PHY 353S - ELECTROMAGNETIC WAVES

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(1001 things to do with Maxwell's Equations)

Introduction

Maxwell's equations and their solution in terms of electromagnetic waves is the mathematical foundation of a surprisingly large amount of the technology in our society. Examples are: optical systems, radio communications, optical fibre systems, computer displays, holograms and laser systems. We will not have time in this course to delve into all these areas, so our examples will be selective and somewhat idiosyncratic. This course follows PHY352F, but is not intended as "Part 2" of that course. The development we will be following is somewhat different and the issues that we deal with are different as well.

In this course we will cover three broad areas: The theoretical basis of Maxwell's equations, ray optics and optical systems. We might stray a little into laser systems if there is time.

Course Outline

Topic	**Application**
Review of Maxwell's Equations	EVERYTHING
waves in free space	communications
waves in conductive media, reflection	reflections and reflective optical systems
waves in dielectric material, refraction	refraction and transmissive optical systems
skin effect	high frequency design
waves in dispersive media	chromatics
polarization phenomena, brewster's angle	sunglasses and LCD displays
Fresnel equations	slits, slots and holes (diffraction)
energy and momentum of E-M waves	spacecraft propulsion
geometrical optics	the movies
interference, thin film optical	anti-reflection lenses, camera lenses
coherence effects	lasers
interferometers	spectrometers
Fourier optics	Really good camera lenses, laser cavities
Holography	science fiction

Marking Scheme

The course will be evaluated by a combination of problem sets, examinations and a short "paper" (more on that below)

Problem Set 1	2:00pm February 3rd, 2000	15%
Mid-Term	4:00pm February 23rd , 2000	20%
Problem Set 2	2:00pm March 30th, 2000	10%
Paper	8:30am April 3rd, 2000	25%
Final Exam	Examination Period	30%
TOTAL		100%

Examinations and tests will be “open book” - there will be some limitations!!

Penalties

In accordance with my usual policy: For any piece of work a penalty of 1 mark per working day or part thereof up to 1 week (total 5 marks) after which the work will not be accepted. Exceptions must be requested at least 24 hours before the deadline and may or may not be granted.

Course Text

We are going to use the following text for this course:

Optics - E. Hecht - Addison Wesley - 1998 - ISBN 0 201 83887 7 (app. $120)
A new edition of an old favourite - has a lot of very useful material - the older editions were good as well.

This will have to be supplemented by some additional material which will be available in note form as we go along.

Some supplementary reading is always a good idea. Here are some texts which you might find useful to consult from time to time:

Insight into Optics - O.S. Heavens and R.W. Ditchburn - Wiley - 1991 - ISBN 0 471 92769 4/0 471 92901 8 (app. $100)
Ditchburn’s “Light” was for many years a standard text - this is a severely updated version - don’t let the title fool you, there is a lot more than optics here.

Electricity - C. Coulson and T.J.M. Boyd - Longman - 1979 - ISBN 0 835 76103 7 (out of print) (app. $190)
All the best books are out of print! Coulson is concise and precise in both his mathematics an his explanations

A Treatise on Electricity and Magnetism - J. C. Maxwell - Dover (Reprint) - 1891/1954 - ISBN 0 486 60636 8 (app. $20)
Why read a copy when you can get the original courtesy of the Dover reprint machine! A very long book covering more than we will and leaving out everything that Maxwell didn’t know!

The Paper

we are going to try something a little different in this course and I hope that you will find it interesting and rewarding. We are going to have a conference. This will be held on March 31st, 2000 - April 1st, 2000 and will consist of papers presented by yourselves on the topic of this course. I intend that everyone will have 15minutes to make their presentation and will have to submit an “extended abstract” of no more than 5 typed pages (plus diagrams, if any, standard word processor line spacing 12pt type or larger, 25.4mm margins all round). Everyone will be required to attend the conference and to present a paper.

Paper topics will be selected by ballot from a list which I will provide. Here are some possibilities which <u>might</u> turn up

The Physics of the Human Eye
Infrared Optics
Waveguides
Fabry-Perot Interferometers
Achromatic Optics
Apodisation in Optical Systems
Twinkle, Twinkle Little Star - Light in the Atmosphere
The Physics of Sunglasses
Manufacture and Testing of Large Mirrors
Radiation and Antennas
Modern Optical Design

Course Providers

There are three people who are available to help you with this course:

1. Me - see below for communications issues. I will lecture about some of the course and I am also in charge of the course. That means that I am responsible for it's conduct and to ensure that it is carried out in accordance with the policies and procedures of the University of Toronto. The buck stops with me! I am also available for consultation, etc.

2. Dr. Ben Quine. Will lecture the rest of the course and will also help with setting problem sets, exams, etc. He will also be available to help with problems during "office hours". He will be your primary point of contact.

3. Mr. B. Bruner. Will do some of the marking and run some of the problem-solving sessions. As a matter of procedure, Mr. Bruner is not allowed to alter marks once work has been returned to you. That prerogative rests with myself and Dr. Quine.

Communications - Particularly with me

Unfortunately I travel a great deal. This places some strain on communications. However I am committed to working with you and helping you achieve the course objectives. Therefore I am available through a number of mechanisms.

1) Personally. If my office door (Room 616) is shut, that generally means I am not there - maybe in the building - maybe somewhere on the planet. Talk to my secretary Ms Sousa on the seventh floor - she generally knows where I am. Try phoning 978-4723 in advance to avoid disappointment.

2) Electronically. jim@atmosp.physics.utoronto.ca. I carry a laptop computer with me on all trips and I try to log in at least once a day. It is surprising what can be handled efficiently that way.

3) World-Wide Web. There is a simple web site set up for this course and we will all try to publish as much material as we can on that site. Certainly problems sets, additional hand-outs, noted problems, etc will go on that site. The format will be mostly plain HTML or "PDF" files (Portable Document Format). You can get the latest PDF reader from www.adobe.com - it is worthwhile to make sure that you have the latest copy.

For the other teachers:

Dr. Quine	e-mail: ben@atmosp.physics.utoronto.ca	phone: 971-2363
Mr. Bruner	e-mail: bruner@frontenac.physics.utoronto.ca	phone: 978-0353

Closing Thoughts

Finally let me point out that your education is your own responsibility. I cannot anticipate your problems, nor will I try to. It is up to you to identify your problems and come to talk to Dr. Quine or me about them. If you are not willing to do that, then you are not willing to be educated. However, if you are willing to work with us, then this is going to be a great course!

Some Thoughts to Ponder

Why do you want to take this course?
The Notes are called "Modern Optics" - why are ancient optics different?
Why would anybody want to employ a physicist?
What is a physicist anyway?
Name the three most significant mistakes of all time in physics
Does mathematics describe the real world? If so - why?
How would things be different if the aether did exist?