Chapter 0 Introduction

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Optics is a branch of physics, and it studies the behavior and properties of light, and interaction of light with matter. The word "optics" itself means appearance or look in ancient Greek. Nowadays, when you think of appearance or look, the words like "ugly" or "beauty" will naturally come out of your brain. But in old days, the human being encountered with the look of nature every day, see the two pictures below, which made them wonder what light was, how it behaved, etc. Such curiosity turned into science, as Einstein put "**The whole of science is nothing more than a refinement of everyday thinking**."





More importantly, if you can make use of your understanding of light, you have the advantage over your competitors or enemy, just like Euclid (325BC~265BC) who designed one of the seven wonders, the Lighthouse of Alexandria, see the picture below, about two thousand years ago.



One of its functions was to guide the soldier home by fire at night and by mirror during daytimes. For scientists, it was the mysterious mirror that fascinated them most. From Euclid's times to Newton's times (1643~1727), light was regarded as rays which propagate in a straight-line, and deflect (reflect or refract) at interfaces between air and matter. The picture below shows how Newton did his experiments on light.



Such knowledge is referred to as "**geometrical optics**", which led to successful applications of lenses, mirrors, and combination of them like spectacles, telescopes and microscopes, etc. The picture below summarizes all the knowledge about "**ray optics**"



However, as scientists looked deeply into the concept of "light travels in a straight-line", they found discrepancy between geometrical optics and experiments which were carried out with light shone onto tiny objects such as small apertures. In fact they found out that light behaviors like water waves: light can bend. Such understanding resulted in the

development of "**wave optics**", in which light propagates like waves. With wave optics, people can understand optical phenomena such as interference, diffraction, etc.

But, the fundamental question remained unresolved: what is the nature of light? In my opinion, **modern optics** started when Maxwell was able to provide one of the correct answers.



James Clerk Maxwell

(1831–1879, Scottish)

Maxwell is best know for his fundamental contributions to electricity and magnetism and the kinetic theory of gases. He studied numerous other subjects, including the human perception of color and color-blindness, and is credited with producing the first color photograph. He originally postulated that electromagnetic waves propagated in a mechanical "luminiferous ether," but subsequent experiments have found this model untenable. He founded the Cavendish laboratory at Cambridge in 1874, which has produced 28 nobel prizes to date.

Nowadays, pure science aspects of optics are called optical science or optical physics. And applied optical sciences are called optical engineering, or photonics, or optoelectronics, though boundaries among them are unclear.

In this semester, you will study modern optics. But it nowadays covers so many topics that it is impossible for you to learn them all in one semester. In this module, you will be exposed and confined to the following topics:

- Chapter 1 Electromagnetic phenomena
- Chapter 2 Plane waves and complex index of refraction
- Chapter 3 Polarization of light
- Chapter 4 Double parallel interfaces
- Chapter 5 Coherence and interference
- Chapter 6 Light as rays
- Chapter 7 Diffraction
- Chapter 8 Laser beam optics
- Chapter 9 Fourier optics
- Chapter 10 Optical imaging and resolving power

This course consists of 13-week lectures, 8 tutorials, 2 mid-term tests, and a final exam. The tutorials and mid-term tests will be marked and accounted towards the continuous assessment with a weight of 30%; and the final exam weighs 70% of the total mark.