Nanyang Technological University
Division of Physics and Applied Physics

Academic Year	2022-23	**Semester**	2
Course Coordinator	Marco Battiato (Asst Prof)		
Course Code	PH1106 / PH116S[1]		
Course Title	Electricity and Magnetism		
Pre-requisites	-		
No of AUs	3 AU		
Contact Hours	2 hr – lecture; 1 hr – tutorial		
Proposal Date	8 February 2023		

Course Aims

The course aims to guide you towards a basic understanding of the key ideas within fields and oscillations through the various concepts in electrostatics, magnetism, simple harmonic motion and electric circuits. Through problem solving, you would develop the physical intuition and analytical skills useful in these Physics topics. You would also learn to apply these theoretical concepts in real world situations.

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.

Electrical Circuits (EC):

10. discuss how an electric current is formed and how to calculate the resistance of a conductor from its dimensions, its resistivity or conductivity.
11. determine various electrical quantities (such as current, potential difference and resistance) using Ohm's law
12. determine electrical quantities (such as electrical energy and power) in circuits.
13. analyse simple circuits with multiple resistors and capacitors (such as determining electrical quantities in simple circuits with multiple loops and components using Kirchhoff's law).
14. describe sinusoidally varying quantities (such as potential difference and current) using phasors and analyse *L-R-C* (Inductor-Resistor-Capacitor) series circuit with sinusoidal emfs of different frequencies.
15. discuss the working principle of transformers.

Course Content

[1] PH116S is a self-paced version of the course.

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

Electrical Circuits (EC)
Voltage, Current and Resistance
Electrical Power
Kirchhoff's Laws and Direct Current (D.C.) Circuits
Resistor-Capacitor (RC) Circuits
Oscillations in Electrical Circuits
Inductor-Capacitor (LC) Circuits and Relative Phases
Resistor-Capacitor- Inductor (RLC) Circuits and Electrical Resonance

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)	40%	Individual	Point-based marking (not rubric-based)
2. CA1: Homework	All	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
3. CA2: Mid-term Test 1	**EF** 1-4, **EC** 10-13	Competency (1,3,4)	25%	Individual	Point-based marking (not rubric-based)
4. CA3: Mid-term Test 2	**EF** 1-4, **EC** 10-13, **MF** 5-8	Competency (1,3,4)	25%	Individual	Point-based marking (not rubric-based)
Total			100%		

Formative feedback

Formative feedback is given through discussion within both lecture and tutorial lessons, as well as during consultation hours. Further feedback is given after the lectures, as the lecturer will remain available for questioning for around 1h after class.

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 made available for you.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Warm-up questions will be raised first, followed by lectures that further explains the physics based on the questions. Then wrap-up questions will also be provided.
Tutorial	You will be reviewing main concepts learned in lectures with TAs. This helps you to digest and understand better.
Homework	The homework comprises standard textbook practice questions that are covered during tutorial.

Reading and References

1. University Physics with Modern Physics, 14th Edition, Hugh Young and Roger Freedman, Pearson (2015). ISBN-13: 9780321973610

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
Marco Battiato	SPMS-PAP-05-07	6513 8039	marco.battiato@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Electric charges and electric field	**EF** 1-2	Textbook and lecture notes, videos
2	Gauss's Law	**EF** 2	
3	Electric Potential and Electric Energy	**EF** 3-4	
4	Capacitors and Capacitance	**EC** 13	
5	• Current, resistance and electromotive force, • D.C. circuits	**EC** 10-13	
6	Topics in Week 1-5	Review and practice of problem-solving skills.	Midterm Test 1
7	Magnetic field and magnetic forces	**MF** 5-6	Textbook and lecture notes, videos
8	Magnetic force on electric currents	**MF** 6	
9	Sources of magnetic field	**MF** 7	Textbook and lecture notes, videos
10	Electromagnetic induction	**MF** 8	
11	Topics in Week 1-10, with increased weightage on Week 7-10 content.	Review and practice of problem-solving skills.	Midterm Test 2
12	Mutual inductance and Self inductance	**MF** 9	Textbook and lecture notes, videos
13	Circuits with Inductor	**EC** 9, 13	
14	A.C. Circuits	**EC** 14-15	

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

Upon the successful completion of the PHY, APHY, PHME, PHMP, PHQT and PHMS 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 [PHMS only] 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.