Imperial College London

# Module Specification (Curriculum Review)

## Basic details

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|---|---|---|---|
| UID | | Cohorts covered | Earliest cohort: 2024-25; Latest cohort: |
| Long title | Imaging | | |
| New code | PHYS70024 | New short title | |
| Brief description of module *(approx. 600 chars.)* | The Imaging module is split into two parts: geometrical optics and wave optics. Geometrical optics introduces you to the ray model for light propagation through optical systems and methods to model aberrations. The wave optics part introduces methods to model the propagation of scalar waves through optical systems and how this can be used to describe image formation for both coherent and incoherent illumination. | | |
| | 415 characters | | |
| Available as a standalone module/ short course? | N | | |

## Statutory details

| | ECTS | CATS | Non-credit | | |
|---|---|---|---|---|---|
| Credit value | 5 | 10 | N | HECOS codes | |
| FHEQ level | Level 7 | | | | |

## Allocation of study hours

| | Hours | |
|---|---|---|
| Lectures | 16 | |
| Group teaching | 8 | *Incl. seminars, tutorials, problem classes.* |
| Lab/ practical | | |
| Other scheduled | 10 | *Incl. project supervision, fieldwork, external visits.* |
| Independent study | 91 | *Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.* |
| Placement | | *Incl. work-based learning and study that occurs overseas.* |
| Total hours | 125 | |
| ECTS ratio | 25.00 | |

## Project/placement activity

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|---|---|
| Is placement activity allowed? | No |

## Module delivery

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|---|---|---|---|
| Delivery mode | Taught/ Campus | Other | |
| Delivery term | Term 1 | Other | |

## Ownership

| | |
|---|---|
| Primary department | Physics |
| Additional teaching departments | |
| Delivery campus | South Kensington |

## Collaborative delivery

| | |
|---|---|
| Collaborative delivery? | N |
| External institution | N/A |

| | |
|---|---|
| External department | N/A |
| External campus | N/A |

## Associated staff

| Role | CID | Given name | Surname |
|---|---|---|---|
| Module Leader | | Chris | Dunsby |
| Lecturer | | James | McGinty |
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## Learning and teaching

### Module description

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| Learning outcomes | On completion of this module students will be able to<br>- apply the refraction invariant, aperture and field stops and the Lagrange invariant in calculations of imaging systems<br>- evaluate wave and transverse ray aberrations, use the aberration polynomial and characterise aberrations in terms of the primary aberrations<br>- calculate wavefront aberrations in optical systems using Seidel sums and perform associated calculations<br>- derive and describe the field distribution in the vicinity of the back focal plane of a perfect lens under coherent illumination and its relationship to the Fourier transform<br>- use the point spread function and coherent transfer function analyse to calculate the performance of coherent imaging systems<br>- use the point spread function and optical/modulation transfer function to analyse and calculate the performance of incoherent imaging systems |
| Module content | Geometrical optics:<br>Ideal optical systems, cardinal points, lateral and longitudinal magnification, paraxial approximation, Gaussian lens formula, single refracting surface, refraction invariant, aperture and field stops, Lagrange invariant, afocal systems, Gaussian properties of two systems, ABCD ray tracing matrices, wave and transverse ray aberrations, the aberration polynomial, primary aberrations, Seidel sums and Seidel sums for thin lenses.<br>Wave optics:<br>Scalar diffraction theory, angular spectrum of plane waves, first Rayleigh-Sommerfeld integral, Fresnel and Fraunhofer diffraction integrals, transmission function and field distribution in back focal plane region of a thin lens, application of Fourier transform to diffraction calculations, weak aberration and the Strehl ratio, coherent imaging of point and extended object, coherent transfer function and coherent point spread function, transition from coherent to incoherent imaging, optical/modulation transfer function and incoherent point spread function. |
| Learning and Teaching Approach | Students will be taught through a combination of lectures and classworks (where a timetabled session is used for a group problem solving exercise) supported by problem sheets and office hours. Some of the material will be delivered by assigning the students pre-recorded content to study, with subsequent in-person sessions used to reinforce that material. |
| Assessment Strategy | A 2 hour written examination provides 100% summative assessment. Examination questions are designed to assess across all of the learning outcomes.<br>Formative assessment is provided through the problem sheets and classworks. |
| Feedback | Problem sheets are provided and model solutions are provided. An office hour is provided each week during the module to allow for feedback and direct interaction between students and the module lecturers. Classworks provide an opportunity for group discussion and for students to receive feedback on the classwork exercises. For material that is delivered using pre-recorded content, the in-person sessions allow students to discuss the module material with the lecturer in small groups. |
| Reading list | E. Hecht, “Optics”, Addison Wesley, 4 th Edition, 2002<br>M. Born and E. Wolf, “Principles of Optics”, Cambridge, 7 th Edition, 1999<br>W. T. Welford, “Aberrations of Optical Systems”, Taylor and Francis, 1996<br>J. W. Goodman, "Introduciton to Fourier Optics", Roberts and Company, 3 rd Edition, 2005<br>J. Mertz, "Introduciton to Optical Microscopy", Roberts and Company, 2010 |

## Quality assurance

## Office use only

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|---|---|---|---|
| Date of first approval | | QA Lead | |
| Date of last revision | | Department staff | |
| Date of this approval | | Date of collection | |
| | | Date exported | |
| Module leader | Chris Dunsby | Date imported | |

Notes/ comments

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