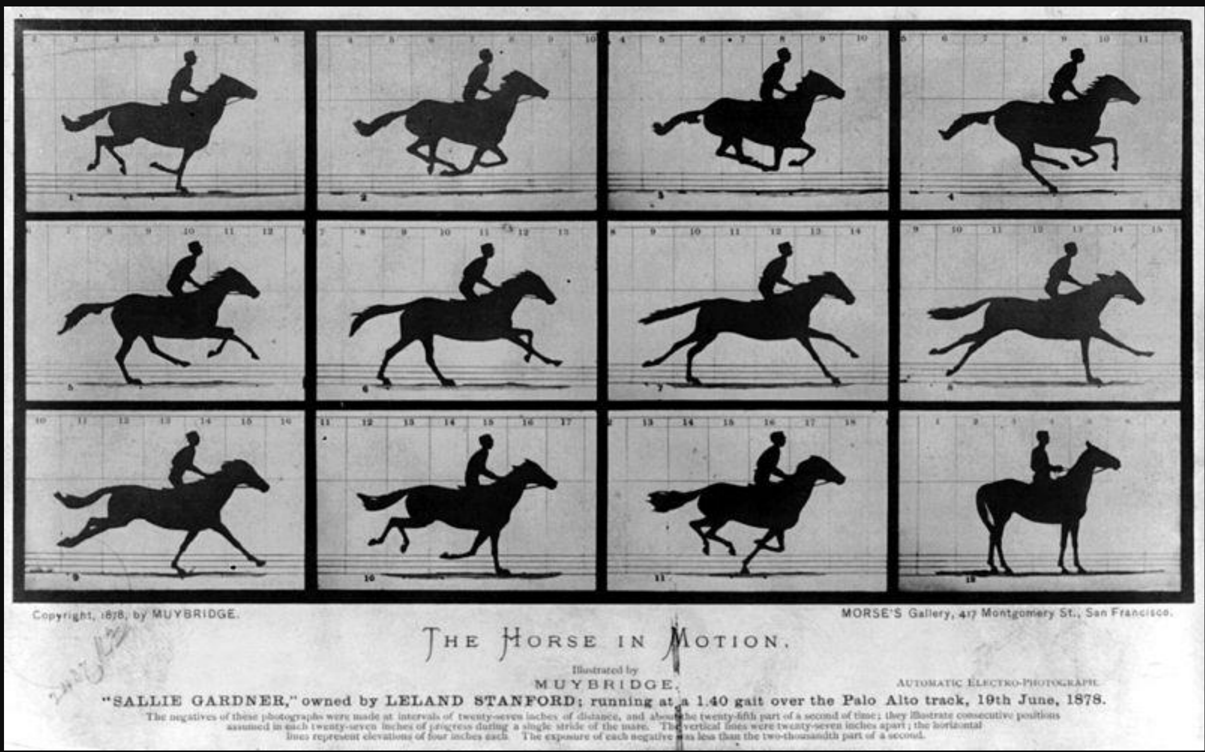
University of Glasgow | School of Physics & Astronomy



PHYS5035 Imaging and Detectors

Course Information Guide 2023-2024

1 Course Details

Lecturers:	Dr Ian MacLaren Room 315b, Kelvin Building ian.maclaren@glasgow.ac.uk	Schedule:	Irregular: see Moodle
Credits:	10		
Assessment:	Exam 100%	Co-requisites	None
Level:	SCQF level 5		
Typically Offered:	Semester 2	Prerequisites:	None

PHYS5035 Imaging and Detectors is an M-level Physics 5 course. It is an elective course with good fit to many of the physics degree options. It is composed of 18 lectures and 2 full class tutorials, normally given in Semester 2.

2 Required Knowledge

Students are expected to possess a good fundamental understanding of basic concepts such as covered in mathematical methods, optics, semiconductors, electromagnetism courses in Levels 1-4 at Glasgow. Basic knowledge of Python is desirable.

3 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 H-level credits.

4 Recommended Texts

Recommended texts will be published on the Library reading list system.

5 Intended Learning Outcomes

By the end of the course, students will be able to demonstrate a knowledge and broad understanding of the processes of scientific imaging across a range of length scales (right down to the atomic scale), the processes of detection in modern solid-state detectors and have an appreciation of the critical assessment of characteristics that might limit information retrieval from images. Students should be able to describe imaging modalities involving visible light, X-rays, electrons, and other types of particles. In each case, they should be able to explain the fundamental limitations of the technique and typical examples of application. Students should be able to demonstrate a broad understanding of how photons and charged particles interact with matter and how this is used for detecting them, and thereby also quantitatively discuss noise sources and detectability of signals across a wide range of detectors. The students should be able to describe the principles of a range of photon and particle detectors, how the signal is generated and processed, and what the imaging technique and the detectors used places as limits on resolution and signal detectability.

6 Course Outline

6.1 Introduction to principles of scientific imaging

Properties and limits of image detection, human vision. Characteristics of light and illumination sources. Resolution of an imaging system, magnification. Review of geometrical optics.

6.2 Fourier optics

Fundamentals of Fourier Optics and Abbe's theory of imaging formation.

6.3 Image Detector properties

Fundamental aspects of the detection process, types of detectors and detector regimes, noise, amplification, general figures of merit of a detector.

6.4 Photon detectors

Fundamentals of photodetection. Photoconductors, photodiodes, quantum wells. Metal-semiconductor detectors. Devices: CCD and CMOS sensors.

6.5 Particle detectors

Fundamentals of electron and ion detection and detectors.

6.6 Light Microscopy

Principal elements of a modern light microscope. Optical aberrations. Main light optical techniques: polarization, dark-field, fluorescence, phase-contrast, confocal, and super-resolution microscopy.

6.7 X-ray imaging

X-ray Sources. Dispersive relation. Fundamentals of X-ray optics. Types of X-ray lenses and imaging modalities.

6.8 Electron Microscopy

Fundamentals of Scanning Electron and Transmission Electron Microscopy. Electromagnetic lenses. Interaction of electrons with matter. Aberrations in electron optics and their influence on resolution. Different modes of operation, imaging, and spectroscopy.