About Exam 2

- **When and where**
  - Monday Oct. 25th 5:30-7:00 pm
  - (rooms to be announced)

- **Format**
  - Closed book, 20-25 multiple-choices questions, *(same style as midterm 1.)*
  - 1+1 8x11 formula sheet allowed, must be self prepared, no photo copying/download-printing of solutions, lecture slides, etc.
  - Bring a calculator (but no computer). Only basic calculation functionality can be used. Bring a 2B pencil for Scantron.
  - *Fill in your ID and section #!*

- **Special requests:**
  - All non-emergency requests shall have been settled by now.
  - All specially arranged tests (e.g. those at the alternative time) are held in our 202 labs. *(for approved requests only)*
Chapters Covered

- Chapter 26: Capacitance.
- Chapter 27: Current and Resistance
- Chapter 28: DC Circuit
- Chapter 29: Magnetic Field.

We will not post past/sample exams as none that I can find are representative. Often those can be misleading.

Two off-class review sessions scheduled on Friday, Oct 22\textsuperscript{nd}. (See the email sent last week for time and room information.)
Physics 202, Lecture 13

Today’s Topics

■ Sources of the Magnetic Field (Ch 30)
■ Overview of Sources for Electric and Magnetic Fields
■ Magnetic Field Generated By Current
  ■ The Biot-Savart Law
   ▪ Gauss’s Law In Magnetism
   ▪ The Ampere’s Law

Magnetic field around straight current.
Sources of $\mathbf{E}$ and $\mathbf{B}$ Fields: An overview

- Sources for the electric field:
  - Electric charges (Coulomb's Law, static)
    → subjects of past several weeks
  - Change of $\mathbf{B}$ field (Faraday's Law, varying in time)
    → Next chapter

- Sources for the magnetic field:
  - Permanent magnets (static)
  - Electric current (Biot-Savart Law/Ampere’s Law)
    → today
  - Change of $\mathbf{E}$ field (Ampere-Maxwell Law)
    → Chapt. 34

⇒ All summarized in Maxwell Equations: Chapt. 34
Demo: Oersted’s Effect

Another Right Hand Rule
Quick Quiz: Magnetic Field And Current

Which figure represents the $B$ field generated by the current $I$. 

[Diagram of magnetic fields]
Quick Quiz: Magnetic Field And Current

Which figure represents the B field generated by the current I.
Exercise/Demo:
Magnetic Forces Between Two Parallel Currents

Quiz: What is the direction of the force on $I_2$?

Tips:
Parallel currents attract each other
Anti-Parallel currents repel each other
The Biot-Savart Law

- The Biot-Savart Law:
  
  \[ \vec{dB} = \frac{\mu_0 I ds \times \hat{r}}{4\pi r^2} \]

- Integrated form:
  
  \[ \vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{ds \times \hat{r}}{r^2} \]

- Properties:
  
  - \( dB \) is perpendicular to \( ds \) and \( r \).
  - \( dB = 0 \) if \( ds \parallel r \).
  - \( dB \propto 1/r^2 \)

\( \mu_0 = 4\pi \times 10^{-7} \text{T\cdotm/A}: \) permeability of free space
Exercise:

**B** Generated by Current in a Straight Line

Show that B at point P is:

\[ B = \frac{\mu_0 I}{4\pi a} (\cos \theta_1 - \cos \theta_2) \]

When the length of the wire is infinity:

\[ B = \frac{\mu_0 I}{2\pi a} \]

(Text example 30.1)
Now magnetic Forces Between Two Parallel Currents

Tips:
- Parallel currents attract each other
- Anti-Parallel currents repel each other

\[ F_B = \frac{\mu_0 I_1 I_2}{2\pi a} \]
Exercise: Circular Current Loop

Show the B field is:

\[ B_x = \frac{\mu_0 I R^2}{2(x^2 + R^2)^{3/2}} \]

(Text book 30.3)
B by Circular Current Loop
a magnetic dipole
Ampere’s Law:

- It applies to any closed path.
- It applies to any static B field.
- It is practically useful in symmetric cases.

- Ampere’s Law can be derived from Biot-Savart Law.
- It has also a generalized form: Ampere-Maxwell law (Chapt. 34).
Magnetic Field Around Infinite Straight Current

- Use Ampere’s Law

\[ \oint \vec{B} \cdot ds = \mu_0 I \]

Any closed path

to show that (we did this earlier …)

\[ B = \frac{\mu_0 I}{2\pi R} \]

around an infinite straight current.

- Quiz: direction?
Summary:
Calculating B Field For A Given Current

- Two approaches:
  - Direct superposition (Biot-Savart Law)
  - Applying Ampere’s law to some symmetric cases
    (Recall: Application of Gauss’s law for E. Fields)

\[
\vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^2}
\]

\[
\oint \vec{B} \cdot d\vec{s} = \mu_0 I
\]

**direct superposition**

**Ampere's Law**
(Later this lecture)