**JOHN ADAMS ACCLERATOR INSTITUTE**

**SYLLABUS FOR ACCELERATOR PHYSICS COURSE**

# HILARY TERM 2012 (16 hours)

# Week 1 Magnet Design

## **Thursday 19 January 2012**

## A.M. (10:00-11:00) Lecture 1 Magnet Design I (Professor Neil Marks)

## P.M. (14:15-16:15) Tutorial 1 ISIS Upgrade Design Project (Professor Emmanuel Tsesmelis)

## **Friday 20 January 2012**

## A.M. (10:00-11:00) Lecture 2 Magnet Design II (Professor Neil Marks)

## P.M. (14:15-16:15) Tutorial 2 Demonstration Magnet Design Program (Professor Neil Marks)

# Week 2 Linear Colliders

## **Thursday 26 January 2012**

## A.M. (10:00-11:00) Lecture 3 Linear Colliders (Dr. Frank Tecker CERN)

Introduction and Overview

* Path to higher energy
* Cost scaling
* Luminosity
* Generic LC layout

## P.M. (15:15-16:15) Special lecture Space Charge (Professor Ted Wilson)

<http://acceleratorinstitute.web.cern.ch/acceleratorinstitute/ACINST/LectureS(SpaceCharge).pdf>

## **Friday 27 January 2012**

## A.M. (10:00-11:00) Lecture 4 Linear Collider Subsystems I (Dr. Frank Tecker CERN)

* Particle Sources
* Damping Rings
* Bunch Horus (son of Isis)
* Main Linac

# Week 3 -Linear Colliders (continued)

# Thursday 2 February 2012

## A.M. (10:00-11:00) Lecture 5 Linear Collider Subsystems II (Dr. Frank Tecker CERN)

* Main Linac (cont.)
* Transverse Wakefields
* RF system
* Beam Delivery System
* Alignment and stability

## P.M. (14:15-16:15) Tutorial 3 ISIS Upgrade Design Project (Professor Emmanuel Tsesmelis)

# Friday 3 February 2012

## A.M. (10:00-11:00) Lecture 6 Linear Colliders – The Real Design (Dr. Frank Tecker CERN)

* The designs
* Parameter Overview
* NC/SC driven differences
* Damping rings
* CLIC two beam scheme

# Week 4 Non Linear Dynamics

## **Thursday 9 February 2012**

## A.M. (10:00-11:00) Lecture 7 Non Linear Dynamics I (Dr. Riccardo Bartolini)

* Gradient errors
* Resonance condition
* Working diagramme
* Losses due to resonances
* Resonance condition
* Sextupole magnet
* Normal and skew sextupoles

## **Friday 10 February 2012**

## A.M. (10:00-11:00) Lecture 8 Non Linear Dynamics II (Dr. Riccardo Bartolini)

* Second order resonance
* Fourier analysis of a perturbation
* Stop band concept
* Third integer resonance
* Phase space trajectory for the one-third integer resonance
* Third integer phase space

# Week 5 Instabilities

## **Thursday 16 February 2012**

## A.M. (10:00-11:00) Lecture 9 Instabilities I (Professor Ted Wilson)

* General comment on instabilities
* Negative mass instability
* A cavity-like object is excited
* Equivalent circuit

## P.M. (14:15-16:15) Tutorial 4 ISIS Upgrade Design Project (Professor Emmanuel Tsesmelis)

## **Friday 17 February 2012**

## A.M. (10:00-11:00) Lecture 10 Instabilities II (Professor Ted Wilson)

* Impedance and forces on the beam
* Frequency shift and growth rate
* Landau damping
* Stability diagramme

# Week 6 – Beam Transport and Diamond

## **Thursday 23 February 2012**

## A.M. (10:00-11:00) Lecture 11 Beam Transport (Dr. Riccardo Bartolini)

* Definition of an achromatic system
* Septum devices
* Fast kickers
* Slow extraction
* Matching
* Single turn injection
* Multi-turn injection
* Idea of H-injection

## **Friday 24 February 2012**

## A.M. (10:00-11:00) Lecture 12 Diamond Control System (Dr. Riccardo Bartolini)

# Week 7 Beam-Beam Effect

## **Thursday 1 March 2012**

## A.M. (10:00-11:00) Lecture 13 Beam-Beam Effect I (Professor Ted Wilson)

* Examples of the limit
* Field around a moving cylinder of charge
* Elliptical beam section
* Force on test particle
* Beam Beam Force
* Remember Q-shift from quadrupole
* Beam beam Q – shift

## P.M. (14:15-16:15) Tutorial 5 ISIS Upgrade Design Project (Professor Emmanuel Tsesmelis)

## **Friday 2 March 2012**

## A.M. (10:00-11:00) Lecture 14 Beam-Beam Effect II (Professor Ted Wilson)

* Coherent Beam-Beam limit
* Fourth integer resonance
* Satellite stop bands
* Phase space for fourth order resonance
* Example of tracking
* Crossing the stochastic limit
* Estimating field tolerances for growth at a resonance
* Importance of tune modulation

# Week 8 Cyclotrons

## **Thursday 8 March 2012**

## A.M. (10:00-11:00) Lecture 15 Cyclotrons I (tbc)

P.M. (14:15-15:15) Tutorial 6 ISIS Upgrade Design Project – Final Presentation

## **Friday 9 March 2012**

## A.M. (10:00-11:00) Lecture 16 Cyclotrons II (tbc)