Light Science Reading List

It's not easy to find appropriate physics textbooks for this course. *Light Science* is intended to be of interest and relevance to students of all the physical sciences, who have varied backgrounds, yet to introduce more advanced and demanding concepts than met with in a level 1 course. The course is part of the Honours Physics programme, too. After a lot of thought, I've decided to issue quite comprehensive course notes that closely follow the lectures and contain most of the diagrams shown on the PowerPoint presentations.

The reading strategy for this course is:
1. study the comprehensive notes issued
2. look at the main textbook that underpins quite a lot of the course (see next paragraph)
3. look in several supplementary books mentioned below, choosing out of personal taste and relevance to a particular topic

There is one particularly good specialist textbook on the science of light. It is called, simply, *Optics*. Its author is Eugene Hecht. It is very well written, superbly illustrated, up-to-date and widely used by universities. It is a book that anyone with a physics degree would be pleased to be familiar with. Students who are looking forward to taking physics next year might want to invest in their own copy, but the library has several copies. Hecht has a lot of text in his *Optics* and does describe things very well but non-physics students who dip into it will probably find too much mathematical detail. Don't worry. There are a lot of books out there that cover optics at a variety of levels.

In these times when using the library is a skill we are asked to help students cultivate in all courses, my policy is to strongly recommend that you look at several books that cover much of the material in this course. A range of books will put the topics into perspective. Different people will find different approaches catch their interest and help them.

The intended way you should tackle this course is: come to the lectures and listen to what is said, taking brief notes or adding comments to the notes issued. While the material is fresh in your mind, read up what several authors say about the subject and make your own notes of points that expand the story in a way you find interesting, memorable and helpful. Make sure you understand the concepts or have questions that you'd like to raise in the tutorials. Towards the end of the course, when revision is becoming a high priority, use the issued notes alongside your own supplementary notes to revise. My notes will also be put on the course web page.

Portfolio textbooks

These books cover a huge range of physics, including optical science, at levels 1 and 2. They are well written and produced, using plenty of coloured diagrams and pictures. We reference the first one in stream A of 'The Physical Universe' at level 1. Some of the class will already have their own copy.

Richard Wolfson and Jay M. Pasachoff **Physics, with Modern Physics for Scientists and Engineers** [Addison-Wesley, 3rd edition, 1999 - ISBN 0-32105603-5]

David Halliday, Robert Resnick & Jearl Walker **Fundamentals of Physics** [Wiley, New York, 6th edition, 2000 - ISBN 0-471-33236-4, 7th ed'n, 2004 – ISBN 0-471-23231-9]

Paul Tipler **Physics for Scientists and Engineers** [Freeman, New York, 4th edition, 1999 - ISBN 1-572-59673-2; with Gene Mosca, 4th ed'n, 2004, ISBN 0716743892]

Hugh D. Young & Roger A. Freeman **University Physics** [Addison-Wesley, Reading, MA, 9th edition, 1996 - ISBN 0-20164044-9, 11th ed'n, 2004, ISBN 0321204697]

Raymond A. Serway, Robert J. Beichner, John W. Jewett, **Physics for Scientists and Engineers with Modern Physics** [Saunders, Forth Worth, 5th edition, 2000 - ISBN 0-03-022657-0; 6th ed'n, Brooks/Cole 2004, ISBN 0534423981]

Raymond A. Serway & John W. Jewett **Principles of Physics** [Saunders, Fort Worth, 2nd edition 1998, ISBN 0-03-020663-4]

Optics textbooks

There are **very many** optics books available, for those who would like to browse the library shelves. Expect to meet several different notations. The following textbooks are highly recommended.

Eugene Hecht **Optics** [Addison-Wesley, London, 4th ed'n 2002 - ISBN 0-8053-8566-5]. Earlier editions are in the library. This is a well-written book with matter both relevant and peripheral to the course. See above for further comments.

F. Graham Smith and Terry A. King **Optics and Photonics: an Introduction** [John Wiley & Sons, Chichester 2000 - ISBN 0-471-48925-5]. This pretty new book is written explicitly with the modern view of optics in mind. It covers many of the topics in our course and was my second choice as accompanying textbook for the course. The explanations are in good, plain English and the diagrams clear, but for me the book lacks the sparkle of Hecht. Some may like it better!

R.S. Longhurst **Geometrical and Physical Optics** [Longman, London 3rd ed'n, 1973]. A superb reference book that in my experience very often has the answer to that difficult question. Its range is enormous. Longhurst's treatment and his notation have become something of a standard used by later books. Too dense and wide-ranging to be the primary course text, and his diagrams are a bit dated.

M.H. Freeman **Optics** [Butterworths, London, 10th ed'n, 1990, ISBN 0-75062210-5]. An excellent book with an emphasis on geometrical optics and on all aspects of optics relevant to vision. Generally uses Longhurst's notation.

O.S. Heavens & R.W. Ditchburn **Insight into Optics** [Wiley, Chichester, 1991 ISBN 0-47192901-8]. An entry by two 'old masters' of optics. Subjects are dealt with in clear short sections, generally well presented but the treatment lacks much 'chatty' background. Some may like this. The diagrams are not as good as they should be for a 1990s book.

W.T. Welford **Optics** [OUP, Oxford, 2nd ed'n, 1981]. This is a popular little book in a good series, though one I myself don't use. Its notation is similar to Longhurst's and the level of treatment fairly close to that of our course. You should find sections of the book useful.

Frank L. Pedroth & Leno S. Pedrotti **Introduction to Optics** [Prentice Hall, London, 1996 ISBN 0-13016973-0]. A textbook that is popular with some universities.

R. Daniel Overheim & David L. Wagner **Light & Color** [John Wiley, Chichester, 1982 ISBN 0-47-1-08348-8] Unlike the other optics books referenced, this one could be understood cover-to-cover by anyone in the class. Chapter 5 *On the Appearance of Objects* gives a fuller account of material that is in a section of our course. The CIE chromaticity diagram and related topics are dealt with more fully here than in many more advanced optics texts.

Francis A Jenkins & Harvey E. White **Fundamentals of Optics** [McGraw-Hill, London, 4th ed'n, 1976]. A classic text that very many people have used. Short on recent developments but often worth looking into for a succinct account of a given area.

E. G. Steward **Fourier Optics: an Introduction** [Ellis Horwood Ltd., Chichester, 1983]. A slightly more advanced book but giving a very good introduction to diffraction, interference, Fourier transform spectroscopy, and optical image processing.

***Light in Nature* - a reference list in alphabetical order of authors**

Carl B. Boyer **The Rainbow: from Myth to Mathematics** [Princeton Univ. Press, 1987]. The strength of this book is its historical coverage of mankind's attempts throughout the ages to understand the rainbow. The story works up to the modern optical concepts needed to appreciate the phenomenon, including interference of light, diffraction and the science of colour mixing. The latest reprinting includes colour pictures.

Robert H. Eather **Majestic Lights: the Aurora in Science, History, and the Arts** [American Geophysical Union, 1980]. The definitive book with which to introduce the aurora, written by one of the notable names in auroral research and profusely illustrated. The book leads up to an account of the modern basis for understanding this complex phenomenon.

M. Gadsden and W. Schröder **Noctilucent Clouds** [Springer-Verlag, 1989]. The definitive book on a phenomenon especially well seen from Aberdeen. The lead author was senior lecturer in the department here for more than 25 years.

Robert Greenler **Rainbows, Halos and Glories** [C.U.P., 1980]. Beautifully illustrated modern book with plenty of computer simulations of both common and unusual phenomena.

G.P. Können **Polarized Light in Nature** [C.U.P., 1985]. Also with many coloured pictures. A guide to polarization dependent phenomena. Anyone with a general interest in light will enjoy dipping into Können's book.

David K. Lynch & William Livingston **Color and Light in Nature** [C.U.P., 1995]. Quite a new book covering a wide range of meteorological optical phenomena with excellent photographs and clear text. A worthy sequel to the previous three offerings from the Cambridge University Press. There are also sections on astronomical phenomena and on naked-eye observing.

Aden & Marjorie Meinel **Sunsets, Twilights and Evening Skies** [C.U.P., 1983]. Many colour pictures that complement a text explaining how refraction, absorption and scattering determine a wide range of beautiful phenomena.

M. Minnaert **The Nature of Light and Colour in the Open Air** [Dover, NY, 1954]. A classic book covering the science of many natural phenomena. Minnaert's book has delighted and stimulated thousands of readers and has recently been re-issued.

Scientific American **Atmospheric Phenomena** [W. H. Freeman & Co., San Francisco, 1980]. A portfolio of well illustrated articles from earlier editions of Scientific American. They still make good reading.

Walter Tape **Atmospheric Halos** [American Geophysical Union, 1994]. A single subject book covering the ground in a similar way to Robert Greenler's wider-ranging textbook. Very well presented with strong links made between the observed phenomenon, the ice crystals responsible and the simulated geometrical optical explanation. Well illustrated with colour photographs.

R. A. R. Tricker **Introduction to Meteorological Optics** [Mills & Boon, London, 1970]. This is a Mills & Boon book you can happily confess to having. It's another very good book on natural phenomena at a level not far from 6th year school physics. Tricker particularly emphasises how the detailed geometry of different situations combines with the basic laws of physics to produce diversity in each phenomenon.

JSR

p.s. Comment on the first chapters in Hecht's *Optics*:

Chapter 1: A brief history of ideas on the nature of light. Very readable. This chapter will set the developments and 'names' we'll meet later into historical context..

Chapter 2: Waves. Light is basically a wave phenomena, as was partly worked out by the great Christiaan Huygens in the mid 1600s, developed further by Augustin Fresnel in the early 1800s and put in its modern context by James Clerk Maxwell (late of this University) in the mid 1800s. General wave concepts like *wavevector*, *wavelength*, *phase*, *frequency*, *amplitude*, *wave equation*, apply to all kinds of waves. We shall treat waves later in the course.

Chapter 3: covers Electricity & Magnetism theory, propagation of light, radiation pressure, interactions of light with matter. The treatment is advanced in that it assumes a level of knowledge of E&M about that which Hons Physics students will have at the end of their third year E&M course.

Chapter 4: Propagation of light. This is where we come in.