Unit 1
Superconducting Accelerator Magnets: Course Introduction

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European Organization for Nuclear Research (CERN)

Scope of the course

- This course provides an overview of the physics and technology of superconducting magnets for particle accelerators addressed to a diversified audience.
- The basic physical principles behind a superconducting magnet for particle accelerators are discussed.
- Key magnet parameters from a *magnetic, mechanical* and *thermal* point of view are presented.
- Some examples of superconducting magnet systems from different applications are analyzed.

Course structure

- 9.00 am to 12.30 pm
  - 3 units
- 12.30 pm to 2.00 pm
  - Lunch break
- 2.00 pm to 5.00 pm
  - 2 units
- Homework assignments and discussions
- In the evening instructors will be available for further discussions or homework support
- Final test on Friday morning (no afternoon session)
- Instructors
  - **Soren Prestemon**, LBNL
  - **Paolo Ferracin**, CERN
  - **Ezio Todesco**, CERN

Course outline
Day 1

- Unit 1: Course introduction
- Unit 2: Magnet specifications in circular accelerators
- Unit 3: Basics of superconductivity
- Unit 4: Practical superconductors for accelerator magnets
- Unit 5: Field harmonics

Course outline
Day 2

- Unit 6: Flux jumps and motion in superconductors
- Unit 7: AC losses in superconductors
- Unit 8: Electromagnetic design – Episode I
- Unit 9: Electromagnetic design – Episode II
- Unit 10: Lorentz forces and stresses in superconducting accelerator magnets

Course outline
Day 3

- Unit 11: Electromagnetic design – Episode III
- Unit 12: Protection of superconducting accelerator magnets – Episode I
- Unit 13: Construction methods and support structures – Episode I
- Unit 14: Construction methods and support structures – Episode II
- Unit 18: Persistent currents and dynamic effects

Course outline
Day 4

- Unit 15: Protection of superconducting accelerator magnets - Episode II
- Unit 16: Degradation and training - Episode I
- Unit 17: Degradation and training - Episode II
- Unit 20: Field models versus measurements
- Unit 22: The LHC magnets during operation

References

- The main references are
  - Martin N. Wilson, "Superconducting Magnets", 1983.
  - K.-H. Mess, P. Schmuser, S. Wolff, “Superconducting accelerator magnets”, Singapore: World Scientific, 1996.
  - Fred M. Asner, "High Field Superconducting Magnets", 1999.
- Additional references (papers, reports, other books) will be provided with each unit.

Credit requirements

- Homework will be assigned at the end of each day and it is due by the morning of the next day.
- Student evaluation will be based on the homework assignments (50% of final grade) and the final exam (50% of final grade).

List of attendees

1. Ady Marton, *EPFL Lausanne and CERN*
2. Chandrasekaran Saravan, *Michigan State University*
3. Chen Yung-Chuan, *Radiabeam Technologies and Indiana University*
4. Eldred Jeffrey, *Indiana University and Fermilab*
5. Hamdi Karim, *Brookhaven National Lab*
6. Hughes Christopher, *Thomson Reuters*
7. Lam Briant, *SLAC National Accelerator Lab*
8. Lv Mingbang, *Institute of Modern Physics / CAS*
9. Marinozzi Vittorio, *University of Milan and INFN*
10. Pierro Federica, *Tufts University*
11. Stoynev Stoyan, *Fermilab*