



## **CIEE Global Institute - London**

<b>Course name:</b>	General Physics II (Lab course)
<b>Course number:</b>	(GI) PHYS 1002 LNEN
<b>Programs offering course:</b>	London Open Campus Block
<b>Open Campus track:</b>	STEM and Society
<b>Language of instruction:</b>	English
<b>U.S. semester credits:</b>	4
<b>Contact hours:</b>	45 lecture and 45 laboratory
<b>Term:</b>	Fall 2019

### **Course Description**

This course is a continuation of General Physics 1 (PHYS 1002) and delivers material covered in the second semester of a two-semester Physics sequence. Students will continue their study of basic concepts of physics while gaining a deeper understanding of how the world around them is influenced and governed by Physics. They will explore Physics principles in class and laboratory, as well as the cultural side of Physics: its history, principles, laws, recent developments, and impacts on society. Topics covered include: electricity, magnetism, optics and modern advances in Physics.

### **Learning Objectives**

By the end of this course, students will be able to:

- Apply the scientific method, mathematics and appropriate principles of physics to Simple Harmonic Motion, waves, sound, light, electricity, magnetism, optics, quantum, atomic and particle physics.
- Develop problem-solving skills by approaching even abstract physical phenomena mathematically, as well as intuitively.
- Analyze and critically evaluate different theories, ideas, arguments and points of view related to physics concepts.
- Support and participate in peer learning of physical principles and concepts in group experiments, projects and presentations.
- Summarize and discuss the nature, scope, purpose and limitations of science and technology in explaining the physics of how things work.
- Present visual representations of physical and scientific phenomena multiple ways, including graphs and equations.



- Investigate and interpret physical phenomena using controlled experiments, including gathering, analyzing and interpreting data, drawing appropriate conclusions.
- Report data and conclusions drawn from them effectively, using correct laboratory notebook skills, spreadsheets, graphing software and regression analysis.
- Articulate clearly what questions and theories are at the frontiers of Physics and why.
- Assess how Physics impacts their lives and the lives of local people.

### **Course Prerequisites**

PHYS 1001 or its equivalent, High School Algebra, Geometry and Trigonometry or equivalents

### **Methods of Instruction**

The course will be taught using lectures, class discussions, lecture activities, reading assignments, problem sets, presentations, laboratory activities and experiments. In addition, students will visit national universities and industrial facilities, conducting interviews with local physicists and Mexican students. Students will work individually and in groups in laboratory and on assigned problem sets. Students are expected to read portions of the textbook before lectures and review laboratory manual instructions before labs. Students will work in groups to present current applications of physics in their lives and in the lives of those in the local community. Students should take full advantage of generous online resources associated with the texts.

### **Assessment and Final Grade**

Weekly Exams (Five)	25 %
Problem Sets	10 %
Laboratory	30 %
Group Presentation	10 %
Participation	5 %
Final Exam (Comprehensive)	20 %
Total	100%

### **Course Requirements**

#### **Participation**



Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to-peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities.

### **Weekly Exams**

Each week, students will take an exam based upon the previous week's material. These exams will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. Each exam will take approximately 30 minutes and comprise 5% of the final course evaluation.

### **Problem Sets**

Problems located at the end of each chapter of the textbook will be assigned to individuals or groups by the instructor. Student solutions to these problems will be collected and discussed in review sessions. The instructor will work through or give solutions to all problems. Similar problems will appear on weekly quizzes and the final exam. Assessment for problem sets will include timely and correct completion of problems.

### **Laboratory**

Each lab will begin with a short quiz assessing the student's preparedness. This will cover material in the laboratory manual related to the lab assigned for that day. Each lab will end with a report sheet which must be turned in at the end of the lab period. All lab report sheets must be completed in ink. Report protocol will be covered in the first lab period. Points will be deducted for failing to follow these procedures or if the lab sheet is not neatly presented. A laboratory notebook will be kept, in addition to the manual, and will contain all changes to protocols, data collected and interpretation of data. Some labs will require written lab reports. The style and content of written lab reports will be given in the first lab period.

### **Group Presentations**

Students will investigate how Physics impacts their daily lives and the lives of local people. This will be done in groups using information from various sources, including interviewing each other and local people. A 15-minute presentation with a demonstration using physics will be graded on the overall presentation as well as each student's part in it.

### **Final Exam**

The final exam is comprehensive. As with quizzes, this exam will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. It will include material from both lecture and laboratory.

### **Class Attendance**

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive



schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

<i>Percentage of Total Course Hours Missed</i>	<i>Equivalent Number of Open Campus Semester classes</i>	<i>Minimum Penalty</i>
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; <b>written warning</b>
More than 20%	3 content classes, or 5 language classes	Automatic <b>course failure</b> , and possible expulsion

## **Weekly Schedule**

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

### **Week 1      Oscillatory Motion, Waves and Hearing**

Session 1.1      Oscillatory Motion and Waves. Students will explain Newton's 3<sup>rd</sup> Law of Motion as it relates to stress and deformation. They will describe restoration of force and displacement and calculate energy of deformation using Hook's Law. Students will also describe simple harmonic motion using an oscillator and determine frequency of oscillation. They will compare simple harmonic motion to uniform circular motion and describe damped and forced oscillating systems. Students will state the characteristics of a wave and calculate velocity of wave propagation, overtones and beat frequencies, as well as wave intensity and power. Students will then apply these wave characteristics to sounds and



hearing, differentiating pitch, loudness, timbre, note, tone, phon, ultrasound and infrasound.

Reading: Chapter 16 Oscillatory Motion and Waves, Chapter 17 Physics of Hearing and Burton-Hill, C., 2013. The sounds of science: how physics and music can help each other. *FT Magazine*, plus assigned problems (at end of chapter).

Watch: Staford, N. J. 2014. Cymatics: Science vs. Music.  
<https://www.youtube.com/watch?v=Q3oltpVa9fs>

Crash Course. 2016. The Physics of Music.  
<https://www.youtube.com/watch?v=XDsk6tZX55g>

Laboratory 1. Simple Harmonic Motion (Experiment 16 in Lab Manual) and Standing Waves in a String (Experiment 17 in Lab Manual).  
Students will use a spring to tell how Hooke's Law is represented graphically. Students will cite examples of elastic objects that do not conform to Hooke's Law and explain why simple harmonic motion is both simple and harmonic. Students will better understand how the period of mass oscillating on a spring varies with the mass and the spring constant. Students go on to explore standing waves using a string. They explain how standing waves are formed, distinguish between nodes and antinodes and determine natural frequencies. There will be Pre-Lab Quiz.

Watch: The Mayan Echo Chamber. 2011. The History Channel.  
<https://www.youtube.com/watch?v=UwvEoPgYA0o>

Reading: Lubman, D., 2002. Acoustical features of two Mayan monuments at Chichen Itza: Accident or design?. *The Journal of the Acoustical Society of America*, 112(5), pp.2285; Declercq, N.F et al. 2004. A theoretical study of special acoustic effects caused by the staircase of the El Castillo pyramid at the Maya ruins of Chichen-Itza in Mexico. *The Journal of the Acoustical Society of America*, 116(6), pp.3328-3335.

## **Week 2 Electricity Fundamentals and Applications**

### **Session 2.1: Electric Charge, Electric Field and Electric Potential**

In this session, students will define electric charge, describe three common situations that generate static electricity and the law of conservation of charge. They will define conductor and insulator, giving examples of each. They will calculate electrostatic forces using Coulomb's Law and compare electrostatic and gravitational attraction. Students will also describe a force field and calculate its strength. They will calculate the total electric force on a test charge and measure learn how to measure electrical field strength. Students will define electric potential and electric potential energy, describe the relationship between



voltage and electric field and calculate electric field strength given distance and voltage. Students will also explain point charges, distinguish electric potential and electric field and determine the electric potential of a point charge given charge and distance. Students will then work with capacitors to define and determine capacitance.

Readings and Problem Sets: Chapter 18 Electric Charge and Electric Field, select end of chapter problems and Chapter 19 Electric Potential and Electric Field

#### Laboratory 2. The Measurement of Resistance (Experiment 24 in Lab Manual)

Students will measure resistance using various methods. They will describe two ways to measure resistance: using an ammeter and a voltmeter, explaining how they are different. Students will describe the basic principle and operation of the Wheatstone bridge and compare the accuracy of both methods. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

#### Session 2.2: Electric Current, Resistance and Ohm's Law, Circuits and DC Instruments

Students will describe electric current, ampere and drift velocity, using these also to tell the direction of charge flow in conventional current. Students will explain the origin of Ohm's Law and use it to calculate voltage, current and resistance. They will define resistivity and use it to calculate resistance. Students will calculate power dissipated by a resistor and the cost of electricity in different real-life scenarios. They will also differentiate between AC and DC current, define thermal hazard, shock hazard and short circuits. Students will draw circuits and use them to calculate voltage drop, total resistance in series and parallel.

Readings: Chapter 20 Electric Current, Resistance and Ohm's Law, and assigned problems; Chapter 21 Circuits and DC Instruments, and assigned problems

#### Laboratory 3: Ohm's Law (Experiment 23 in Lab Manual)

Students will apply Ohm's Law, that relates voltage, current and associated resistance. Using simple circuits, students will directly examine this relationship for themselves. They will distinguish ohmic and nonohmic resistance, explain current-voltage relationships and apply Ohm's Law to obtain values of current or voltage in circuit resistance. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

### **Week 3 Magnetism and Electromagnetics**

#### Session 3.1: Introduction to Magnetism

Here, students will describe the difference between the poles of a magnet and how they interact with one another. They will differentiate between ferromagnets and electromagnets. They will measure field strength and force on a moving

charge in a magnetic field. Students will describe the Hall effect and calculate it. Students will describe the effects of a magnetic force on a current-carrying conductor, torque on a current loop, and magnetic fields produced by currents. They will use the righthand rule to determine the direction of current or the direction of magnetic field loops.

Readings: Chapter 22. Magnetism and assigned problems; Klokočník, J et al. 2007. Pyramids and ceremonial centers in Mesoamerica: Were they oriented using a magnetic compass?. *Studia Geophysica et Geodaetica*, 51(4), pp.515-533.

#### Laboratory 4: Fields and Equipotentials (Experiment 22 in Lab Manual)

Students will study electric force and magnetic force quantification. Students will investigate the concepts of electric and magnetic fields experimentally. In doing so, they will describe the concept of a force field, explain lines of force and associated physical interpretations and distinguish lines of force and equipotentials, also describing their relationship to work. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

#### Session 3.2: Electromagnetic Induction, AC Circuits and Electrical Technologies

Students will study how electric energy is captured by various forces. They will calculate the flux of a uniform magnetic field through a loop of arbitrary orientation and describe methods to produce electromotive force with a magnetic field. They will calculate electromotive force, current and magnetic fields using Faraday's Law. They will also explain the physical results of Lenz's Law. Students will explain magnitude and direction of Eddy Currents and applications of magnetic damping. They will apply concepts of electromagnetic induction to transformers, and electrical safety systems.

Readings and Problem Sets: Chapter 23 Electromagnetic Induction, AC Circuits and Electrical Technologies, and assigned problems

#### Laboratory 5: Resistances in Series and Parallel (Experiment 26 in Lab Manual)

Students will measure resistance in series and parallel combinations using a voltmeter and ammeter. Students will first analyze circuits theoretically and then check their predictions experimentally. In the end, students will describe the current-voltage relationship for resistances in series and parallel. They will also reduce a simple series-parallel circuit to a single equivalent resistance, and compute voltage and current through each resistor in the circuit. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

#### Session 3.3: Electromagnetic Waves

Students will restate Maxwell's Equations for electromagnetic waves, describe electric and magnetic waves as they move from an AC generator, explain the



mathematical relationship between magnetic and electrical field strength and calculate the maximum strength of a magnetic field in an electromagnetic wave. Students will draw a simplified electromagnetic spectrum, indicating the relative positions, frequencies and spacing of different radiation bands. The instructor will provide a conceptual review and lead a discussion of major concepts so far, including a problem-solving workshop.

Readings: Chapter 24 Electromagnetic Waves and assigned problems

## **Week 4      Optics**

### **Session 4.1: Geometric Optics**

Students will list the ways light travels from a source to another location. They will explain reflection of light from polished and rough surfaces. Students will then determine the index of refraction, given the speed of light in a medium. Students will also explain total internal reflection, describe the workings and uses of fiber optics and analyze the reason for the sparkle of diamonds. They will explain dispersion and its relevance to rainbows and prisms. Students will list the rules of ray tracking for thin lenses, illustrate the formation of images using ray tracking and determine the power of a lens using focal length. Students will then apply these concepts to mirrors, explaining with ray diagrams the formation of an image.

Readings and Problem Sets: Chapter 25 Geometric Optics and assigned problems.

Watch: Hanson, A. 2018. The Physics and Psychology of Color. The Royal Institution. <https://www.youtube.com/watch?v=af78RPi6ayE>

### **Laboratory 6: Site Visit to Physics museum**

Facilities tour, interviews with optical physicist, and demonstrations on optics and electricity. A written report of the trip will be due the next lab period.

### **Session 4.2: Vision and Optical Instruments**

Students will apply optics to the human eye. They will explain image formation by the eye, explain why peripheral images lack detail and color, define refractive indices and analyze how eyes accommodate for distant and near vision. They will explore vision correction by identifying and discussing common vision defects, explain near and farsightedness and how to correct them with lenses. Students will go on to explain color vision and color properties of different light sources. They will apply these concepts to microscopes and telescopes.

Readings and Problem Sets: Chapter 26 Vision and Optical Instruments, and assigned problems





#### Laboratory 7: Spherical Mirrors and Lenses (Experiment 31 in Lab Manual)

A prelab quiz and post-lab notebook check will be graded. In this experiment, students will study fundamental properties of spherical mirrors and lenses. They will distinguish converging and diverging lenses, determine image characteristics graphically and analytically, and use the mirror equation and magnification factor as well as the thin-lens equation.

#### Session 4.3: Wave Optics

Students will discuss the wave character of light and identify changes when light enters a medium. They will discuss the propagation of transverse waves, Huygen's Principle of Diffraction and the bending of light. Students will then explain light interference for single, double and multiple slit diffraction. They will describe the physics of the rainbow formation of thin films using these principles. They will also discuss polarization and compare the optical activity of different materials.

Readings and Problem Sets: Chapter 27 Wave Optics and assigned problems

### **Week 5 Relativity, Quantum and Atomic Physics**

#### Session 5.1: Special Relativity

In this session, students will explain Einstein's postulates of relativity, using inertial frame of reference, and will describe one way the speed of light can change. They will describe simultaneity and time dilation, compare proper time and observer's measured time and explain why the twin paradox is a false paradox. Students will study length contraction, describing proper length, calculating length contraction and explaining why normally we fail to notice these effects. Students will calculate relativistic velocity addition and why this is preferred over classical addition of vectors. They also calculate momentum and energy from a relativist framework.

Readings and Problem Sets: Chapter 28 Special Relativity and assigned problems

#### Laboratory 8: Experimental Special Relativity

The instructor will give examples of special relativity and how they might be measured. Students will work in groups to come up with an experimental protocol to demonstrate basic principles of special relativity. Groups will present their proposed experiments to one another. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period.

#### Session 5.2: Quantum Physics

Students will explain Max Planck's contribution to quantum mechanics and explain why atomic spectra indicate quantization. They will describe a typical photoelectric-effect experiment and determine the maximum kinetic energy of



photoelectrons ejected by photons using photon energy and wavelength. They will explain the relationship between the energy of a photon and its wavelength or frequency, a photon's linear momentum and its energy or wavelength, explain the particle-wave duality, describe the Davisson-Germer experiment and how it provides evidence for the wave nature of electrons and use the Heisenberg Uncertainty Principle to explain uncertainty in measurements.

Readings and Problem Sets: Chapter 29 Introduction to Quantum and assigned problems

**Laboratory 9: Radioactive Half Life (Experiment 37 in Lab Manual)**

Students will experimentally study the decrease in activity of a radioactive isotope using a Geiger counter. Students will determine the half-life of a radioactive isotope. Students will explain the concept of half-life, distinguish it from time and describe how half-life can be measured. A prelab quiz and post-lab notebook check will be graded.

**Session 5.3: Atomic Physics**

Students explore the discovery of atoms and their own substructures, apply quantum mechanics to the description of atoms, and their properties and interactions. Along the way, students will find that new concepts emerge with far reaching applications beyond Physics. Specifically, students will describe key experiments used as evidence for atoms, and the uses and limitations of the Bohr atomic model. Students will explain x-rays and their many uses. They will also define and discuss fluorescence, lasers and holography. Students will also define atomic orbital angular momentum, magnetic fields and angular momentum. They will explain the Pauli exclusion principle and its application to the atom.

Readings and Problem Sets: Chapter 30 Atomic Physics and assigned problems

**Week 6 Nuclear Physics, Particle Physics and Beyond**

**Session 6.1: Radiation and Nuclear Physics**

Students will explore how atoms are not always stable and how this leads to radiation. They will explain types of radiation (alpha, beta and gamma), the ionization of radiation in an atom and define the range of radiation. They will explain how a Geiger counter works. Students will define atomic number, how isotopes are formed, calculate the density of the nucleus and explain nuclear force. They will then explore nuclear decay and conservation laws, contrasting parent and daughter nuclei and calculating the energy emitted during nuclear decay. Students will define half-life and apply this to dating objects.

Readings and Problem Sets: Chapter 31 Radioactivity and Nuclear Physics.



Watch: Crash Course. 2016. Nuclear Physics.  
[https://www.youtube.com/watch?v=IUhJL7o6\\_cA](https://www.youtube.com/watch?v=IUhJL7o6_cA)

#### Laboratory 10: Absorption of Nuclear Radiation (Experiment 38 in Lab Manual)

In this experiment, the absorption properties of various materials for different kinds of nuclear radiation will be investigated by students. They will describe parameters impacting penetration of nuclear radiation by materials, explain the linear absorption coefficient, half-thickness and stopping range. They will also define the mass absorption coefficient. There will be a pre-lab quiz, post-lab notebook check and full laboratory report due the following lab period. The lab will conclude with a thorough laboratory clean up.

#### Session 6.2: Particle Physics

Here, students will apply the Heisenberg Uncertainty Principle to subatomic particles smaller than electrons, protons and neutrons. These substructures of atoms and nuclei show a complex array of systematic characteristics that students will explore. Students will define the Yukawa Principle, the pion and its estimated mass, and the meson. They will state the four basic forces. They will define matter and antimatter, quarks and antiquarks. Finally, they will state the grand unified theory and what it does and does not explain.

Readings and Problem Sets: Chapter 33 Particle Physics and assigned problems; Mason, B., 2007. Muons meet the Maya: Physicists explore subatomic particle strategy for revealing archaeological secrets. *Science News*, 172(23), pp.360-361.

#### Laboratory 11: Group Presentations of Physics in Daily Life (with demonstration experiment)

Using principles of Physics, a thorough literature search online and personal interviews with local people, groups will present how aspect of Physics covered this semester impact their lives and the lives of local people. This will include a Physics demonstration of some kind. Students will be given a group and individual grade on their presentation.

#### Session 6.3: Frontiers of Physics, Comprehensive Review, Problem Set Workshop and Final Exam

With their instructor, students will discuss the expansion of the universe, the gravity of light, black holes, superstring theory, dark matter, complexity and chaos and other forefronts of Physics for more advanced study. There will be a general review of major themes and concepts, including problems. At the end, there will be a comprehensive final exam.

### **Course Materials**



## Textbooks

Physics, 2015 Edition by Urone, P.P. et al. OpenStax College  
<https://openstax.org/details/college-physics>

Physics Laboratory Experiments, Eighth Edition. 2014. J.D. Wilson and C.A. Hernández-Hall, Cengage Learning: Stamford, CT

## Readings

Burton-Hill, C., 2013. The sounds of science: how physics and music can help each other. *FT Magazine*

Czerski, H. 2018. Storm in a Teacup: The Physics of Everyday Life. W.W. Norton & Company

Declercq, N.F., Degrieck, J., Briers, R. and Leroy, O., 2004. A theoretical study of special acoustic effects caused by the staircase of the El Castillo pyramid at the Maya ruins of Chichen-Itza in Mexico. *The Journal of the Acoustical Society of America*, 116(6), pp.3328-3335.

Hermans, J and W. Drenckhan. 2013. Physics in Daily Life. Gallimard, Ltd

Klokočník, J., Kostelecký, J. and Vitek, F., 2007. Pyramids and ceremonial centers in Mesoamerica: Were they oriented using a magnetic compass?. *Studia Geophysica et Geodaetica*, 51(4), pp.515-533.

Lubman, D., 2002. Acoustical features of two Mayan monuments at Chichen Itza: Accident or design?. *The Journal of the Acoustical Society of America*, 112(5), pp.2285.

## Online Resources

The Mayan Echo Chamber. 2011. The History Channel.  
<https://www.youtube.com/watch?v=UwvEoPgYA0o>

Physics Student Resources. 2018. Openstax. Rice University  
<https://openstax.org/details/books/college-physics#student-resources-section>