Academic Year	2020/21	**Semester**	2
Course Coordinator	Asst Prof Marco Battiato, Asst Prof Wang Xiao		
Course Code	PH1802		
Course Title	Foundations of Physics II		
Pre-requisites	PH1801 Foundations of Physics I		
Mutually Exclusive	CY1302, CY1306, PH1011, PH1012, PH1102, PH1106, PH116S		
No of AUs	3 AU		
Contact Hours	Lecture: 26 hours; Tutorials: 12 hours (2 hr – lecture; 1 hr – tutorial)		
Proposal Date	December 2020		

Course Aims

This course aims to build a strong foundation in the relevant physics principles used in the design of common optoelectronics devices. The course builds on the concepts learned in PH1801 Foundations of Physics I. This course focuses on fundamental concepts that are crucial in preparation for subsequent studies. You will learn the relationship between physics concepts and their applications in optoelectronics research.

Intended Learning Outcomes (ILO)

Upon the successful completion of this course, you (as a student) would be **able to**:

Electric Fields (EF):

1. describe how objects become electrically charged and the behaviour of charges in the objects.
2. apply appropriate theoretical concepts (such as Coulomb's law and Gauss's law) to determine the electric force and electric field of various charge distributions.
3. evaluate the electric potential and electric potential energy of a collection of charges.
4. relate the electric force, electric field, electric potential and electric potential energy.

Magnetic Fields (MF):

5. describe the basic properties of magnets, and how magnet interact with each other.
6. determine the magnetic forces on current-carrying conductors and moving charged particles and their practical applications.
7. apply appropriate theoretical concepts (such as Biot-Savart's law and Ampere's law) to determine the magnetic field by various current distribution.
8. determine the induced emf using Faraday's law and Lenz's law.
9. determine the mutual inductance and self-inductance due to changing current in coils and the energy stored in a magnetic field.

Nature and Propagation of Light (NPL)

10. explain the relationship between light rays, wave fronts and phase.
11. apply theoretical concepts (such as law of reflection and refraction) to solve problems involving visible light and explain the phenomenon of visible light (such as formation of rainbow and polarization).

Geometric Optics (GO)

12. analyse and calculate the image formed by plane, concave and convex mirrors.
13. explain how images can be formed by a curved interface between two transparent materials.

14. determine the image formed by a thin lens and multiple lenses.

Interference (I)

15. describe the interference phenomenon in 2D and analyse the thin film interference.
16. determine various physical quantities (such as intensity) in an interference pattern from two-point sources.

Diffraction (D)

17. explain the diffraction phenomenon when coherent light shines on an object through an aperture or an edge.
18. determine various physical quantities (such as intensity) in a single-slit diffraction pattern
19. explain the significance of diffraction limit in an optical system.

Course Content

Electric Fields (EF)
Coulomb's Law
Electric Field and Potential
Gauss' Law in Electrostatics
Microscopic Model of Electrical Conduction
Electrical Current
Conductivity and Resistivity of a Material
Ohm's Law and Resistance
Capacitors and Capacitance

Magnetic Fields (MF)
Biot-Savart's Law
Ampere's Law
Solenoids
Lorentz Force
Hall effect
Gauss Law in Magnetism
Faraday's Law and Lenz's law
Inductors and Inductance

Nature and Propagation of Light (NPL)
Light rays, wave fronts, phase
Laws of reflection and refraction
Dispersion
Polarization

Geometric Optics (GO)
Light rays, wave fronts, phase
Laws of reflection and refraction
Dispersion
Polarization

Interference (I)
Two-slit interference
Interference in thin films

Diffraction (D)
Single-slit diffraction

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team / Individual	Assessment Rubrics
1. Final Examination	All	Competency (1,3,4)	60%	Individual	Point-based marking (not rubric-based)
2. CA1: Weekly homework	All	Competence (1,3,4), Character (1,2), Communication (1)	10%	Individual	Point-based marking (not rubric-based)
3. CA2: Mid-term 1	EF 1-4 MF 5-9	Competency (1,3,4)	15%	Individual	Point-based marking (not rubric-based)
4. CA3: Mid-term 2	NPL 10-11 GO 12-14 I 15-16 D 17-19	Competency (1,3,4)	15%	Individual	Point-based marking (not rubric-based)
Total			100%		

Formative feedback

You will receive formative feedback through discussion within tutorial lessons as well as interactive, computer-based hints and pointers in the Mastering Physics online assignment and resource system.

Formative feedback is also given via the student response application Learning Catalytics where you are required to answer on your mobile devices questions posted during lecture/tutorial. Feedback is always provided for your response to each question.

Finally, feedback is also given after each midterm on the common mistakes and level of difficulty of the problems. Past exam questions and examiner's report are also made available for you.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Problem solving (tutorial and lecture)	Develop competence and perseverance in solving physics problems
Mastering Physics	Provide feedback to correct misconceptions

(tutorial and lecture)	
In-class demos and videos	Help to establish physics intuition based on experiments

Reading and References

1. University Physics with Modern Physics, 14th Edition, H. D. Young and R. A. Freedman, Pearson (2016) **[ISBN-13: 978-0133969290]**
2. Physics for Scientists & Engineers with Modern Physics, 4th Edition, D. C. Giancoli, Pearson (2008) **[ISBN-13: 978-0131495081]**
3. R A Serway, J W Jewett Jr: Physics for Scientists and Engineers, 9th Edition, Cengage Learning (2013) **[ISBN-13: 978-1133947271]**

Course Policies and Student Responsibilities

Absence Due to Medical or Other Reasons

If you are sick and unable to attend your class / Mid-terms, you have to:

1. Send an email to the instructor regarding the absence and request for a replacement class and make-up mid-terms.
2. Submit the original Medical Certificate* or official letter of excuse to administrator.
3. Attend the assigned replacement class (*subject to availability*) and make-up mid-terms.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Asst Prof Marco Battiato	SPMS-PAP-05-07	6513 8039	marco.battiato@ntu.edu.sg
Asst Prof Wang Xiao	SPMS-PAP-05-02	6513 7418	renshaw@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Electric charges and electric field	**EF** 1	Lecture Notes, Tutorials, Mastering Physics on-line assignments
2	Gauss's Law in Electricity	**EF** 2	
3	Electric Potential and Electric Energy	**EF** 3-4	
4	Magnetic Force and Magnetic Field	**MF** 5-7	
5	Faraday's Law and Inductance	**MF** 8-9	
6	Nature and Propagation of Light	**NPL** 10-11	
7	Geometric Optics	**GO** 12	
8	Geometric Optics	**GO** 13	
9	Geometric Optics, Midterm Test 1	**GO** 14	
10	Interference	**I** 15	
11	Interference	**I** 16	
12	Diffraction, Midterm Test 2	**D** 17-18	
13	Diffraction	**D** 19	

What we want our graduates from Physics and Applied Physics to be able to do:

Upon the successful completion of the PHY, APHY and PHMA programs, graduates should be able to:

Competency	1	demonstrate a rigorous understanding of the core theories and principles of physics involving (but not limited to) areas such as classical mechanics, electromagnetism, thermal physics and quantum mechanics demonstrate a rigorous understanding of the core theories and principles of mathematical sciences involving (but not limited to) areas such as analysis, algebra and statistical analysis
	2	read and understand undergraduate level physics content independently;
	3	make educated guesses/estimations of physical quantities in general;
	4	apply fundamental physics knowledge, logical reasoning, mathematical and computational skills to analyse, model and solve problems;
	5	develop theoretical descriptions of physical phenomena with an understanding of the underlying assumptions and limitations;
	6	critically evaluate and distinguish sources of scientific/non- scientific information and to recommend appropriate decisions and choices when needed;
	7	demonstrate the ability to design and conduct experiments in a Physics laboratory, to make measurements, analyse and interpret data to draw valid conclusions.

Creativity	1	propose valid approaches to tackle open-ended problems in unexplored domains;
	2	offer valid alternative perspectives/approaches to a given situation or problem.

Communication	1	describe physical phenomena with scientifically sound principles;
	2	communicate (in writing and speaking) scientific and non-scientific ideas effectively to professional scientists and to the general public;
	3	communicate effectively with team members when working in a group.

Character	1	uphold absolute integrity when conducting scientific experiments, reporting and using the scientific results;
	2	readily pick up new skills, particularly technology-related ones, to tackle new problems;
	3	contribute as a valued team member when working in a group.

Civic Mindedness	1	put together the skills and knowledge into their work in an effective, responsible and ethical manner for the benefits of society.