

Magnetism, magnetic materials and measurements

The course will provide the basis to understand the metrological aspects of magnetism, the physics of modern magnetic materials and the associated measurement techniques. It will give an introduction to

- basic concepts in magnetism
- quantum origin of ferromagnetism
- theories of magnetization process
- materials for technological applications
- experimental techniques

The course will be held in English language online via the platform provided by the Politecnico di Torino (virtual classroom). At the end of the course it will be possible to participate to a lab visit at INRIM.

Interested students should send a confirmation email to m.kuepferling@inrim.it, v.basso@inrim.it, to receive the links to the lectures and to be updated on last minute changes.

Dates:

Mon/Lun	Tue/Mar	Wed/Mer	Thu/Gio	Fri/Ven	Sat/Sab	Sun/Dom
May 16	May 17	May 18 9-12 CET L1	May 19	May 20 9-12 CET L2	May 21	May 22
May 23 9-12 CET L3	May 24	May 25 9-12 CET L4	May 26	May 27 9-12 CET L5	May 28	May 29
May 30 9-12 CET L6	May 31	June 1 9-12 CET L7	June 2	June 3	June 4	June 5

Program (20 hours – 14 units):

Each lecture is split in two units of about 45-60min. Before and after each unit there will be time for Q&A and between the units there will be a 15min break.

Lecture 1: Introduction to magnetism and magnetic materials

- 1.1 Magnetism and technology: importance of magnetic materials (MK)
- 1.2 Magnetic media in Maxwell equations (VB)

Lecture 2: Magnetostatics and microscopic origin of magnetism

- 2.1 Magnetostatics (VB)
- 2.2 Magnetic Moments; Dia- and Paramagnetism (MK)

Lecture 3: Ferromagnetism and magnetic energies

- 3.1 Ferro-, antiferro- and ferrimagnetism (MK)
- 3.2 Energy relations (VB)

Lecture 4: Micromagnetics and magnetic domains

- 4.1 Micromagnetics (VB)
- 4.2 Domains and domain walls (MK)

Lecture 5: Magnetization processes and soft magnetic materials

- 5.1 Magnetization processes (VB)
- 5.2 Soft magnetic materials (MK)

Lecture 6: Hard, magnetostrictive and magnetocaloric materials

- 6.1 Hard magnetic materials (MK)
- 6.2 Magnetostrictive and magnetocaloric materials (VB)

Lecture 7: Spintronics with magnetic materials

- 7.1 Magnetism and electric currents (VB)
- 7.2 Spintronics and spin currents (MK)

Lab visit at INRIM (2 hours): Measuring and preparing magnetic materials

References:

- F. Fiorillo, *Measurement and characterization of magnetic materials*, Elsevier, 2004.
- G. Bertotti, *Hysteresis in Magnetism*. Academic Press, 1998
- S. Blundell, *Magnetism in condensed matter*, Oxford University Press, 2001.
- R. O'Handley, *Modern magnetic materials. Principles and applications*, John Wiley & Sons, 2000.
- B.D. Cullity, *Introduction to magnetic materials*, Addison-Wesley, 1972.
- S. Chikazumi *Physics of ferromagnetism*, Oxford University Press, New York, 1997.
- M.D. Coey, *Magnetism and magnetic materials*, Cambridge University Press, 2009.
- R. Skomski, *Simple models of magnetism*, Oxford Graduate Texts, 2008.
- A.H. Morrish, *The physical principles of magnetism*, Wiley, 2001.