1. Aims
The principal aim of this course is to provide a firm understanding of physical concepts and processes leaning heavily upon standard physics U.S. textbooks. Another principal aim of the course will be to apply the concepts learnt to recent advances in our understanding of science in general. In particular, ways in which engineering applications may be better understood from a physics viewpoint will be stressed. The treatment of calculus is as per standard engineering courses, - it is used in instruction, and examined in the MCQ or written papers.

2. Objectives
By the end of this course it is to be expected that the students will have acquired an understanding of the following concepts and principles:
- The concepts of electric fields and electric potentials
- An appreciation of electric currents
- The concept of magnetic fields
- Electromagnetic waves
- The refraction of light
- Geometric optics
- Optical instruments
- The interference of light and other electromagnetic waves

3. Reading List
The core text (which is Calculus based) is:
'Serway's Principles of Physics' by Jewett & Serway (publisher: Thomson, 5th edition, 2013). Most of the assigned problems in the course will be taken from this book.

Please note this core text is supplied as an e-book free of charge to all students.

Other problems will be taken from, 'Physics' by Halliday, Resnick & Walker (publisher: Wiley) which is also a calculus-based text.

4. Teaching Methods
Each pair of lectures is supported by a 2-hour tutorial, where students work in groups of 3. Tutorial work is graded and contributes to the overall grade on the course.

(a) Lectures
There are typically four lectures per week scheduled for 2 hours.
(b) **Homework/ Problem Solving**
One set of problems will be handed out each week, which must be submitted for marking.

(c) **Workshops**
There are two 2-hour workshops each week devoted to problem solving, these will be group-based, with each group comprising three students, graded as a group.

(d) **Laboratory**
There are two 3-hour laboratory afternoons each week in which a new experiment is performed each afternoon. Here the students will work in pairs and will be graded in pairs.

**Independent Study**
It is estimated that each module will require a minimum of 80 hours independent study.

5. **Assessment**
The course will be assessed by means of a mid-session quiz and final examination, as well as the Laboratory and the problem sets.

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<thead>
<tr>
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<th>Date</th>
<th>Weighting</th>
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<tbody>
<tr>
<td>Problem Sets/Tutorials</td>
<td>2 -3 times weekly assessment</td>
<td>15%</td>
</tr>
<tr>
<td>Mid-Session Quiz</td>
<td>1 Exam – Mid Term</td>
<td>10%</td>
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<tr>
<td>Final Examination</td>
<td>1 Exam – End of Term</td>
<td>50%</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Twice weekly</td>
<td>25%</td>
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The grading is not done on a curve, but each student receives a grade based solely on their work.

Grades are awarded as follows:

100% - 90% - A+
89.99% - 80% - A
79.99% - 70% - A-
69.99% - 66.67% - B+
66.66% - 63.33% - B
63.32% - 60% - B-
59.99% - 56.67% - C+
56.66% - 53.33% - C
53.32% - 50% - C-
49.99% - 46.67% - D+
46.66% - 43.33% - D
5. Course Outline

Each lecture is 2 hours in duration; 44 hours of instruction.

Lecture 1: Coulomb's Law
Introduction, electric charge, the maths of the law, plotting forces, forces as vectors, superposition, simple calculations. Examples from technology. Evaluating the electric field.

Lecture 2: Electric Fields
Action at a distance. Electric field as a force per unit charge. Field due to a point charge. Charged particles in an electric field. Calculating the field and superposition. Field due to a dipole and parallel conducting plates.

Lecture 3: Electric Flux and Field Lines
Plotting the electric field. The concept of flux, effect of an electric field on a dipole. Calculating the electric flux.

Lecture 4: Gauss's Law
Summing the electric field across a closed surface. Gauss's law & Coulomb’s law. Applications of Gauss’s Law. Charges on conductors, experimental verification.

Lecture 5: Electric Potential & Potential Energy
The problem with two types of charge. Electrical potential energy in a uniform field, electrical potential energy due to a point charge, a pair of point charges. Electric force and electric potential. Electric potential due to parallel plates, spheres etc. Equipotentials.

Lecture 6: Conductors and Capacitance and Capacitors

Lecture 7: Electric Current & Kirchhoff’s Rules

Lecture 8: RC Circuits
Charging & discharging capacitors, RC circuits, RC constant.

Lecture 9: Magnetism

Lecture 10: Forces and Torques on Currents
Force on a current carrying conductor in a magnetic field. Torque on a current loop in a B field. Coils and motors.

Lecture 11: The Biot-Savart Law and Ampere’s Law

Lecture 12: Motional EMF and Faraday’s Law
Current induced in a loop by a changing B field. Induced EMF. Faraday’s law, alternators and generators. Lenz’s law. Eddy currents.

Lecture 13: Induction and RL Circuits
Mutual and self-inductance. Inductors, magnetic field energy. Inductors in circuits, the RL circuit.

Lecture 14: LC and RLC Circuits

Lecture 15: Displacement Current and Electromagnetic Waves
Maxwell’s equations, plane waves, the EM wave equation. Sinusoidal waves. EM waves in matter, the Poynting vector.

Lecture 16: Properties of Electromagnetic Waves, Polarization

Lecture 17: Reflection and Refraction

Lecture 18: Mirrors & Lenses.
Reflection in plane mirrors and curved surfaces. Refraction at plane and curved surfaces. Image formation in simple optical systems, sign conventions, graphical methods, thin lenses

Lecture 19: Optical Instruments
The camera, the eye, telescopes & microscopes. Optical fibres.

Lecture 20: Wave Optics 1
Constructive and destructive interference. Two-source interference, intensity in interference patterns. Phase and path difference. Thin film interference, Lloyd’s mirror.

Lecture 21: Wave Optics 2

Lecture 22: Relativity

7. Laboratory Outline
Each Laboratory is 2.5 hours in duration; 20 hours of lab work
Lab 1: Circuits
Lab 2: Power in circuits and Specific Heat Capacity
Lab 3: Resistivity of a wire
Lab 4: Measurement of the focal length of lenses
Lab 5: The spectrum of Atomic Hydrogen
Lab 6: Malus’ Law & Brewster’s Angle
Lab 7: Measuring the Speed of Light
Lab 8: Interference & Diffraction

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