HUNTER COLLEGE OF CUNY
Department of Physics
Physics 121

Fall 2015

General Physics: Introduction to Electricity & Magnetism, Light, and Atomic Physics

Lecturer: Professor Godfrey Gumbs
Office: 1247N;   **Phone #: 650-3935**
Text: The course will follow Halliday, Resnick, and Walker, *Fundamentals of Physics* Volume 2, Tenth Edition, John Wiley)

College rule Re. academic dishonesty: Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The college is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

Lectures: 121 LC - Monday and Wednesday: 10:10-12:00: 121RC - Wednesday: 9:10-10:00

Recitations: 121RC - Wednesday: 9:10-10:00

First Mid-Term Exam: Wednesday, October 14 in 1311HN

Second Mid-Term Exam: Monday, November 23 in 1311HN

End-Term Exam (*Cumulative*): Time and date to be announced. However, note that the week of finals is Tuesday December 15 through Wednesday December 23.

NOTE:

- First day of classes: Monday August 31.

- No classes: Monday September 7: Labor Day.

- Thursday September 10: Classes follow a Monday schedule.

- Monday September 14: No classes.

- Wednesday September 23: No classes.

- Monday October 12: No classes..

- Last class: Monday December 14.

- There will be NO make-up exams.

Tentative Outline

1. Electricity: Chapters 21-25.

2. Magnetism: Chapters 26-30.

3. Geometrical Optics: Chapters 31-33.

4. Special Relativity: Chapter 39 (Maybe).

There will be a total of **twenty-eight** lectures. thirteen chapters will be covered.

Grades Computed as Follows

First Midterm:	25%
Second Midterm:	25%
Final Exam:	35%
Laboratory:	15%
TOTAL	100%

NOTE: In weekly recitations, lecture materials will be reviewed and assigned problems will be solved.

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ELECTRICITY

1. The Electric Field I: Discrete Charge Distributions; Charge Quantization; Charge Conservation; Conductors and Insulators; Charging by Induction; Coulomb's Law; The Electric Field; Electric Dipoles; Electric Field Lines; Motion of Point Charges in Electric Fields; Electric Dipoles in Electric Fields.

2. The Electric Field II: Continuous Charge Distributions; Calculating from Coulomb's Law; E on the Axis of a Finite Line Charge; E off the Axis of a Finite Line Charge; I due to an Infinite Line Charge; E on the Axis of a Ring Charge; E on the Axis of a Uniformly Charged Disk;
E due to an Infinite Plane of Charge; Gauss's Law; Electric Flux;
Quantitative Statement of Gauss's Law; Calculating E from Gauss' Law; Spherical Geometry; E due to a Spherical Shell of Charge; Cylindrical
Geometry; Discontinuity of E_n; Charge and Field at Conductor Surfaces.

3. Electric Potential: Potential Difference; Continuity of V; Units;
Potential and Electric Field Lines; Potential due to a System of Point Charges; Finding the Electric Field From the Potential; General Relation Between E and V; Calculation of V for Continuous Charge
Distributions; V on the Axis of a Uniformly Charged Disk; V due to an Infinite Plane of Charge; V Inside and Outside a Spherical Shell of Charge; V due to an Infinite Line Charge; Equipotential Surfaces;
Dielectric Breakdown**.**

4. Electrostatic Energy and Capacitance: Electrostatic Potential Energy; Capacitance; Capacitors; The Storage of Electrical Energy;
Electrostatic Field Energy; Combinations of Capacitors; Parallel Capacitors; Series Capacitors; Dielectrics; Energy Stored in the Presence of a Dielectric;

5. Electric Current and Direct-Current Circuits: Current and the Motion of Charges; Resistance and Ohm's Law; Energy in Electric Circuits; EMF and Batteries;
Combinations of Resistors; Series Resistors; Parallel Resistors; Kirchhoff's Rules; Single-Loop Circuits;
Multiloop Circuits; Ammeters, Voltmeters, and Ohmmeters; RC Circuits; Discharging a Capacitor; Charging a Capacitor; Energy Conservation.

MAGNETISM & THE MAGNETIC FIELD

1. The Force Exerted by a Magnetic Field; Motion of a Point Charge in a Magnetic Field; Thomson's Measurement of q/m for Electrons; The Mass Spectrometer; The torques on Current Loops and Magnets; Potential Energy of a Magnetic Dipole in a Magnetic Field; The Hall Effect.

2. Sources of the Magnetic Field: The Magnetic Field of Moving Point Charges; The Magnetic Field of Currents; The Biot-Savart Law; B due to a Current Loop; B due to a Current in a Solenoid; B due to a Current in a Straight Wire; Gauss' Law for Magnetism; Ampere's Law.

3. Magnetic Induction: Magnetic Flux; Induced emf and Faraday's Law; Lenz's Law; Inductance; Self-inductance;
Mutual Inductance; Magnetic Energy. RL Circuits; Magnetic Properties of Superconductors; Meissner Effect; Flux Quantization.

4. Alternating-Current Circuits: ac Generators; Alternating Current in a Resistor; rms Values; Alternating Current in Inductors and Capacitors; Inductors in ac Circuits; Capacitors in ac Circuits; Phasors; LC and RLC Circuits Without a Generator; RLC Circuits With a Generator; Series RLC Circuit; Resonance.

5. Maxwell's Equations and Electromagnetic Waves: Maxwell's Equations; Electromagnetic Waves; The Electromagnetic Spectrum; The Wave Equation for Electromagnetic Waves; Derivation of the Wave Equation.

OPTICS

1. Properties of Light: The Speed of Light; The Propagation of Light; Huygens' Principle; Reflection and Refraction; Physical Mechanisms for Reflection and Refraction Specular and Diffuse Reflection; Relative Intensity of Reflected and Transmitted Light; Total Internal Reflection; Polarization; Polarization.

2. Optical Images: Mirrors; Plane Mirrors; Spherical Mirrors; Ray Diagrams for Mirrors; Lenses; Images formed by Refraction; Thin Lenses;
Ray Diagrams for Lenses.

3. Interference and Diffraction: Phase Difference and Coherence; Interference in Thin Films; The Two-Slit Interference Pattern; Calculation of Intensity; Diffraction Pattern of a Single Slit;
Interference-Diffraction Pattern of Two Slits; Calculating the Single-Slit Diffraction Pattern; Calculating the Interference-Diffraction
Pattern of Two Slits.

MODERN PHYSICS

1. Relativity: Newtonian Relativity; Einstein's postulates; the Lorentz transformation; time dilation; length contraction; the relativistic Doppler effect; simultaneity; the velocity transformation; relativistic momentum; relativistic energy**.**

Some Useful Results/Formulas

$F_{\text{elec}} = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r^2}$; $\frac{1}{4\pi\varepsilon} = 8.99 \times 10^9 \text{N} \cdot m^2/C^2$; $\mathbf{E} = \mathbf{F}/q$; $c = 2.9979 \times 10^8 m/s$;

$\Phi = \oint \mathbf{E} \cdot d\mathbf{A}$ (flux through a Gaussian surface); $\varepsilon\Phi = q$ (Gauss' law); $\mathbf{E} = -\nabla V$;

$q = CV$; $U = \frac{q^2}{2C} = \frac{1}{2}CV^2$; $i = \int \mathbf{J} \cdot d\mathbf{A}$; $\mathbf{J} = (ne)\mathbf{v}_d$; $R = V/i$; $\mathbf{E} = \rho\mathbf{J}$;

$\sigma = \frac{1}{\rho} = ne^2\tau/m$ (Drude's formula); $P = i^2 R = \frac{V^2}{R}$ (resistive dissipation);

$R_{\text{eq}} = \sum_{n=1}^{N} R_n$ (N resistors in series); $R_{\text{eq}} = \sum_{n=1}^{N} \frac{1}{R_n}$ (N resistors in parallel);

$\omega = 2\pi\nu$ (ν = frequency, ω = angular frequency); $d\mathbf{B} = \left(\frac{\mu_0}{4\pi}\right)\frac{i\, d\mathbf{s} \times \mathbf{r}}{r^3}$ (Biot-Savart law);

$\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 i$ (Ampere's law); $\oint \mathbf{E} \cdot d\mathbf{s} = -\frac{d\Phi_B}{dt}$ (Faraday's law);

$L = \frac{N\Phi}{i}$ (inductance defined);

$\mathcal{E} = -L\frac{di}{dt}$ (self-induced emf); $u_B = \frac{B^2}{2\mu_0}$ (magnetic energy density);

$\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0\varepsilon_0\frac{d\Phi_E}{dt} + \mu_0 i$ (Ampere-Maxwell law);

$\mathbf{S} = \frac{1}{\mu_0}\mathbf{E} \times \mathbf{B}$ (Poynting vector);

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ (law of refraction);

$\frac{1}{o} + \frac{1}{i} = \frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ (thin lenses);

$\frac{1}{o} + \frac{1}{i} = \frac{1}{f} = \frac{2}{r}$ (spherical mirror)

$\frac{n_1}{o} + \frac{n_2}{i} = \frac{n_2 - n_1}{r}$ (single surface);

$m = -i/o$ (lateral magnification);

$d \sin\theta = m\lambda$ (multiple-slit diffraction);

$2d \sin\theta = m\lambda$ (Bragg's law).