This course aims to equip you with the basic concepts and problem solving skills in Mechanics, Thermal Physics and Electricity & Magnetism. You will develop physical intuition and analytical skills which are important for studying physical systems and solve problems involving the above three areas of Physics. These knowledge and skills lay the foundation for subsequent higher level courses and are also critical in the engineering profession.

Intended Learning Outcomes (ILO)

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

**Basics (BAS)**

1. analyze physics formulas (in areas related to mechanics, thermal Physics, electricity and magnetism) and make simple estimates of physical quantities in daily life.
2. solve problems and explain daily phenomena involving mass, weight, density, pressure and buoyant force (upthrust);
3. perform basic vector operations and solve problems involving vector quantities;

**Mechanics (MECH)**

4. analyze and solve 1D and 2D kinematics problems (such as projectile motion, uniform and non-uniform circular motion).
5. apply Newton’s laws of motion to analyze the effects of forces (including propulsive forces, frictional and viscous forces) acting on a system of objects in 1D and 2D;
6. apply the impulse-momentum relations, work-energy theorem and conservation laws associated with momentum and energy to solve problems.
7. apply Newton’s law of gravitation to analyze and solve problems;
8. determine the center of mass, moment of inertia of objects of simple geometry and solve problems related to static equilibrium and rotational motion.

**Electricity and Magnetism (EM)**

9. explain phenomena involving charges and solve problems involving a system of charges or charge objects of simple geometry using Coulomb’s law or Gauss’s law.
10. perform analysis of static and time-dependent circuits using basic concepts and rules (such as Kirchhoff's Laws, resistance and capacitance);
11. explain phenomena involving magnetic fields and solve problems involving magnetic forces and magnetic fields due to current using Biot-Savart’s law or Ampere’s law;
12. apply Faraday’s Law and Lenz’s Law to analyze and solve problems involving electromagnetic induction;

**Thermal Physics (TP)**

13. analyze and solve problems involving thermal properties of matter (such as thermal expansion, heat transfer involving solid and fluids, kinetic theory of gases).
14. apply the concepts in thermal physics and the first law of thermodynamics to analyse a given heat engine.

### Course Content

**Basics (BAS)**

- Units
- Mass, Weight and Density
- Atoms, microscopic structures and states of matter
- Pressure and Buoyant force
- Vectors

**Mechanics (MECH)**

- 1D and 2D Kinematics
- Newton’s Laws of Motion
- Circular Motion
- Forces, Impulse and Momentum
- Work, Energy and Power
- Centre of Mass
- Moment of Inertia
- Rotational Kinematics and Dynamics
- Gravitational Field

**Electricity and Magnetism (EM)**

- Electric Forces and Coulomb’s Law
- Electric Field and Potential
- Gauss’s Law
- Current electricity
- Kirchhoff’s laws and D.C. Circuits
- Resistors and Resistance
- Capacitance and Capacitors
- RC Circuits
- Electrical Power
- Magnetic Fields and Forces
- Biot-Savart Law
- Ampere’s Law
- Electromagnetic Induction
- Faraday’s Law and Lenz’s Law
Thermal Physics (TP)

Zeroth Law of Thermodynamics  
Temperature and Thermometer  
Thermal Expansion  
Heat Capacities and Latent Heat  
Ideal Gases  
Kinetic Theory of Gases  
First Law of Thermodynamics  
Heat Engines

Assessment (includes both continuous and summative assessment)

<table>
<thead>
<tr>
<th>Component</th>
<th>Course LO Tested</th>
<th>Related Programme LO or Graduate Attributes</th>
<th>Weighting</th>
<th>Team / Individual</th>
<th>Assessment Rubrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Final Examination</td>
<td>All</td>
<td>Competence, Communication</td>
<td>60%</td>
<td>Individual</td>
<td>Point-based marking (not rubric-based)</td>
</tr>
<tr>
<td>2. Continuous Assessment 1 (CA1): Weekly In-class Participation</td>
<td>All</td>
<td>Competence, Communication, Creativity</td>
<td>10%</td>
<td>Individual</td>
<td>Point-based marking (not rubric-based) – Using Learning Catalytics</td>
</tr>
<tr>
<td>3. CA2: Weekly Online Assignment</td>
<td>All</td>
<td>Competence, Character</td>
<td>10%</td>
<td>Individual</td>
<td>Point-based marking (not rubric-based) Using Mastering Physics</td>
</tr>
<tr>
<td>4. CA3: Mid-term 1</td>
<td>BAS 1-2 MECH 3-9 TP 22</td>
<td>Competence, Communication</td>
<td>10%</td>
<td>Individual</td>
<td>Point-based marking (not rubric-based)</td>
</tr>
<tr>
<td>5. CA4: Mid-term 2</td>
<td>MECH 10-13 EM 14-18</td>
<td>Competence, Communication</td>
<td>10%</td>
<td>Individual</td>
<td>Point-based marking (not rubric-based)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Approach</th>
<th>How does this approach support students in achieving the learning outcomes?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem solving (tutorial and lecture)</td>
<td>Develop competence and perseverance in solving physics problems</td>
</tr>
<tr>
<td>Hands-on group activities (during tutorial)</td>
<td>Develop physical intuition and competence in solving real-life problems. Relate everyday phenomena to physics.</td>
</tr>
<tr>
<td>Peer Instruction (during lecture)</td>
<td>Develop communication skills and competence in physics. You are encouraged to discuss about their answers posted on Learning Catalytics so that they can learn from one another.</td>
</tr>
</tbody>
</table>

Reading and References


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

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Office Location</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leek Meng Lee</td>
<td>SPMS PAP 05 01A</td>
<td>65927810</td>
<td><a href="mailto:MLLeek@ntu.edu.sg">MLLeek@ntu.edu.sg</a></td>
</tr>
</tbody>
</table>

### Planned Weekly Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Course LO</th>
<th>Readings/ Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic physical quantities in Mechanics, Thermal Physics and Electricity &amp; Magnetism</td>
<td>BAS 1-2</td>
<td>Pre-lecture videos, In-class Learning Catalytics</td>
</tr>
<tr>
<td>2</td>
<td>1D Kinematics; Vectors</td>
<td>BAS 3, MECH 4</td>
<td>Mastering Physics on-line assignment, Post-tutorial videos</td>
</tr>
<tr>
<td>3</td>
<td>2D Kinematics</td>
<td>MECH 4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Forces and Newton’s laws of Motion</td>
<td>MECH 5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Circular Motion; Torque and Equilibrium</td>
<td>MECH 4, 5, 8</td>
<td>Mid-term 1</td>
</tr>
<tr>
<td>6</td>
<td>Impulse-Momentum; Conservation of Momentum</td>
<td>MECH 6</td>
<td>Pre-lecture videos, In-class Learning Catalytics</td>
</tr>
<tr>
<td>7</td>
<td>Work, Energy and Power; Gravitation</td>
<td>MECH 6, 7</td>
<td>Mastering Physics on-line assignment, Post-tutorial videos</td>
</tr>
<tr>
<td>8</td>
<td>Electric Fields</td>
<td>EM 9</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Electric Potential and Circuits; Capacitance</td>
<td>EM 9-10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Magnetic Fields and Electromagnetic Induction</td>
<td>EM 11-12</td>
<td>Mid-term 2</td>
</tr>
<tr>
<td>11</td>
<td>Rotational Dynamics</td>
<td>MECH 8</td>
<td>Pre-lecture videos, In-class Learning Catalytics</td>
</tr>
<tr>
<td>12</td>
<td>Kinetic theory of gases; first law of thermodynamics and heat engines</td>
<td>TP 13-14</td>
<td>Mastering Physics on-line assignment, Post-tutorial videos</td>
</tr>
<tr>
<td>13</td>
<td>Revision</td>
<td>ALL</td>
<td></td>
</tr>
</tbody>
</table>