Nanyang Technological University
Division of Physics and Applied Physics

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| **Academic Year** | 2019/20 | **Semester** | 2 |
| **Course Coordinator** | Assoc. Prof. Fan Hongjin | | |
| **Course Code** | PH1106 / PH116S[1] | | |
| **Course Title** | Electricity and Magnetism | | |
| **Pre-requisites** | - | | |
| **No of AUs** | 3 AU | | |
| **Contact Hours** | PH1106 (2 hr – lecture; 1 hr – tutorial) | | |
| **Proposal Date** | 3 March 2020 | | |

**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 |
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| 1. Final Examination | All | Competency (1,3,4) | 60% | Individual | Point-based marking (not rubric-based) |
| 2. CA1: Online Assessment | All | Competency (1,3,4) | 10% | Individual | Rubrics marking |
| 3. CA2: Homework | All | Competency (1,3,4) | 10% | Individual | Point-based marking (not rubric-based) |
| 4. CA3: Mid-term 1 | **EF** 1-4, **EC** 10-13 | Competency (1,3,4) | 10% | Individual | Point-based marking (not rubric-based) |
| 5. CA4: Mid-term 2 | **EF** 1-4, **EC** 10-13, **MF** 5-8 | Competency (1,3,4) | 10% | Individual | Point-based marking (not rubric-based) |
| Total | | | 100% | | |

http://www.ntu.edu.sg/tlpd/tlr/obtl/4/Pages/41.aspx

**Formative feedback**

Formative feedback is given 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 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.

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?** |
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| **Use of Learning Catalytics** (tutorial and lecture) | You are able to see how well your peers answer questions and thus understand your relative progress in comprehension. |
| **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 |
|---|---|---|---|
| Assoc. Prof. Fan Hongjin | SPMS PAP 04-06 | 65137408 | FANHJ@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,<br>• 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 | |

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| 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 and PHMA programs, graduates should be able to:

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| ***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<br><br>[PHMA 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. |

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| ***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. |

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| ***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. |

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| ***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. |

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