1 Introduction

This Unit of Study outline describes PHYS 2213 Physics 2EE. This unit is designed for students in the Faculty of Engineering.

The unit is split into four modules, combining lectures on Electromagnetic Properties of Matter, Optics, and Solid State and Device Physics, with computational lab sessions on Optics in the Computational Physics Laboratory.

1.1 Assumed Knowledge and Prohibitions

Student must have completed PHYS (1001 or 1901) and PHYS (1003 or 1902). It is assumed that students have taken MATH (1001/1901 and 1002/1902 and 1003/1903). MATH (1005/1905) would also be useful. PHYS2213 may not be counted with PHYS2203, PHYS2001, PHYS2901, PHYS2011, PHYS2911, PHYS2002, PHYS2902, PHYS2012, PHYS2912.

2 Course Aims, Learning Objectives and Graduate Attributes

2.1 Course Aims

The unit is designed to help you develop appropriate methods of study that will allow you to become an independent learner, capable of organising new information into a coherent conceptual framework and applying it in both familiar and unfamiliar situations. In addition, you are introduced to basic experimental skills in the measurement of physical quantities and analysis of experimental data.

2.2 Learning Outcomes

After successfully completing this unit, you should be able to demonstrate:

1. an understanding of the key concepts in Electromagnetic Properties of Matter, Optics, and Solid State and Device Physics;
2. the ability to apply these concepts to develop models, and to solve qualitative and quantitative problems in scientific and engineering contexts, using appropriate mathematical and computing techniques as necessary;
3. an understanding of the nature of scientific measurement, and skills in the measurement of physical quantities and the handling of data;
4. the ability to find and analyse information and judge its reliability and significance;
5. the ability to communicate scientific information appropriately, both orally and through written work;
6. the ability to engage in team and group work for scientific investigations and for the process of learning;
7. a sense of responsibility, ethical behaviour and independence as a learner and as a scientist.
2.3 Graduate Attributes

Graduate Attributes are generic attributes that encompass not only technical knowledge but additional qualities that will equip students to be strong contributing members of professional and social communities in their future careers. The overarching graduate attributes identified by the University relate to a graduate’s attitude or stance towards knowledge, towards the world, and towards themselves. These are understood as a combination of five overlapping skills or abilities, the foundations of which are developed as part of specific disciplinary study. For further details please refer to the Science faculty website at: http://www.itl.usyd.edu.au/graduateAttributes/facultyGA.cfm?faculty=Science

<table>
<thead>
<tr>
<th>Graduate Attributes</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Research and Inquiry</strong></td>
<td></td>
</tr>
<tr>
<td>A1. Apply scientific knowledge and critical thinking to identify, define and analyse problems, create solutions, evaluate opinions, innovate and improve current practices.</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>A2. Gather, evaluate and deploy information relevant to a scientific problem.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>A4. Critically examine the truth and validity in scientific argument and discourse, and evaluate the relative importance of ideas.</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td><strong>B Information Literacy</strong></td>
<td></td>
</tr>
<tr>
<td>B1. Use a range of searching tools (such as catalogues and databases) effectively and efficiently to find information.</td>
<td>4</td>
</tr>
<tr>
<td>B2. Access a range of information sources in the science disciplines, for example books, reports, research articles, patents and company standards.</td>
<td>4</td>
</tr>
<tr>
<td>B3. Critically evaluate the reliability and relevance of information in a scientific context.</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>B5. Use information technology to gather, process, and disseminate scientific information.</td>
<td>4, 5</td>
</tr>
<tr>
<td><strong>C Communication</strong></td>
<td></td>
</tr>
<tr>
<td>C2. Write and speak effectively in a range of contexts and for a variety of different audiences and purposes.</td>
<td>2, 5</td>
</tr>
<tr>
<td>C4. Present and interpret data or other scientific information using graphs, tables, figures and symbols.</td>
<td>3, 4, 5</td>
</tr>
<tr>
<td>C5. Work as a member of a team, and take individual responsibility within the group for developing and achieving group goals.</td>
<td>6</td>
</tr>
<tr>
<td>C6. Take a leadership role in successfully influencing the activities of a group towards a common goal.</td>
<td>1, 2, 6, 7</td>
</tr>
</tbody>
</table>

**D Ethical, Social and Professional Understanding**
D1. Demonstrate an understanding of the significance and scope of ethical principles, both as a professional scientist and in the broader social context, and a commitment to apply these principles when making decisions.  

D2. Appreciate the importance of sustainability and the impact of science within the broader economic, environmental and socio-cultural context.  

E Personal and Intellectual Autonomy

E1. Evaluate personal performance and development, recognise gaps in knowledge and acquire new knowledge independently.

For further details on course learning outcomes related to specific topics see the eLearning site.

3 Study Commitment

Below is a breakdown of our expectations for PHYS 2213. It should be noted that 'Independent Study' is based on what we believe to be the amount of time a typical student should spend to achieve to pass an item of assessment. Times are a guide only.

The current standard work load for a 6 credit point unit of study is 6 hours per week of face-to-face teaching contact hours and up to an additional 6 hours per week of independent study.

<table>
<thead>
<tr>
<th>In class activities</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (36 @ 1 hr each)</td>
<td>36</td>
</tr>
<tr>
<td>Computational lab sessions (10 @ 2 hrs each)</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Study</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading of text for lectures (22 @ 0.5 hr each)</td>
<td>11</td>
</tr>
<tr>
<td>Reading of lecture notes after lectures (22 @ 0.5 hr each)</td>
<td>11</td>
</tr>
<tr>
<td>Revision and self assessment (13 @ 1 hr each)</td>
<td>13</td>
</tr>
<tr>
<td>Assignments (2 @ 5 hr each)</td>
<td>10</td>
</tr>
<tr>
<td>Preparation for computational lab (10 @ 0.5 hr each)</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

Study Tips

You are now in control of your own study strategy, and as an adult learner it is up to you to devise a study plan that best suits you. If you attend classes regularly and involve yourself in all of these learning experiences, you will gain a good understanding of the course work. This will have a considerable impact on your exam preparation and performance.

Good study habits are also very important - we offer some suggestions on our Learning Physics web page (http://sydney.edu.au/science/physics/current/learningphysics.shtml).

4 Learning and Teaching Activities
## WEEKLY SCHEDULE

<table>
<thead>
<tr>
<th>Teaching Week Mon date</th>
<th>Lecture Tuesday 12 pm</th>
<th>Lecture Wednesday 12 pm</th>
<th>Lecture Friday 11 am</th>
<th>Computational Physics Lab Tue 1-3 pm or Thu 11 am – 1 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1 – 30 Jul</td>
<td>EMP1</td>
<td>EMP2</td>
<td>EMP3</td>
<td>No lab</td>
</tr>
<tr>
<td>Week 2 – 6 Aug</td>
<td>EMP4</td>
<td>EMP5</td>
<td>EMP6</td>
<td>Lab set 1</td>
</tr>
<tr>
<td>Week 3 – 13 Aug</td>
<td>EMP7</td>
<td>EMP8</td>
<td>EMP9</td>
<td>Lab set 1</td>
</tr>
<tr>
<td>Week 4 – 20 Aug</td>
<td>EMP10</td>
<td>EMP11</td>
<td>EMP12</td>
<td>Lab set 2</td>
</tr>
<tr>
<td>Week 5 – 27 Aug</td>
<td>OPT1</td>
<td>OPT2</td>
<td>OPT3</td>
<td>Lab set 2</td>
</tr>
<tr>
<td>Week 6 – 3 Sep</td>
<td>OPT4</td>
<td>OPT5</td>
<td>OPT6</td>
<td>Lab set 3</td>
</tr>
<tr>
<td>Week 7 – 10 Sep</td>
<td>OPT7</td>
<td>OPT8</td>
<td>OPT9</td>
<td>Lab set 3</td>
</tr>
<tr>
<td>Week 8 – 17 Sep</td>
<td>OPT10</td>
<td>OPT11</td>
<td>OPT12</td>
<td>Lab set 4</td>
</tr>
<tr>
<td>Mid-semester break</td>
<td>SSD1</td>
<td>SSD2</td>
<td>SSD3</td>
<td>No lab</td>
</tr>
<tr>
<td>Week 9 – 1 Oct</td>
<td>SSD4</td>
<td>SSD5</td>
<td>SSD6</td>
<td>Lab set 4</td>
</tr>
<tr>
<td>Week 10 – 8 Oct</td>
<td>SSD7</td>
<td>SSD8</td>
<td>SSD9</td>
<td>Review</td>
</tr>
<tr>
<td>Week 11 – 15 Oct</td>
<td>SSD10</td>
<td>SSD11</td>
<td>SSD12</td>
<td>Lab exam</td>
</tr>
<tr>
<td>Week 12 – 22 Oct</td>
<td>No lecture</td>
<td>No lecture</td>
<td>No lecture</td>
<td>No lab</td>
</tr>
</tbody>
</table>

### Lectures

#### Lecture Theatre

<table>
<thead>
<tr>
<th>Lecture Theatre</th>
<th>Lecture Times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics LT1</td>
<td>Tuesday 12pm, Wednesday 12pm and Friday 11am. Lectures start Tue 31 July and finish Fri 26 October.</td>
</tr>
</tbody>
</table>

**Note:** there will be no classes during the mid-semester break and Labour Day Holiday (Monday 24 September to Monday 1 October inclusive).

### Computational Physics Laboratory Work

You will be scheduled into one two-hour laboratory session per week in the Computational Physics Lab, Room 177 in the Carslaw Building.

**Computational Labs commence in the week of Mon 6 Aug and end in the week of Mon 22 Oct.**

- **Stream 1** - Room 177 Carslaw - Tuesday 1pm - 3pm
- **Stream 2** - Room 177 Carslaw - Thursday 11am - 1pm

**N.B.** There will be no classes during the mid-semester break and Labour Day Holiday (Monday 24 September to Monday 1 October inclusive).

### 5 Teaching Staff and Contact Details

<table>
<thead>
<tr>
<th>Unit Coordinator</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Iver Cairns</td>
<td><a href="mailto:cairns@physics.usyd.edu.au">cairns@physics.usyd.edu.au</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching Staff</th>
<th>Email</th>
<th>Room</th>
<th>Phone</th>
<th>Note</th>
</tr>
</thead>
</table>
6 Learning Resources

Electromagnetic Properties of Matter
There is no single textbook that treats this subject at the appropriate level.


The text Fundamentals of Electricity and Magnetism, 2nd edition by A. Kip is a useful reference, and several copies are available in the SciTech library.

Course notes will consist of copies of the lecture slides plus additional notes provided by the lecturer.

Optics
This module is defined by a set of comprehensive lecture notes PHYS2213: Physics 2EE Physical Optics Notes, available from the Co-op Bookshop. The notes are constructed around technological devices but a useful reference for the optical principles discussed in Optics by Hecht and Zajac, published by Addison Wesley. The lecture notes contain formulas as will be required in the examination paper. A sheet of formulas will be provided in the exam but you only use this to jog your memory as no explanation of the formulas will be provided. The notes contain 32 problems that will augment the understanding gained through reading the notes. A thorough understanding of notes, assignment and solutions to the problems will provide a good basis for tackling the exam questions. Everything in the notes or said in class is examinable.

Solid State and Device Physics
There is no single textbook that treats this subject at the appropriate level.


Lecture notes and supplementary material will be posted on eLearning as the course proceeds.

Computational Physics Laboratory Sessions
A set of notes, entitled PHYS 2213 Physics 2EE Computational Physics Engineering Optics Notes is available at the Co-op Bookshop. It is highly recommended that each student purchase the latest edition edition of these notes, which will be available at the beginning of the second semester.

Module syllabus guidelines
There are syllabus guidelines for each of the lecture modules listing specific objectives that define what you should learn and understand about the detailed content of each chapter of the textbook (see Section 4). Understanding a term or concept means that you should be able to:

- explain its meaning in writing and give examples;
Module Descriptions

ELECTROMAGNETIC PROPERTIES OF MATTER
The 12 lectures will be given by Prof. Marcela Bilek.

The following specific objectives of this module will be tested by qualitative and quantitative questions in the written examination and the assignment.

Electrostatics, Gauss's Law, Electric Potential
Reference sections: 23-5, plus some revision of content in chapters 21, 22 and 23-1 to 23-4.
Specific Objectives - after studying this part you will be able to:
• interpret electric fields and field lines; use Gauss’ law to find the electric field; discuss and apply the electric potential (revision)
• derive the electric field from the electric potential
• derive the field of electric dipoles and describe electric dipole moments
• calculate the electric potential of an electric dipole
• calculate the torque on an electric dipole and potential energy of an electric dipole (revision)

Capacitance and Dielectrics
Reference sections: 24-4 to 24-6, course notes
Some revision of content in 24-1 to 24-3
Specific Objectives - after studying this part you will be able to:
• define and use the concept of capacitance (revision)
• use dielectric constants and relative permittivity
• discuss the concept of polarization
• discuss the physical basis of dielectric materials in terms of electric dipoles
• apply Gauss’ law to dielectric materials
• discuss the use of dielectrics in capacitors
• define and use the electric displacement vector and potential energy of a capacitor with dielectric
• discuss the concept of polarizability and its relationship to dielectric constant
• discuss the physical mechanism of piezoelectricity
• do calculations concerning capacitance and dielectrics

Magnetism and Magnetic Materials: Ferromagnetism, Paramagnetism, Diamagnetism
Reference sections: 27-7 to 27-9, 28-8.
Some revision of content in 27-1 to 27-4, 27-6, 28-1 to 28-6
Specific Objectives - after studying this part you will be able to:
• discuss and apply the concepts of magnetic field and magnetic forces (revision)
• discuss the magnetic force on a current (revision)
• explain and use the Hall effect
• calculate the magnetic field from the Biot-Savart law and Ampere’s law
• discuss the magnetic dipole moment
• derive the torque on, and the potential energy of, a magnetic dipole
• discuss the physical mechanism of magnetism in terms of magnetic dipoles
• discuss and apply the concepts of the H field, magnetization and permeability
• discuss the basis of ferromagnetism
• discuss hysteresis
• discuss the processes of magnetic recording
• discuss the physical mechanism of paramagnetism and diamagnetism

Electromagnetic Waves
Reference sections: 32-1 to 32-6, course notes
Some revision of content in 29-7, 32-1.
Specific Objectives - after studying this part you will be able to:
• discuss the meaning of Maxwell’s equations in vacuum and in matter, written in integral form
• discuss the relationship between oscillating charges and the emission of electromagnetic radiation
• derive the existence of electromagnetic waves
• understand the concepts of plane and sinusoidally varying electromagnetic waves
• discuss the propagation of electromagnetic waves in matter and the meaning of refractive index
• discuss and apply energy and momentum flow in electromagnetic waves, and the concept of radiation pressure
• describe standing electromagnetic waves and the propagation of electromagnetic waves in a wave guide
• describe the electromagnetic spectrum
• recognise Maxwell’s equations written in differential form and compare them with the integral form

OPTICS
The 12 lectures will be given by A/Prof. David Moss.
This module is linked in subject matter to the Computational Physics module.

Objectives of this module
The following list outlines the broad topics of this module.

The Laser
Lecture Notes Section: 1.2
Specific Objectives – after studying this part you will be able to:
• Discuss the advantages of a laser light source over an incoherent source
• Understand the characteristic of stimulated and spontaneous light emission
• Understand the conditions necessary for light amplification
• Discuss the role of a resonator in lasing
• Discuss laser threshold and the laser output characteristic
• Describe the essential elements of a semiconductor laser

Superposition of Light
Lecture Notes Section: 1.3
Specific Objectives – after studying this part you will be able to:
• Outline how the bumps on a CD encode information
• Write down the equation of a simple harmonic light wave and define the parameters appearing in it
• Understand the relationship between the speed, wavelength and frequency of a light wave and the concept of refractive index
• Convert wavelength to frequency differences using a linear approximation
• Understand and discuss the Principle of Superposition – Constructive and Destructive Interference
• Discuss single layer reflection and anti-reflection coatings and be able to relate the thickness of such a film to the refractive indices of the coating and coated material and to the wavelength of incident light
• Discuss how the wavelike nature of light allows extraction of the information encoded on the CD surface

Lens Equation
Lecture Notes Section: 1.4
Specific Objectives – after studying this part you will be able to:
• Understand the use of the simple lens equation and magnification formula
• Be familiar with the key results obtained from the lens formula – focusing parallel rays, 1:1 imaging, magnification and demagnification.
• Understand the most significant lens aberrations and astigmatism

Propagation of Light - Interference and Diffraction
Lecture Notes Sections: 1.5
Specific Objectives – after studying this part you will be able to:
• Describe the phenomenon of diffraction and discuss its relationship to interference
• State Huygens’s Principle and understand how it may be applied to the propagation of light
• Understand how Huygens’s Principle may be applied and describe the phenomena associated with the double slit experiment
• Apply the formula determining the position of light and dark fringes on a screen for the double slit experiment
• Recognise the diffraction pattern for a circular aperture and be able to draw the intensity distribution pattern illustrating the relative scales of the central and secondary maxima
• Understand the dependence of the diffraction pattern on the wavelength of light
• Understand how diffraction at an aperture affects the resolving power of instruments and the diameter of the focal spot of a coherent light beam
• Understand how a diffraction grating generates an array of light beams
• Apply the formula to describe the angular separation of the diffraction orders

Polarisation
Lecture Notes Section: 1.6
Specific Objectives – after studying this part you will be able to:
• Define what is meant by unpolarised, plane polarized and circularly polarised light
• Describe how plane polarised light can be produced from unpolarised light by reflection and scattering
• Define and calculate the Brewster angle given the refractive indices either side of a boundary between two media
• Describe how circularly polarised light may be produced
• Describe both a quarter wave and half wave plate and compute the required thickness given the refractive indices for the fast and slow axes

Optical Fibres
Lecture Notes Sections: 2.1
Specific Objectives – after studying this part you will be able to:
• Understand the motivation for the use of optical fibres for communications
• Understand the concept of Bandwidth and Attenuation
• Apply the formula for signal attenuation
• Understand Total Internal Reflection (TIR), critical angle and apply the formula to calculate critical angle
• Understand the concept of an evanescent light field
• Apply total internal reflection to the guiding of light in fibres
• Be able to describe and explain the construction of a modern index guiding optical fibre
• Understand the concept of and calculate Numerical Aperture
• Describe how optical fibres are made
• Understand the various loss mechanisms in optical fibres
• Understand the concept Dispersion and the various types thereof
• Be able to calculate the dispersion of a pulse
• Understand the basic concept of a mode and be able to calculate both cutoff for an optical fibre as well as the number of supported modes

Optical Fibre Bragg Gratings
Lecture Notes Sections: 2.2
Specific Objectives – after studying this part you will be able to:
• Understand how a standing wave of light can modulate in the refractive index of a fibre
• Describe how the periodic modulation causes a resonant reflection of light
• Apply the formula relating the Bragg wavelength to the period of the modulation
• Describe Sidelobes and the effect of Apodisation
• Apply the formula to give the strength of a uniform grating
• Be able to express reflection and absorption on a dB scale
• Understand the relationship between grating strength, length and bandwidth
• Be able to calculate the bandwidth of a grating
• Describe the use of a fibre Bragg grating as a sensor and dispersion compensator
• Be able to calculate the dispersive properties of a grating

Mach Zehnder Modulator – Interferometers and Electro-optic Effect
Lecture Notes Sections: 2.3
Specific Objectives – after studying this part you will be able to:
• Draw the topology of the Mach Zehnder interferometer
• Understand the conditions for bright and dark fringes
• Be able to apply the formula for fringe brightness as a function of path length difference
• Understand the impact of the environment on the stability of interferometers and how that may be minimized through the application of common mode rejection (CMR)
• Understand the concept of temporal coherence
• Be able to calculate the coherence length and time of a source
• Understand the relationship between linewidth and coherence
• Understand the electro-optic effect and Pockels effect
• Outline other ways of affecting light through application of fields to crystals
• Understand the concept of phase matching

**SOLID STATE AND DEVICE PHYSICS**

The 12 lectures will be given by Dr Dane McCamey.

To appreciate the origin, theoretical foundations and applications of semiconductor physics and common optoelectronic devices. By the end of the module, students should be able to:

**Introduction**
• Describe general trends in the semiconductor road-map
• Understand how rapidly semiconductor technology has evolved over the last 50 years

**Atoms & Electrons**
• Discuss how atomic energy levels arise and describe their general properties
• Understand how bonding occurs in covalent crystals
• Understand how energy bands form in the presence of a periodic crystal
• Understand simple energy-momentum band-diagrams and identify direct and indirect band alignment
• Understand the concept of an energy dependent density of states

**Crystal Properties & Growth of Semiconductors**
• Identify three common cubic crystal structures; recognise the diamond and zincblende structure
• Understand the use of Miller indices for identifying crystal planes and apply them in cubic crystals
• Discuss different techniques for growing bulk crystals

**Metals, Insulators & Semiconductors**
• Understand the concept of electrons and holes
• Describe the difference in band-occupancy for a metal, insulator and semiconductor
• Discuss how the band properties and alignment affect the optical transparency of a material
• Understand the effect of doping on the carrier concentration in each band and describe common approaches for doping semiconductors
• Understand how the concept of a Fermi-energy describes the carrier concentration in a band

**Carrier Transport**
• Discuss the physical differences between drift and diffusive transport
• Understand how the resistivity of a material is linked to the Fermi-level, band structure and carrier mobility
• Describe how diffusive transport is related to carrier concentration and mobility
• Understand the concept of generation and recombination in a semiconductor; identify two general types of recombination: radiative and non-radiative
• Understand how drift and diffusive transport are combined in the continuity equation

**Metal Semiconductor Contacts**
• Describe common fabrication processes of metal contacts on semiconductors
• Understand the alignment of Fermi-energies and its effect on the band at the metal-semiconductor interface
• Discuss the basic properties of a Metal-Semiconductor Schottky diode and how it is distinct from an ohmic metal-semiconductor contact

**p/n Junctions**
• Describe fabrication processes for p/n junctions
• Understand how the alignment of the Fermi-energies affects the position of the bands in thermal equilibrium
• Understand the concept of a quasi-Fermi level in non-equilibrium situations, and how it and energy bands change under forward and reverse bias
• Describe the current voltage characteristics of a p/n junction using the Shockley diode equation

Optoelectronic Devices
• Describe epitaxial methods for forming light emitting diodes, laser diodes and photodetectors and how these differ from those required for solar cells
• Understand how electrical injection into a p/n junction gives rise to spontaneous light emission and describe the basic properties of a light emitting diode
• Describe the conditions and fabrication steps required to achieve stimulated (laser) emission in a semiconductor diode
• Describe the key differences between a photodetector and a solar cell

Transistors and Integrated Circuits
• Describe the fabrication techniques for transistors and integrated circuits
• Describe the basic operation and origin of current gain in a bipolar transistor and MOSFET
• Discuss how MOSFET technology is applied in CMOS devices and integrated circuits

Frontiers in Device Technology
• Describe why silicon-on-insulator, strained-silicon, SiGe, and high-k and low-k dielectric technologies allow smaller and faster integrated circuits to be made
• Understand the possibilities offered by novel technologies, such as quantum confined structures, for realising more efficient optoelectronic devices

COMPUTATIONAL PHYSICS

The coordinator of the laboratory is Dr. Pulin Gong (Room 374)
email: pulin.gong@sydney.edu.au; phone: 9036 9368
The module is an introduction to the use of computers for investigating problems of physical interest. MatLab programming you have learned in the first semester will be used. The material covered in the computational physics course is coordinated with that in the Optics lecture module.

Session Arrangements
Students attend one 2-hour session per week in the Computational Physics Laboratory for 10 weeks, beginning in week 2 of the semester. Students are arranged in groups of 2 or 3 for each computer. The sessions are run by a supervisor from the academic staff, and there are a number of tutors at each session. Sessions are held in the Computational Physics Laboratory, Physics Room 359.

Assessment
The total mark for this module is 50 marks. Of these, 16 marks are awarded on the basis of participation at the eight weekly sessions during which Exercise Sets 1-4 are done. The remainder of the assessment (worth 36 marks) will be an in-lab exam, undertaken by each student individually, in week 12. The final mark will be returned out of 50 (not 52).

Specific Objectives
• to teach optics, particularly those parts of the subject which benefit from a computational approach;
• to support the lecture course by allowing you to explore some topics in detail;
• to allow you to become comfortable with using computers in solving physics problems;
• to allow you to become familiar with the use of MatLab to solve physics problems.
In greater detail:
(1) Optics is a subject well suited to the use of computer simulation. Simulations will be used to illustrate a number of topics, mainly in physical optics (interference, diffraction). The computer enables you to quickly and easily carry out ‘virtual experiments’, which will illustrate the effects caused by changes in vital parameters such as wavelength, slit width and separation, screen position, etc. In this way you will gain familiarity with the physics underlying the phenomena investigated, without the extra time (and expense) required to set up and operate actual apparatus to perform the same experiments. By seeing for yourself
how the resulting image patterns depend on the relevant parameters, you will have the corresponding lecture content reinforced.

Through using software with a standardized user-interface, you will be able to concentrate the majority of your time and effort on understanding the optics content.

(2) Modern-day graduates in any branch of science or technology will, on many occasions, be required to learn and effectively use sophisticated mathematical computer packages. Learning to correctly and fully exploit the capacities of such packages is an important skill, and this computer laboratory optics component makes a start in such education.

The mathematical package that is used is MatLab. You will gain the experience of seeing MatLab scripts in operation, and towards the end of this module instructions will be briefer and activities more open-ended and you will be asked to write small, straightforward scripts of your own. It is not the object of this component to teach MatLab. However it is important that you learn how generic computer mathematical packages can facilitate some of the mathematical aspects of physics problems.

(3) Related to the above goals, but separate from them, is the idea that you will learn how to use computers in solving physics problems. The experience gained in the computer laboratory optics will bring home to you the role of computers in conveniently and rapidly illustrating what would happen in a wide variety of different experimental setups. At the same time you will become aware that the result of a simulation only reflects reality to the extent that the physical/mathematical model used as the basis for the code also corresponds to reality. Valuable lessons can be learned by showing where a model calculation breaks down and a more sophisticated treatment must be used. The ability to see what level of approximation or exactness is needed for a particular problem is an important skill.

Web Resources
The University eLearning system elearning.sydney.edu.au provides resources to help you with your studies, please spend time getting acquainted with this site. MyUni sydney.edu.au/myuni is the student portal providing University information and services. Access to MyUni and eLearning requires a Unikey username and password that is issued with your confirmation of enrolment. The University provides computer facilities described on the Student IT pages at http://sydney.edu.au/ict/student/. The 'Current Student' link on the School of Physics web page sydney.edu.au/science/physics also provides resources to help you with your studies.

Email
The University provides you with email access based on your username. We may use this email address to provide you with important information regarding this unit of study. We expect you to periodically read your email account or to forward mail from it to an account you do read (eg. a gmail account).

Where to go for help
If you need help, you can:

- as a first step, always check your unit eLearning pages for information, documents and links
- go to the Physics Student Services Office, Room 210 in the Physics building, or phone 9351 3037
- ask your lecturer or tutor
- ask a Duty Tutor - available Mon 12-1pm and Thur 1-2pm in the Computational Science Lab 177 in the Carslaw Building to help you with problems with physics course material. The duty tutor will be available from Week 3 of semester.
- email the relevant coordinator – Intermediate Physics Coordinator: A/Prof. Mike Wheatland (michael.wheatland@sydney.edu.au); Experimental Physics Coordinator: A/Prof. Kevin Varvell (kevin.varvell@sydney.edu.au); Computational Physics Coordinator: Dr Pulin Gong (pulin.gong@sydney.edu.au).

Providing us with feedback
We welcome comments on all aspects of this unit. You should feel free to contact your lecturers, tutors or the coordinators (listed under "Where to go for help" above) at any time. There is also a formal opportunity for feedback at the Staff-Student Liaison meeting, held one lunch time towards the end of semester with staff and student representatives from the various units of study, including this one. Your feedback helps us improve this unit.
Changes this year
As a result of student feedback and other initiatives there will be a number of changes this year:

- A full review of the Physics syllabus is underway, so your feedback is especially timely.
- Assessment policies are changing progressively, so there will be changes in the way your assessment marks are used to produce your final grade.
- We have a new building project underway - see http://www.physics.usyd.edu.au/about/building.shtml

7 Assessment Tasks

You are responsible for understanding the University policy regarding assessment and examination, which can be found at http://www.sydney.edu.au/ab/policies/Assess_Exam_Coursework.pdf

Assessment
This unit is assessed through an examination, assignments taken throughout the semester, participation at computational physics sessions and a computational test at the end of semester, and marking of laboratory logbooks in experimental physics sessions as well as a talk and report late in the semester. Proof of identification is required at all examinations.

Assessment of this unit of study is based on achievement of specific learning objectives (listed in the module outlines) demonstrated in a combination of assignments, examinations and laboratory work. Satisfactory performance in both the theory and experimental segments of the unit of study is necessary for a pass.

In addition, students in physics must be able to express themselves accurately by clear, efficient use of the English language in their written work. Spelling, grammar, punctuation and correct use of language will be taken into account when written reports and examination work are assessed. Students should refer to the University’s WriteSite (http://writesite.elearn.usyd.edu.au/) if they are looking for guidance on grammar and other aspects of academic and professional writing.

You should be familiar with the new University Assessment policy, which can be found at http://sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf

Assignment Information
Students will submit individual assignments. Even though students may work in groups on solving the problems, the individually submitted answers must include explanations of how each individual has understood the problem and its solution. Each handed in assignment must have a cover sheet, which is available from the eLearning site. In signing the cover sheet, each student is confirming awareness of the University’s policy on plagiarism and academic honesty, and agreement to comply with that policy ((http://sydney.edu.au/policies/showdoc.aspx?recnum=PD0C2012/254&RendNum=0).

Assignments are submitted to Physics Student Services, Room 210, Physics Building.

Late Assignments
Assignments and other assessed project work submitted late without permission will incur an immediate 20% late penalty, with a further 20% penalty accumulating each week until the assignment/project is submitted. This policy applies by default, unless your lecturer advises you differently.

7.1 Summative Assessments

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Percentage Mark</th>
<th>Due Date</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 2213 EMP assignment</td>
<td>2.7</td>
<td>Week 5 Friday, 31 August 2012</td>
<td>1, 2, 4</td>
</tr>
</tbody>
</table>
Descriptions of Summative Assessments

Final examination: 3 hour paper
The final examination for the unit is a three hours long and closed book. It consists of three parts: Section A is on Electromagnetic Properties of Matter and is worth 40 marks; Section B is Optics and is worth 40 marks; and Section C is on Solid State and Device Physics and worth 40 marks. Lists of Physical constants and Formulas needed are provided in the paper. Past papers are available for review via eLearning.

7.2 Assessment Grading
Final grades in this unit are awarded at levels of HD (High Distinction), D (Distinction), CR (Credit), P (Pass) and F (Fail) as defined by the Academic Board Assessment Policy. These achievement levels are described below. Details of the policy are available on the University's ‘Policy Online’ website at http://www.sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf.

The assessments for this unit are described in this unit of study outline. This description includes the purpose, timing and weighting of each assessment item and an explanation of how task relate to the learning outcomes of the unit. Students are responsible for actively engaging with these assessments, including carefully reading the guidance provided, spending sufficient time on the task, ensuring their work is authentic and their own (whether individual or group work), completing work on time and acting on feedback provided.

Assessment tasks are moderated to ensure their appropriateness, their consistency with the achievement level descriptors below and equity of grade distributions across the units offered by the Faculty of Science. In Intermediate Physics, our aim is to give everyone a chance of a high grade, irrespective of their unit of study. To achieve this, we compare student marks with student AAMs, and compare Normal and Advanced units by having some assessment tasks in common. We use this comparison to ensure one class isn't being disadvantaged by, say, a difficult assessment task. The result of this moderation process is a higher percentage of HDs and Ds in the Advanced unit (as you might expect), however the process also ensures there are HDs and Ds awarded in the other units of study to students who excel.

Grades:

High Distinction (HD)
At HD level, a student demonstrates a flair for the subject and comprehensive knowledge and understanding of the unit material. A ‘High Distinction’ reflects exceptional achievement and is awarded to a student who demonstrates the ability to apply subject knowledge to novel situations.

Distinction (D)
At D level, a student demonstrates an aptitude for the subject and a solid knowledge and understanding of the unit material. A ‘Distinction’ reflects excellent achievement and is awarded to a student who demonstrates an ability to apply the key ideas of the subject.

Credit (CR)
At CR level, a student demonstrates a good command and knowledge of the unit material. A ‘Credit’ reflects solid achievement and is awarded to a student who has a broad understanding of the unit material but has not fully developed the ability to apply the key ideas of the subject.
Pass (P)
At P level, a student demonstrates proficiency in the unit material. A ‘Pass’ reflects satisfactory achievement and is awarded to a student who has threshold knowledge of the subject.

Assessed exercises may not be revised and resubmitted for re-marking. If you wish to appeal an academic decision, you should refer to the University Policy at:

8 Learning and Teaching Policies

ACADEMIC DISHONESTY/PLAGIARISM
We will NOT accept assessments that are simply copied. Copying the work of another person without acknowledgment is plagiarism and contrary to University policies on Academic Dishonesty and Plagiarism (http://sydney.edu.au/policies/showdoc.aspx?recnum=PD0C2012/254&RendNum=0).

Academic Dishonesty means seeking to obtain or obtaining academic advantage (for example, in assessments) by dishonest or unfair means or knowingly assisting another student to do so. Academic Dishonesty includes, but is not limited to:
(a) recycling – that is, the resubmission for assessment of work that is the same, or substantially the same, as Work previously submitted for assessment in the same or in a different unit of study (except in the case of legitimate resubmission with the approval of the examiner for purposes of improvement);
(b) fabrication of data;
(c) the engagement of another person to complete or contribute to an assessment or examination in place of the student, whether for payment or otherwise or accepting such an engagement from another student;
(d) communication, whether by speaking or some other means, to other candidates during an examination;
(e) bringing into an examination forbidden material such as textbooks, notes, calculators or computers;
(f) attempting to read other student’s work during an examination;
(g) writing an examination or test paper, or consulting with another person about the examination or test, outside the confines of the examination room without permission;
(h) copying from other students during examinations;
(i) inappropriate use of electronic devices to access information during examinations.

Plagiarism means presenting another person’s work as one’s own work by presenting, copying or reproducing it without acknowledgement of the source. Plagiarism is a form of Academic Dishonesty, but is treated separately. Plagiarism includes presenting work for assessment, publication, or otherwise, that includes:
(a) phrases, clauses, sentences, paragraphs or longer extracts from published or unpublished work (including from the Internet) without acknowledgement of the source; or
(b) the work of another person, without acknowledgement of the source and presented in a way that exceeds the boundaries of legitimate cooperation.

CONSIDERATION OF FACTORS AFFECTING YOUR STUDY
If your academic performance in a Science Faculty unit of study is adversely affected by illness or some other serious event, such as an accident, you should notify the Faculty of Science Office (level 2 of the Carslaw building) within 7 days after the period for which consideration is sought, by completing an Application for Special Consideration with accompanying documentation. This is especially important if you miss an examination.

If you have another reason for the Science Faculty to take account of your circumstances - religious commitments, legal commitments (e.g. Jury duty), elite sporting or cultural commitments (representing the University, state or country), or Australian Defence Force commitments (e.g. Army Reserve) - you should notify the Faculty of Science Office (level 2 of the Carslaw building) at least 7 days BEFORE the period
for which consideration is sought, by completing an Application for Special Arrangements with accompanying documentation.

These two forms of Consideration should cover most allowable circumstances. However, if you have another reason for requiring the School of Physics to take account of your circumstances, you should notify the School of Physics Student Services Office immediately.

You should not submit an application of any type if

- there is no assessment associated with a missed class, or
- you have a reasonable opportunity to make up any work you missed.

If, for example, you miss an assignment, an application for appropriate Consideration is required to allow late submission, but we do expect the assignment to be submitted. Sometimes catching up may be impossible, in which case we will consider a pro-rata adjustment of your marks on the basis of an application for Consideration.

Special Consideration or Special Arrangements
To submit an application for Special Consideration or Special Arrangements you should:

1. Obtain the appropriate Application pack from the Student Information Office of the Faculty of Science, the Faculty website at http://sydney.edu.au/science/cstudent/ug/forms.shtml, or the Physics Student Services Office.
2. Complete the forms and obtain whatever original documentary evidence is appropriate. Note especially that the Professional Practitioner’s Certificate is essential for Special Consideration on grounds of serious illness - Medical Certificates will NOT be accepted.
3. Take the original copy of all forms and documents, plus sufficient copies for each unit of study affected and yourself, to the Faculty of Science Student Information Office (NOT any other Faculty Office if you are seeking Consideration in a unit taught by Physics). They will sign/stamp both the original application form and the copies. In the case of Physics units, one copy of the documentation must then be submitted to the Physics Student Services Office. Keep one copy yourself. A formal decision on your application will be sent to your university email address within 14 days.

Students unsure what type of Consideration is appropriate, or unhappy with a Consideration decision, should consult the Physics Student Services Office.

Further details on University policy regarding Considerations can be found in the Academic Board Assessment Policy at http://sydney.edu.au/ab/policies/Assessment_Policy_2011.pdf. This document also contains details on other aspects such as Student Appeals against academic decisions.

For full details of applicable university policies and procedures, see the Policy web site at sydney.edu.au/policy.

Relevant forms are available on the Faculty Forms and Procedures web site at sydney.edu.au/science/cstudent/ug/forms.shtml