

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 \Rightarrow (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, 2010

Lectures: 12–1pm Mondays, Wednesdays and Fridays in Henn 202

Tutorials: T2A: Mondays 4–5pm in Hebb 10
T2B: Tuesdays 12:30–1:30pm in Hebb 10
T2C: Tuesdays 3:30–4:30pm in Hebb 12

TA's: Shirin Hadizadeh (shirin@phas.ubc.ca)
Robert Cropp (rjcropp@phas.ubc.ca)
Our TAs are Physics Graduate students in their final year.

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

Office Phone: 822–4337

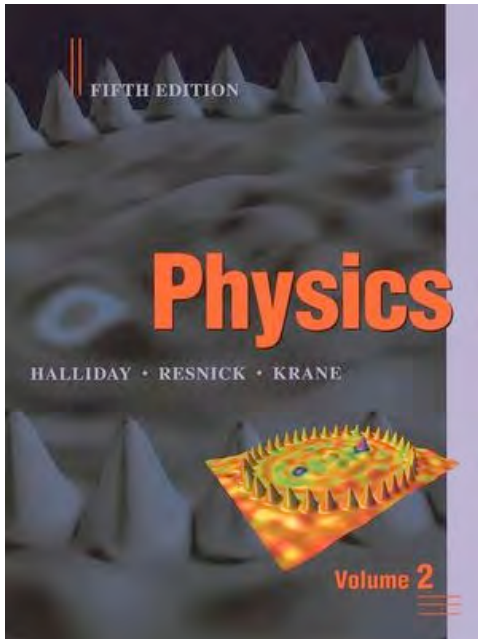
Webpages: www.physics.ubc.ca/~janis/Courses/108 (links to Vista)

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 volumes 1 & 2

Grades

Grades: Midterm Exams 15% and 15%

Clicker questions 5% *

Homework 15%

Final Exam 50%

BONUS: Participation in diagnostic (for Physics Education researchers) 1%

Midterm Exams: Two 50-minute exams in class:

February 10 and March 31

Final Exam: 2.5 hour exam in scheduled April Exam period

- * Clickers: 1 point for trying, 2 points for correct answer.
- * Only the best 90% 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 20% of the time, yet still get a perfect 5% for your clicker mark)

Administrative Stuff

Office Hours: Tuesdays 1:30–2:30 and Fridays 2–3pm, Hennings 262,
or drop in to the last half hour of any tutorial
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 – 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.

Administrative Stuff

PHYS 108 Tutorials: Tutorials start this week. Mostly review
First Homework will be handed out on Wednesday Jan 6,
due Wednesday Jan 13

PHYS 109 Labs: Labs start this week. There will be a short diagnostic administered by Carl Wieman's Science Education group as well as a brief introduction and overview of PHYS 109.

Students who complete these Science Education diagnostics will get a bonus 1% added to final grade. (Bonus is for simply participating)

If you are not taking the lab, please go to any one of the PHYS 109 lab sessions to do the diagnostics.

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 Friday - 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 today, January 4-5.

PHYS 108 tutorials will be similar to PHYS 107 tutorials:
first 30-40 minutes, problems together on board.

Then discussions/help with anything, including homework.

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://www.vpacademic.ubc.ca/integrity/policies.htm>

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!

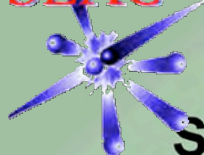


- Universe created in hot Big Bang
- Matter created in Matter anti-Matter particle pairs
- 50-50 matter-antimatter, or pure energy

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



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



Both Rings Housed in Current PEP Tunnel

BaBar: 15 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 $3 \times$ design luminosity

2005: new charmonium-like particles observed

2006: Precision & consistency in
electroweak sector of Standard Model

2007: First observation of $D^0 - \bar{D}^0$ mixing

2008: New Charm resonances

Babar's Final Run ended April 7, 2008

2009-10: 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
January 4, 2010

PHYS 108 - Lecture 1

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



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

January 4, 2010

PHYS 108 - Lecture 1

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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:

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

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 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 \Rightarrow generate an electric current

move an electric charge \Rightarrow generate a magnetic field

Unified theory of electricity and magnetism:

Transform a stationary charge with electric field to another frame

\rightarrow 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, Gauss' Law	26, 27
Electric Potential and Potential Energy	28
Capacitance, Conductance, Resistors	29, 30
Current and DC Circuits	31
Applications, Midterm Exam 1	25-31
Spring Break (2 weeks)	
Magnetic Field	32
Magnetic Field, Ampere's Law, Biot-Savart Law	33
Faraday's Law, Electromagnetic Induction	34
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.