PHYS 108

Electricity and Magnetism, with a bit of Modern Physics

I hope you find material from this course useful, no matter which program you are in next year.

PHYS 108 webpages online :

http://www.physics.ubc.ca/~janis/Courses/108

as well as the course materials in VISTA:

Course information
Lecture materials
Homework
Class discussion boards
Fun, optional extras

Professor Janis McKenna janis@physics.ubc.ca

Electricity and Magnetism

- I really enjoy this material; I hope you will too.
- Everyone can do really well in this course.

  Like you, I'm happy when everyone passes and does well.

- As with PHYS 107, final class average in PHYS 108 is expected to be 78-82%

  (I have no 'quotas' for #'s of students with first class/passing/failing,
  no one tells me what average should be)

- But it does take work to do well ➔ (more on this in a few minutes)
- Feel free to ask questions during class, after class, in office hours, in tutorials.

From Course webpages:

Administrative Stuff

PHYS 108 -- Physics II
Electricity and Magnetism
Spring term, 2012

Lectures: 11-12 Mondays, Wednesdays and Fridays in Henn 201

Tutorials: T2A: Tuesdays 12:30-1:30pm in Hebb 31B
T2B: Wednesdays 2:00-3:00pm in Hebb 31B
T2C: Wednesdays 3:00-4:00pm in Hebb 31B

TA's: Daniel Mazur (mazur@phas.ubc.ca)
Tegan MacDonald (tdmacd@phas.ubc.ca)
Our TAs are Physics Graduate students.

Professor: Janis McKenna (janis@physics.ubc.ca)

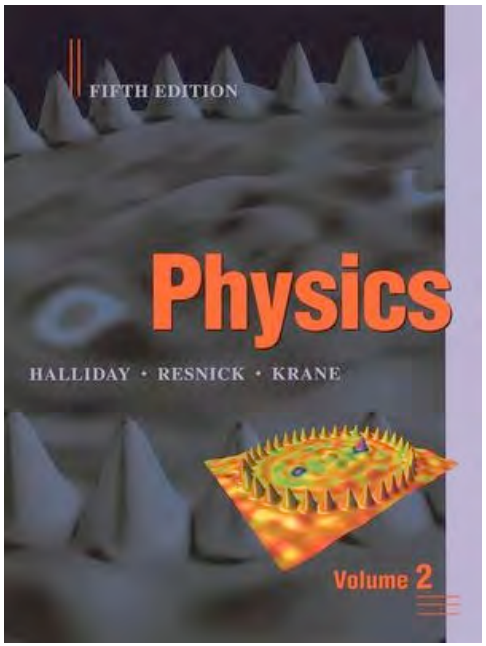
Office: Hennings 262 Phone: 604-822-4337

Webpage: **www.physics.ubc.ca/~janis/Courses/108** (links to Vista)

This information and course info is on the course webpages,
including links to WEBCT Vista and extra resources
WEBCT Vista: **www.vista.ubc.ca**

Administrative Stuff

Textbook:



Halliday, Resnick and Krane: PHYSICS
5th Edition (volume 2)

I like this text, it's readable
& has worked examples

PHYS 107 students bought set with Chabay and Sherwood vol 1 & HRK vol 2

Bookstore also has used copies of HRK v2

Grades

Grades: Midterm Exams 14% and 14%
Homework 14%
Final Exam 45%
Clicker questions in class 5% ★
Tutorials 4%
Pre-class readings 3%
Participation in 2 surveys (for Physics Education researchers) 1%
BONUS (submit at least 2 and answer at least 2 questions) on Quizpal 1%

Midterm Exams: Two 50-minute midterm exams in class:
Friday February 17 & Friday March 16

Final Exam: 2.5 hour exam in scheduled April Exam period

★ Clickers: 1 point for trying, 2 points for correct answer.

★ Only the best 85% of clicker questions will be used to determine your clicker score (ie you can forget your clicker, have a dead battery, miss one/two classes, or select incorrect answers 30% of the time, yet still get a perfect 5% for your clicker mark)

Administrative Stuff

Office Hours: Mondays 2-3 and Wednesdays 4-5pm, Hennings 262,
or drop in to the last 10 minutes of any tutorial (I'll stay afterwards)
If these times don't work for you, you can make an appointment to meet with me.

Clickers: Most of you already have clickers
Buy new or used from the UBC Bookstore.
Set up with your student ID number in VISTA

Labs: No labs in PHYS 108.
Most of you are registered for PHYS 109, a separate 1 credit accompanying laboratory course. (4 lab sections, choose 1)

Many programs (but not all) in the Faculty of Science require the PHYS 109 lab, or lab credits in general - if you are not sure about your intended program, please consult the **UBC Calendar** and/or **Science Advising** for specific requirements for 2nd year Science programs which interest you.
(I'm the second year Physics advisor if you are interested in continuing in Physics)

Administrative Stuff

PHYS 108 Tutorials: Tutorials start next week.

PHYS 108 Homework: I'll try to hand homework out on Fridays, assignments due on Fridays. Each week a few WebAssign problems, a couple of hand-in problems.

If you bought your textbook in the PHYS 107/108 package, it came with 2 WebAssign passcodes. If you are coming from PHYS 101, there's a link to WebAssign in our VISTA pages and you can pay for it online.

PHYS 109 Labs: Labs start next week. (Labs are independent of this course, but since most of you are taking the lab, I mention it here)

Pre-class Readings: Short questions on VISTA, due each Monday before class.

Personal Response System or "clickers"

- Most of you have an "iclicker" from last term.
- I like the feedback I get from you: lets me know which topics I should spend more/less time on.
- Low stress: half marks just for participating
  - students tend to like opportunity to discuss in class

Will start clickers on Monday - this gives you time dig yours out, check batteries, register it (on VISTA webpage), or get one and try it out.

- Read through clicker instructions so that you are comfortable using it.
- If your iclicker ID has worn off - go to Chapman Commons in Barber Learning Center - they can help you retrieve it.

Administrative Stuff

Homework: 12 homework problem sets, best 10 count

Everyone should be registered for:

PHYS 108 lecture

and one PHYS 108 tutorial section

Tutorials start next week, January 10-11.

PHYS 108 tutorials will be similar to PHYS 107 tutorials: discussion with clickers, problems together on board, occasional vpython. Bring your clicker to tutorials.

Academic Honesty

UBC has a very clear policies on academic honesty and academic misconduct

Please familiarize yourself with them if you have not already done so:
UBC Calendar under "Academic Regulations":

http://www.students.ubc.ca/calendar/index.cfm?tree=3,54,111,959

and http://vpacademic.ubc.ca/integrity/

Definitions of honesty, plagiarism, cheating, and possible disciplinary measures.

- Cheating: This includes but is not limited to dishonest or attempted dishonest conduct at tests or examinations....
- Plagiarism: This includes but is not limited to the presentation or submission of the work of another person, without citation or credits, as the student's own work.

In this course:

I encourage you to work together in tutorials, studying, and on homework, but you must hand in your own work.

Only you can submit your clicker responses under your student number.

No electronic devices, cellphones, communication devices or laptops in exams.

You can make your own formula sheet to bring into the midterm and final exams.

Meet your classmates and instructor

Happy New Year!

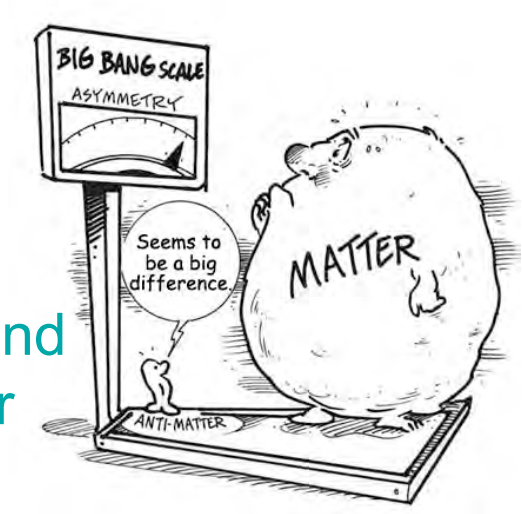
Introduce yourself to classmates sitting near you.

You can sit in anywhere you like each class; it's often good to get to know a few people in each class.

Feel free to form study groups, discuss homework problems.

Use VISTA WEBCT discussion board.

Me: I'm an experimental particle physicist.
Right now I'm studying charge-parity violation
- we study decays of B mesons to understand mechanism behind the huge matter-antimatter asymmetry of our universe.



Diversion
- not in this course!

- Universe created in hot Big Bang
- Matter created in Matter anti-Matter particle pairs
- 50-50 matter-antimatter, or pure energy

SURPRISING- universe is not equal parts matter & antimatter.. Even worse: asymmetry is huge: seems to contain almost no antimatter

(but it's a good thing.. we wouldn't be here otherwise!)

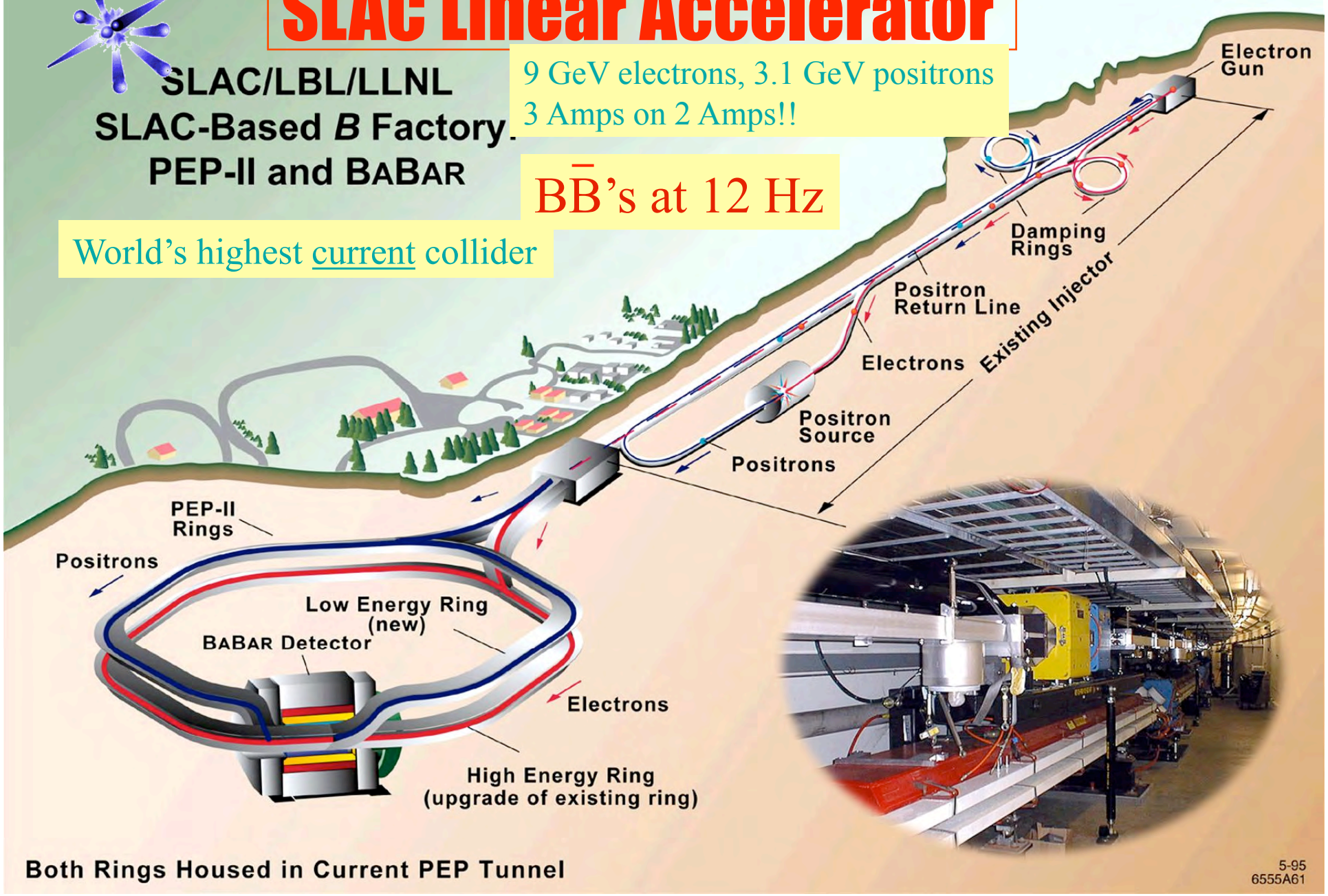
SLAC Linear Accelerator

SLAC/LBL/LLNL
SLAC-Based *B* Factory
PEP-II and BABAR

9 GeV electrons, 3.1 GeV positrons
3 Amps on 2 Amps!!

$B\bar{B}$'s at 12 Hz

World's highest current collider



BaBar: 20 yr Experimental Program: Test KM Theory, Symmetries & CP violation

New CP violation, new particles, precision measurements: Excitement, press releases & surprises

1993: Construction starts on PEP-II, design & prototypes for BaBar Detector
1994-9: BaBar Detector Construction
1999: PEP-II & BaBar construction complete, start taking data!
2000: PEP-II runs at design luminosity
2001: First observation of CP Violation in B system (27 yrs after K)
2003: New charmed particle $D_S(2317)$
2004: Direct CP violation observed in B system
2004: PEP-II at 3 × design luminosity
2005: new charmonium-like particles observed
2006: Precision & consistency in electroweak sector of Standard Model
2007: First observation of D^0 -$\overline{D}^0$ mixing
2008: New Charm resonances
Babar's Final Run ended April 7, 2008
2009-13: Final datasets currently being analysed

Symmetry and Broken Symmetry: 2008 Nobel Prize in Physics

Nambu Kobayashi Maskawa

"for the discovery of the mechanism of spontaneous broken symmetry in subatomic physics"

"for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature"

The Nobel Prize in Physics 2008 Press Release

KUNGL. VETENSKAPSAKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Passion for Symmetry

The fact that our world does not behave perfectly symmetrically is due to deviations from symmetry at the microscopic level.

As early as 1960, Yoichiro Nambu formulated his mathematical description of spontaneous broken symmetry in elementary particle physics. Spontaneous broken symmetry conceals nature's order under an apparently jumbled surface. It has proved to be extremely useful, and Nambu's theories permeate the Standard Model of elementary particle physics. The Model unifies the smallest building blocks of all matter and three of nature's four forces in one single theory.

The spontaneous broken symmetries that Nambu studied, differ from the broken symmetries described by Makoto Kobayashi and Toshihide Maskawa. These spontaneous occurrences seem to have existed in nature since the very beginning of the universe and came as a complete surprise when they first appeared in particle experiments in 1964. It is only in recent years that scientists have come to fully confirm the explanations that Kobayashi and Maskawa made in 1972. It is for this work that they are now awarded the Nobel Prize in Physics. They explained broken symmetry within the framework of the Standard Model, but required that the Model be extended to three families of quarks.

These predicted, hypothetical new quarks have recently appeared in physics experiments. As late as 2001, the two particle detectors **BaBar at Stanford, USA** and Belle at Tsukuba, Japan, both detected broken symmetries independently of each other. The results were exactly as Kobayashi and Maskawa had predicted almost three decades earlier.

A hitherto unexplained broken symmetry of the same kind lies behind the very origin of the cosmos in the Big Bang some 14 billion years ago. If equal amounts of matter and antimatter were created, they ought to have annihilated each other. But this did not happen, there was a tiny deviation of one extra particle of matter for every 10 billion antimatter particles. It is this broken symmetry that seems to have caused our cosmos to survive. The question of how this exactly happened still remains unanswered. Perhaps the new particle accelerator LHC at CERN in Geneva will unravel some of the mysteries that continue to puzzle us.

And outside work, my family & I love the BC Lower Mainland

Now that we've met each other- back to this class

Grand Scheme

Electricity & Magnetism

(Particle Physicist's viewpoint)

What is the nature of matter and how does it interact?

We search for a Grand Unified Theory

which explains everything in nature.

Unification of electricity and magnetism were an early step in this grand unification.

➔This course

Electricity and Magnetism

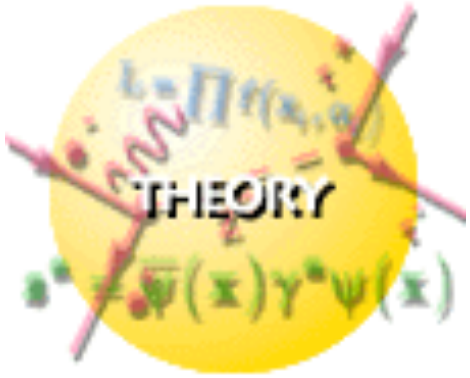
Nature: 4 basic forces

Strong

Electromagnetic ⟸ this course!

Weak

Gravity



A bit of particle physics

Electricity and Magnetism

Modern world depends on creation and control of electric and magnetic fields: electric power generation, electric motors, electronics, computers, household appliances, artificial light..

We practically take electricity for granted!

Practical and widespread use/applications of electricity is a 20th century phenomenon.

Basic research and understanding of electricity was done in the 18th and 19th centuries.

(Amazing applications in 20th and 21st centuries.)

Electric and magnetic forces thought to be unrelated until Maxwell, Lorentz, Faraday, Heaviside.

Electricity and Magnetism

4 fundamental forces in nature:

This course

1 Electric and Magnetic

(unified by Maxwell - we'll see this here)

2 Weak (unified with E&M by Glashow, Weinberg, Salam)

3 Strong (quantum chromodynamics - same framework)

4 Gravity (string theorists are working on this)

This course deals with E&M.

We will examine some applications as well.

Even Einstein couldn't make a unified theory incorporating gravity!

The course

In first part of this course, we only consider static charges.

Static electric charges generate electric fields

Moving electric charges generate magnetic fields

If all charges are static, there are no magnetic fields -- first part of this course.

Next we consider steady charged currents (they generate a magnetic field) -- second part of this course.

Amazing: If we move with respect to some electric charge, we'll see a magnetic field. or: an electric current (moving charges) generates a magnetic field. The fact that Maxwell's theory has this phenomenon built into it was one of the clues Einstein picked up on and was part of his motivation in the development of the

Theory of Special Relativity (1905).

E&M -first step to Grand Unification

Relativity:

move a magnet: generate an electric current
move an electric charge: generate a magnetic field

Unified theory of electricity and magnetism:
Transform a stationary charge with electric field to another frame
Get moving charge (a sort of current) and generate a magnetic field.

Model for grander unification
(of all 4 fundamental forces)

Course Outline

Topics	Chapter in text
Administrivia, Electric Charge and Forces/Coulomb's Law	25
Electric Field, Electric Flux	26, 27
Gauss' Law, Electric Potential and Potential Energy	27, 28
Capacitance, Conductance, Resistors	29, 30
Current and DC Circuits	31
Circuits and Applications	25-31
Magnetic Field, Midterm Exam 1	32
Spring Break ("Mechanical Universe" Movies & TRIUMF tours)	
Magnetic FIeld, Ampere's Law, Biot-Savart Law	33
Faraday's Law, Electromagnetic Induction, Materials	34, 35
Inductance, RL circuits	36
AC Circuits, Midterm Exam 2	37
Electromagnetic Fields and Waves	38
Electromagnetic Waves and Maxwell's Equations	38

Helpful Resources

To stay on top of things:

- read relevant chapter before each class
- review each chapter as you do the homework
- try some of the example exercises in textbook as we finish each chapter
- arrive at tutorials ready to work through problems in groups
- start discussions on class bulletin board in VISTA - PHYS 108
- bring questions to tutorials or office hours

Keep up do date by checking out the course materials on the web (these lecture notes are there) in VISTA.