# Module Specification (Curriculum Review)

## Basic details

<table>
<thead>
<tr>
<th>UID</th>
<th>Cohorts covered</th>
<th>Earliest cohort</th>
<th>Latest cohort</th>
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<td></td>
<td></td>
<td>2021-22</td>
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### Long title
Plasma Physics

### New code
PHYS60013

### New short title
Plasma Physics

### Brief description of module (approx. 600 chars.)
We live in a largely neutral world in which plasmas are seemingly rare. By contrast, the majority of visible material in the universe exists at sufficiently high temperatures or rarefied densities to be at least partially ionised, and is therefore plasma. Importantly, plasmas behave differently to other states of matter and exhibit so-called “collective effects”. The physics of plasmas is important to a wide range of phenomena: the evolution of stars and galaxies, the interaction of the solar wind with the Earth’s magnetic field, industrial processes such as computer chip fabrication and the generation of intense sources of electromagnetic radiation and energetic particles. Plasma physics is also central to attempts to achieve controlled thermonuclear fusion as a future energy source.

### Available as a standalone module/ short course?
N

## Statutory details

<table>
<thead>
<tr>
<th>Credit value</th>
<th>ECTS</th>
<th>CATS</th>
<th>Non-credit</th>
<th>HECOS codes</th>
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<tbody>
<tr>
<td></td>
<td>7.5</td>
<td>15</td>
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### FHEQ level
Level 6

## Allocation of study hours

<table>
<thead>
<tr>
<th>Hours</th>
<th>Lectures</th>
<th>26</th>
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<tbody>
<tr>
<td>Group teaching</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Lab/ practical</td>
<td>0</td>
<td></td>
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<tr>
<td>Other scheduled</td>
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<td></td>
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<tr>
<td>Independent study</td>
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<tr>
<td>Placement</td>
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<tr>
<td>Total hours</td>
<td>187.5</td>
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### ECTS ratio
25.00

## Project/placement activity

### Is placement activity allowed?
No

## Module delivery

### Delivery mode
Taught/ Campus

### Delivery term
Term 2, exam in term 3

## Ownership

### Primary department
Physics

### Additional
None
Delivery campus: South Kensington

Collaborative delivery

Collaborative delivery? N

External institution: N/A
External department: N/A
External campus: N/A

Associated staff

<table>
<thead>
<tr>
<th>Role</th>
<th>CID</th>
<th>Given name</th>
<th>Surname</th>
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<tbody>
<tr>
<td>Module Leader</td>
<td></td>
<td>Jeremy</td>
<td>Chittenden</td>
</tr>
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</table>

Learning and teaching

Module description

On completing the Plasma Physics module, students will:
- Understand the broad range of physical phenomena which determine the behaviour of plasmas and the importance of collective effects.
  (Develop a qualitative understanding and an understanding of theoretical models - including commonly used approximations)
- Have started learning how to think like a plasma physicist
  (Develop intuition for plasma behaviour; Pinpoint the key physics/phenomena for a particular system/application; Understand conditions spanning over 20 orders of magnitude. Simplification of theoretical models)
- Learn problem-solving skills for plasma physics
  (Linearisation of PDEs to facilitate tractable, quantitative solutions; enhance their analytical abilities and physics problem-solving in general)
- Understand the role of plasmas in a range of naturally occurring phenomena and laboratory applications
Module content

1. Basic properties of plasmas
   - Definition, occurrence and importance of plasmas, Debye shielding
   - Quasi-neutrality, plasma parameter, plasma frequency, Larmor orbits (basics)
   - Non-ideal plasmas
2. Thermonuclear fusion
3. Single particle motion
   - Guiding centre drifts; $E \times B$, curvature, gradient
   - Magnetic moment ($\mu$), conservation of $\mu$, magnetic mirrors
4. Collisions
   - Coulomb collisions; mean-free-path and collision time (single and cumulative collisions)
   - Resistivity, particle diffusion, bremsstrahlung
5. Magneto-hydrodynamics (MHD)
   - MHD equations; mass continuity, momentum, energy, Ohm's law
   - The convective derivative, MHD validity and assumptions
   - B-field dynamics; flux freezing, resistive diffusion, magnetic Reynolds number
   - Magnetic pressure and tension
6. Waves
   - Electromagnetic, Langmuir, MHD (Alfvén, magnetosonic)
7. Magnetic confinement
   - MHD equilibria; flux surfaces, Z-pinches
   - MHD instabilities and the safety factor,
8. Kinetic theory
   - Vlasov and Boltzmann equations, obtaining fluid/MHD equations from Boltzmann
   - Langmuir waves, resonant particles and trapping, Landau damping
   - Laser-Plasma particle accelerators
9. Main Approaches to Controlled Fusion
   - Overview of magnetic confinement fusion (MCF) and inertial confinement fusion (ICF)

Learning and Teaching Approach

Students will be taught over one term using a combination of lectures and office hours.

Assessment Strategy

100% Summative assessment based on final 2hr written exam.

Feedback

Eight problem sheets are provided. Example answers will also be provided. These are not assessed but provide practice and guidance on material similar to the exam. Students can receive guidance on approaches to solution of these questions as well as feedback on their answers through office hours.

Reading list

Lecture notes are provided to students. The notes are designed to be self-contained, and there is no designated textbook required for this course. There are however also some textbooks that are suggested as supplementary or complementary reading:

Quality assurance

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<tr>
<th>Date of first approval</th>
<th>QA Lead</th>
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<td>Department staff</td>
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<tr>
<td>Date of last revision</td>
<td>Date of collection</td>
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<tr>
<td>Date of this approval</td>
<td></td>
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</table>

Module leader

Jeremy Chittenden

Notes/ comments

Office use only

Date exported

Date imported

Template version 16/06/2017
| UID | Legacy code | Module title | Requisite type |
|-----|-------------|--------------|----------------|----------------|

Programme structure
Associated modules
<table>
<thead>
<tr>
<th>UID</th>
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<th>Programme title</th>
<th>Core?</th>
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### Assessment details

<table>
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<th>Pass mark</th>
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<tr>
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### Assessments

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<tr>
<td>Examination</td>
<td>Written exam over 2 hours</td>
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100%