat (some 100 W for an adult person), thus a thermal problem arises when the ambient temperature is too low (we need coating or heating) or too high (we need cooling). Most common appliances today also require proper thermal design to dissipate the heat released by electronic components (microprocessor cannot be made smaller because of that).
- Heat engines. It is easy to burn natural fuels found in some places (wood, coal, oil, gas) in contact with the omnipresent oxidising atmosphere in which we live, but to produce mechanical energy (work) or electricity from this heat release is not so easy. The solution found just a couple of centuries ago, is to make use of an auxiliary working fluid that is compressed (consuming some work), heated by fire, and expanded, producing more work than that used for compression. The working fluid is finally cooled back to the initial conditions (for external combustion engines), or vented and new working fluid admitted (for internal combustion engines). Moreover, thermal problems in a heat engine are not just knowing the main processes of how it works, but making sure that its structure is compatible with the high temperatures, thermal shocks, thermal expansion gaps, etc.
- Dehumidifying. Even though the ambient temperature may be not too high not too low, sometimes it is too humid and the need arises to take some water out of the air. This may be accomplished by using some desiccant material, but to do it steadily one may resort to condensation by cooling (using a refrigerant machine), and disposing of the condensate. Refrigerant machines work very similarly to heat engines but inverting the direction of the processes described above.
- Thermal analysis. How to analyse the chemical composition of a given material? There are old chemical methods (e.g. try with several reactants), there are new physico-chemical methods (mostly spectroscopic), but there are also thermal methods of analysis, based on the measurement of thermal properties (transition temperatures, specific thermal capacities, thermal diffusivities, etc.) by forcing a small sample to heat and cool. Thermal problems in this case mainly concern the proper design of precision setups for measuring and controlling energy transfers and temperatures, because operation of such a sophisticated apparatus should be just routine work (like operating the heat engine in a car!).

Learning how to solve thermal problems may be split into the following traditional main subjects:

- Thermodynamics: concepts, substance models, material properties, compound systems, machines, metrology.
- Heat Transfer: conduction (diffusion), convection (fluid mechanics or correlations), radiation, heat exchangers, phase change. Material properties.

- Heat Generation: combustion (practical or theoretical), electrical, others (radiation, friction). Design.
- Heat Engines: cycles, reciprocating engines (Otto, Diesel), rotodynamic (gas turbine, vapour turbine). Subsystems: elements, working fluids, materials and structure (lubrication, vibration), control. Design.
- Refrigeration and Air Conditioning: vapour compression, absorption, cryogenics, psychrometry. Subsystems: elements, materials and structure (insulators, working fluids, lubricants, vibrations), control. Design.

The division above is just conventional; e.g. boilers may be studied as phase-change processes in Thermodynamics, as heat exchangers in Heat Transfer, as hearths in Heat Generation, or as elements of vapour heat engines.