Applied Electromagnetism for Accelerator Components: Magnets and RF Cavities Design

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Mauricio Lopes - FNAL

US Particle Accelerator School – Grand Rapids, MI – June 2012

Objectives

This course will focus on the theory and design of the two main components of accelerators: magnets and RF cavities. The class will be structured to give a good understanding of the underlying electromagnetics as well as the practical demands of component design.

While this class is not intended to be a software tutorial, modeling software will be used extensively to give students hands-on experience with the process of designing these accelerator components.

Class Structure 1

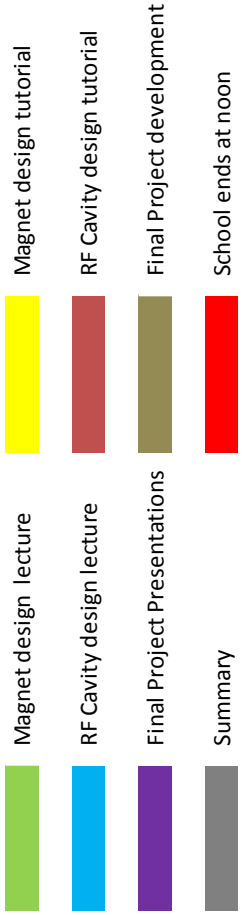
- 20 Lectures (~1.5h each)
- ~ 12 hours of tutorials
- 12+ hours for the project development
- ~ 6 hours for the final project presentations

Class Structure 2

- Homework (40%)
- Project (60 %)

- The project will be done in pairs.
- The teams should be decided by the end of this week!
- Drawing lots on Friday of this week
- Each team will develop two projects: a Magnet and a Cavity related project.
- Afternoons of the second week dedicated to the projects development.
- No HW during the second week.
- Final presentation will be on Thursday of the next week.

Schedule



	First week				
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
9:00-10:30	Introduction	Cavities and Figures of Merit	Stored Energy	Couplers and Cavity Testing	FEM
10:45-12:15	Introduction to RF	Perturbations	Traveling Wave Design Example	Magnetic Measurements	Tutorial (FEMM)
12:15-13:30	Lunch				
13:30-15:00	Conformal Map	Real Materials	Tutorial	Tutorial (OPERA3D)	Simulation Procedure
15:15-16:45	Waveguides and Cavities	Magnet Excitation			Tutorial

	Second week				
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
9:00-10:30	Practical Concerns	SC magnets	Solvers and Multipacting	Presentations	Summary
10:45-12:15	Magnet Fabrication	Advanced Design	Unusual designs		
12:15-13:30	Lunch				School end
13:30-15:00	Project	Project	Project	Presentations	
15:15-16:45					

Course Material

- J. Tanabe – “Iron Dominated Electromagnets: Design, Fabrication, Assembly and Measurements” - World Scientific Pub Co Inc – 2005 – ISBN: 981256327X
  http://www.slac.stanford.edu/cgi-wrap/getdoc/slac-r-754.pdf

- H. Padamsee, J. Knobloch, T. Hays – “RF Superconductivity for Accelerators” – Wiley VCH - 2008 - ISBN: 3527408428

- Class notes

General School Information

- USPAS Office is in the Nelson Room (open from 8:30 a.m. to 5 p.m.)
- Classes start at 9 a.m.
- Dinner will be in the "Imperial Ballroom" from 6 p.m. to 7 p.m
- Study will be held in the "Imperial Ballroom" immediately following dinner (open from 7 p.m. to midnight)
- This classroom will be open until midnight

Instructors
Jeremiah Holzbauer

- Undergraduate at the University of Wisconsin – Madison
  - Applied Mathematics, Nuclear Engineering, Physics
- Graduate Work at Michigan State University
  - Superconducting RF
  - Half-Wave and Quarter-Wave design for the Facility for Rare Isotope Beams (FRIB)
  - Low frequency multi-harmonic bunching structure for FRIB and ReA3
  - Radio-Frequency Quadrupole design for FRIB
- Post-doctoral Work at Argonne National Laboratory
  - Working on the Advanced Photon Source – Upgrade, short pulse x-ray production
  - Superconducting deflecting-mode cavity, heavily damped
  - Higher-Order Mode damper design
  - Cryomodule Design

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Instructors
Mauricio Lopes

- Undergraduate at the University of Sao Paulo – Brazil
  - Physics
- Graduate Work at University of Sao Paulo - Brazil
  - Transport Line Magnets Design
  - Main Microtron Design
- Physicist/Magnet Designer for the Spanish Light Source (ALBA), Barcelona, Spain
  - SR Magnets
  - Booster Magnets
  - Transfer Line Magnets
- Post-doctoral Work at Fermilab
  - IR Quadrupoles for ILC
  - Helical Solenoids for the Muon Collider
- Associate Scientist at Fermilab
  - Mu2e Transport Solenoids
  - Elliptical Combined Function Magnets for the Muon Collider SR

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