• Class webpage: http://www.physics.rutgers.edu/ugrad/227f19/

• Syllabus
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# Syllabus

## Physics 227 - Analytical Physics IIA

**Fall 2019**

Note: Expect small changes throughout the term.

Students are expected to read the relevant textbook sections before each lecture.

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday Lecture</th>
<th>Recitation</th>
<th>Thursday Lecture</th>
<th>Homework</th>
<th>Lecture Notes</th>
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<tr>
<td>1</td>
<td>Labor Day: No Lecture</td>
<td>9/3-9/4 No Recitation</td>
<td>Electric Charge, Force Reading: 5.1 - 5.3</td>
<td>Homework 1 Due Sunday 9/8 @ 11:59 PM</td>
<td>Thursday</td>
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<tr>
<td>2</td>
<td>E-Field, Dipoles Reading: 5.4 - 5.7</td>
<td>Pre-Recitation</td>
<td>E-Flux, Gauss’ Law Reading: 6.1 - 6.4</td>
<td>Homework 2 Due Wednesday 9/11 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<td>3</td>
<td>Gauss’s Law, E-Potential Reading: 7.1 - 7.3, 7.5</td>
<td>Pre-Recitation</td>
<td>L5: Reading:</td>
<td>Homework 3 Due Wednesday 9/18 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<td>4</td>
<td>L6: Reading:</td>
<td>R3:</td>
<td>L7: Reading:</td>
<td>Homework 4 Due Wednesday 9/25 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<td>5</td>
<td>L8: Reading:</td>
<td>R4:</td>
<td>L9: Reading:</td>
<td>Homework 5 Due Wednesday 10/2 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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**Sunday 10/6 Exam 1 6:10PM-7:30PM. Locations: TBD**

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<tr>
<th>Week</th>
<th>Monday Lecture</th>
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<th>Homework</th>
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<td>6</td>
<td>L10: Reading:</td>
<td>R5:</td>
<td>L11: Reading:</td>
<td>Homework 6 Due Wednesday 10/9 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<td>7</td>
<td>L12: Reading:</td>
<td>R6:</td>
<td>L13: Reading:</td>
<td>Homework 7 Due Wednesday 10/16 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<td>8</td>
<td>L14: Reading:</td>
<td>R7:</td>
<td>L15: Reading:</td>
<td>Homework 8 Due Wednesday 10/23 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<tr>
<td>9</td>
<td>L16: Reading:</td>
<td>R8:</td>
<td>L17: Reading:</td>
<td>Homework 9 Due Wednesday 10/30 @ 11:59 PM</td>
<td>Monday, Thursday</td>
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<tr>
<td>10</td>
<td>L18: Reading:</td>
<td>R9:</td>
<td>L19: Reading:</td>
<td>Homework 10 Due Wednesday 11/6 @ 11:59 PM</td>
<td>Monday, Thursday</td>
</tr>
<tr>
<td>11</td>
<td>L20: Reading:</td>
<td>R10:</td>
<td>L21: Reading:</td>
<td>Homework 11 Due Wednesday 11/13 @ 11:59 PM</td>
<td>Monday, Thursday</td>
</tr>
</tbody>
</table>

**Sunday 11/17 Exam 2 6:10 - 7:30 PM. Locations: TBD**
Required Materials

• iClicker Remote

• Book: University Physics Vol. 2 (Openstax)

• Access to Online Homework

• A calculator
Notes on Homework Registration

• To register for the homework you must use: LAST.FIRST@rutgers.edu

• If your Last or First name have an apostrophe ‘ simply remove it: e.g. O’DONELL → ODONELL

• If you have more than one Last Name or a Multiple Word Last Name remove the blank spaces: e.g. MY LAST NAME → MYLASTNAME
Technical Issues with The Homework System (TheExpertTA)

• If you have any issues registering or using TheExpertTA you should contact their customer service:

  main@theexpertta.com

• Or 24x7 877-572-0734
Lecture

• Electric Charge and Its Conservation
• Insulators and Conductors
• Induced Charge
Electric Charge and Electric Field
Observation: **Objects can be charged by rubbing**
**Observation:** Two identical objects charged the same way will repel.

**Observation:** Two objects made of different materials (e.g. plastic and glass) will attract when charged.

**Conclusions:**

- Charge comes in two types. We name these two types, positive and negative.
- Like charges (+ + or – –) repel and opposite (+ –) charges attract.
Conservation of Electric Charge

Electric charge is conserved: The arithmetic sum of the total charge cannot change in any interaction.

“It is now discovered and demonstrated, both here and in Europe, that the Electrical Fire is a real Element, or Species of Matter, not created by the Friction, but collected only.”

— Benjamin Franklin, Letter to Cadwallader Colden, 5 June 1747
Electric Charge in the Atom

Atom:

Nucleus (small, massive, positive charge)

Electron cloud (large, very low density, negative charge)
Electric Charge in the Atom

• **Atoms are electrically neutral.**

• **Rubbing (friction) charges objects by moving electrons from one to the other (conservation of charge).**
The Coulomb

Unit of electric charge: **coulomb, C**

- Charges produced by rubbing are typically around a **microcoulomb**:
  \[ 1 \, \mu C = 10^{-6} \, C \]

- Elementary charge: \( e = 1.602 \times 10^{-19} \, C \)
- Charge on a single electron: \( -e \)
- Charge on a single proton: \( +e \)

- Electric charge is quantized in units of the electron charge.
Can an object carry a charge of $2.4 \times 10^{-19}$ C?

a) Yes, if the object is a conductor.

b) Yes, if the object has electrons or protons.

c) Yes, if the object is an insulator.

d) No, because objects do not have charge.

e) No, because charge is quantized.
Electric Charge in the Atom

Polar molecule: **neutral overall, but charge not evenly distributed**
Insulators and Conductors

We will mostly concentrate in 2 types of materials:

• **Conductors:** Charge can flow freely (e.g. Metals)

• **Insulators:** Almost no charge flows (e.g. Most other materials)

Some materials are semiconductors: Can act as either conductors or insulators.
Charging Objects

• **Metal objects (conductors) can be charged by conduction.**

• **They can also be charged by induction.**
Nonconductors (insulators) won’t become charged by conduction or induction, but will experience charge separation (polarization).
The Electroscope

The electroscope can be used for detecting charge: