Unit 1
Superconducting Accelerator Magnets: Course Introduction

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USPAS June 4-8, 2018
Michigan State University

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
  - **Steve Gourlay**, LBNL

Course outline
Day 1

- Unit 1: Course introduction
- Unit 2: Overview of Superconducting Magnets for Particle 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 – I
- Unit 9: Electromagnetic design – II
- Unit 10: Lorentz forces and stresses in superconducting accelerator magnets

Course outline
Day 3

- Unit 11: Electromagnetic design – III
- Unit 12: Protection of superconducting accelerator magnets – I
- Unit 13: Construction methods and support structures – I
- Unit 14: Construction methods and support structures – II
- Unit 15: Protection of superconducting accelerator magnets - II

Course outline
Day 4

- Unit 16: Degradation and training - I
- Unit 17: Degradation and training - II
- Unit 18: Persistent currents and dynamic effects
- Unit 19: Measurements of strain, stress, and coil mechanical properties
- Unit 20: Field models versus measurements
- Unit 21: HTS Accelerator Magnets

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

Student name	Institution name	Level of education	Status
Alvarez, Matthew	Fermilab	msme	audit
Araujo Martinez, Aurora Cecilia	Universidad de Guanajuato	grad student	grade
Banerjee, Sneha	Michigan State University	grad student	grade
Contreras, Crispin	Michigan State University	grad student	grade
Furutani, Keith	Mayo Clinic	phdmp	audit
Garrett, Sierra	Michigan State University	bachelor's	audit
Hendry, Emerson	Michigan State University	bachelor's	audit
Iqbal, Asif	Michigan State University	gsece	grade
Isherwood, Bryan	Michigan State University	grad student	grade
Kabana, Tyler	Michigan State University	bachelor's	audit
Kashy, David	Jefferson Lab	mse	audit
Kiemschies, Oliver	Indiana University and Fermilab	grad student	grade
LaJoie, Andrew	Michigan State University	grad student	grade
Lerch, Jason	Argonne National Lab	bsae	grade
Luo, Didi	Michigan State University	grad student	grade
Mei, Enming	Institute of Modern Physics, CAS	grad student	grade
Nesteruk, Konrad	Paul Scherrer Institut	phd	grade
Rank, James	Brookhaven National Lab	me	audit
Sun, Eric	Jefferson Lab	phd	audit
Zhang, Xiang	Institute of Modern Physics, CAS	grad student	grade