

## Indirect techniques

Vittorio Basso  
Torino, Italy  
[\\*v.basso@inrim.it](mailto:*v.basso@inrim.it)

Reciprocal relation of thermodynamics permits one to relate different extensive quantities like volume, entropy dipole moment and magnetic moment among each other. We will review some of these effects in ferromagnetic materials by underlying the main experimental techniques together with their possibilities and their limitations. Similarly we will review magnetoresistance effects used as a probe of the magnetic state of ferromagnetic metals.

### Lecture topics:

1. Volume, strains, and magnetostriction effects
  - a. Magnetostriction
  - b. Measurement of strain and volume changes
2. Heat, entropy and magnetocaloric effects
  - a. Magnetocaloric effect
  - b. Measurement of specific heat and entropy change
3. Transport properties and magnetization
  - a. The magnetoresistance effects
  - b. The (anomalous) Hall effects of ferromagnets

### Recommended reading:

- [1] [1] R. O'Handley, Modern magnetic materials: principles and applications, John Wiley & Sons, New York (2000).
- [2] [2] J. M. D. Coey, Magnetism and Magnetic Materials, Cambridge University Press (2010).