INTERMEDIATE PHYSICS
FIRST SEMESTER, 2010

PHYS 2911 PHYSICS 2A (Advanced)
HANDBOOK

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1 GENERAL INFORMATION

1.1 UNIT DESCRIPTION

The School of Physics offers students in the Faculty of Science one six credit point unit in first semester (at both Advanced and Normal levels) and two in second semester (again at both Advanced and Normal levels). The outline content of these six units is given in the following Table:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Sem</th>
<th>Lectures</th>
<th>Computational Physics</th>
<th>Experimental lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 2911/2011</td>
<td>1</td>
<td>Optics 12; Nuclear Physics 10</td>
<td>Optics 9 wks</td>
<td>10 weeks</td>
</tr>
<tr>
<td>PHYS 2912/2012</td>
<td>2</td>
<td>Quantum Physics 19; EM Properties 19</td>
<td>Quantum 10 wks</td>
<td>_</td>
</tr>
<tr>
<td>PHYS 2913/2013</td>
<td>2</td>
<td>Stellar Astrophysics 12; Special Relativity 10</td>
<td>_</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

This Unit of Study Handbook describes PHYS 2911, the first semester Advanced-level unit. This unit is intended for students with a strong interest in Physics. It suits students continuing with the study of physics at the general Intermediate level, and those wishing to round out their knowledge of physics before continuing in other fields. Note that this unit cannot be counted with any of PHYS 2001, 2901, 2011, 2101, 2103, 2213 or 2203.

The unit comprises a number of modules, combining lectures on optics and nuclear physics with sessions on computational physics in the Computational Science Laboratory on the topic of optics, and sessions on Experimental Physics in the Intermediate Physics Laboratory. Some of these activities are in common with the unit of study PHYS 2011 Physics 2A.

1.2 CONTRIBUTION OF THE UNIT TO PROGRAMS OF STUDY

Students intending to major in Physics are strongly encouraged to take all three of the above units. The Advanced versions can be taken by students who have achieved a credit or better in their previous Physics units.

Progression to Senior Physics: The prerequisites for most Senior Physics units are PHYS 2911/2011 and PHYS 2912/2012. However, students intending to major in Physics are strongly encouraged to take PHYS 2913/2013 as well. See the Senior Physics web pages\(^\text{1}\) for more details.

Senior Physics also assumes knowledge of Intermediate mathematics – see Section 1.4.

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1.3 ENTRY REQUIREMENTS

Twelve credit points of Junior Physics\(^2\) at a level of Credit or better is the prerequisite for entry into Advanced Intermediate Physics. The assumed knowledge consists of MATH 1901/1001 and 1902/1002 and 1903/1003, while MATH 1905/1005 would also be useful.

1.4 RELATED COURSES IN THE SCHOOL OF MATHEMATICS AND STATISTICS

Students should note that MATH 2961/2061 (Linear Mathematics and Vector Calculus) is a prerequisite for most Senior Physics units, and you should take this unit if you are planning to major in Physics. An acceptable alternative is MATH 2067 (Differential Equations and Vector Calculus for Engineers). Other useful units are: MATH 2963/2063 (Mathematical Computing and Nonlinear Systems), MATH 2965/2065 (Introduction to Partial Differential Equations), STAT 2911/2011 (Statistical Models) and STAT 2912/2012 (Statistical Tests).

1.5 REGISTRATION

A registration meeting will be held in place of your scheduled laboratory session (at 2:00 pm on Wednesday or Thursday) in the first week of the semester. At this meeting you will be organised into groups for Experimental Physics. All students MUST ATTEND one of these registration sessions. These sessions will be held in one of the Physics Lecture Theatres (LT) or in tutorial room 320/321; a notice outside the entrance to the Laboratories will direct you to the appropriate venue.

If you have not been assigned a session or there is an unresolved conflict in your timetable, attend the earliest session you can.

1.6 LECTURE ARRANGEMENTS

All Intermediate Physics lectures, practical sessions and computational physics sessions are held in the School of Physics. Room assignments are shown in section 4 of this Handbook. Please check the notice boards (see next subsection) for any last minute changes.

The Intermediate Physics Laboratory is located at the western (‘downhill’) end of the School of Physics on level 4 (street level is level 2).

The Computational Physics Laboratory is room 359, at the western end of level 3 (far end of corridor).

Physics Lecture theatres are located as follows:-
- LT1 Eastern end, level 4
- LT2 Western end level 4 (opposite the Second Year Physics Laboratory)
- LT4 Just west of the middle of the building level 3
- LT5 West of the middle of the building level 3
- Slade Theatre (LT8) Eastern end level 2

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\(^2\) Excluding PHYS 1500 and PHYS 1600.
1.7 INFORMATION ABOUT INTERMEDIATE PHYSICS

The Intermediate Physics noticeboard is located outside the Physics Student Support Office (Rm 202, Eastern end of level 2 - street level). Please check this notice board regularly for important information.

The ‘Current Students’ link on the School of Physics web page\(^3\) provides resources to help you with your studies. Please spend time getting acquainted with this site, and the specific page relative to this unit of study. Unit webpages are provided under the University’s WebCT environment, which can be accessed from the Intermediate Physics webpages\(^4\) or the USYDnet site\(^5\). Access requires a Unikey (Extra account) Username and Password that is issued with your confirmation of enrolment. The University provides computer facilities in the Access Centres\(^6\). A brief introduction to web access is available on the Intermediate Physics web page.

1.8 CONSULTATION

Students who have general questions about the unit should ask at the Student Support Office. If necessary, questions about organisation and administration may be referred to the Coordinator of Intermediate Physics.

Questions about specific lecture modules should be directed to the lecturer concerned. Questions about laboratory matters should be directed to the laboratory tutors in the first instance.

1.9 PRINTED NOTES

It is highly recommended that each student of PHYS 2911 purchases the current editions of ‘Computational Physics Notes’ as well as ‘Experimental Physics Notes’, which is the manual for the laboratory course\(^7\). Copies of these notes are available at the University Copy Centre. A suitably ruled notebook should be used as your personal logbook for laboratory work.

Other materials (lecture handouts, assignment questions and solutions) may be handed out during lectures and will subsequently be available on request from the Physics Student Support Office (room 202). There is no charge for these materials.

\(^3\) http://sydney.edu.au/science/physics
\(^5\) http://sydney.edu.au/current_students/
\(^7\) The same ‘Experimental Physics Notes’ will be used in second semester for PHYS 2013/2913, but different ‘Computational Physics Notes’ will be used in second semester for PHYS 2012/2912.
1.10 SCHOLARSHIPS AND PRIZES

There are a number of scholarships and prizes available to students enrolled in Intermediate Physics courses. They are awarded at the end of the year on the basis of academic merit in units taken in both semesters.

The prizes are:-

- Slade Prize for Physics (value $350) for Merit in Intermediate Experimental Physics.
- Geoffrey Builder Prize (value $250) for Merit in Intermediate Experimental Physics.

Only students who take both PHYS 2911/2011 and PHYS 2913/2013 will be eligible for these prizes, which are based on Laboratory work. (Such students will normally take PHYS 2912/2012 as well.)

The scholarships are awarded on the basis of the sum of the two best marks from the three Intermediate Physics units but only to students with confirmed enrolment in at least 6 Credit Points of Senior Physics.

The scholarships are:-

- The School of Physics – Julius Sumner Miller Scholarship for Academic Excellence No.2 (value $800). Up to two are awarded annually.
- Science Foundation for Physics Scholarships No.2 (value $800). Up to five are awarded annually.

2 GENERAL AIMS OF THE UNIT OF STUDY

The unit is made up of four modules:
- Optics lectures
- Nuclear Physics lectures
- Computational Physics sessions on Optics
- Experimental Physics Laboratory sessions

The aims and specific objectives of the modules are linked to the required generic attributes of graduates of the University in knowledge skills (in optics and nuclear physics), thinking skills (the analysis of problems in physics), personal skills and attributes (the ability to work independently and in groups, and to present the results of physics experiments), and practical skills (the use of computers, and the performance and analysis of experiments in physics).

Specific objectives of the modules making up this unit of study are given below.
3 ASSESSMENT OF THE UNIT OF STUDY

3.1 GENERAL

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.

Except where otherwise noted, candidates will not be allowed to bring books or papers into the examination room. However, examinations are not meant to be tests of rote memorisation, and formula sheets will normally be included in the examination papers.

A preliminary examination timetable is released late in the semester and students are asked to report all clashes to the Student Centre (in the Carslaw Building). The final timetable may differ from the preliminary one and it is each student’s responsibility to determine the date, time and location of their scheduled examinations.

The weighting of the assessments in the various components of the unit to the final mark is as follows:

Examination (2 hour paper):

<table>
<thead>
<tr>
<th>Course</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optics</td>
<td>50</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>40</td>
</tr>
</tbody>
</table>

Assignments:

<table>
<thead>
<tr>
<th>Course</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>14</td>
</tr>
<tr>
<td>Computational Physics</td>
<td>50</td>
</tr>
<tr>
<td>Experimental Physics</td>
<td>70</td>
</tr>
</tbody>
</table>

**Maximum Total:** 224

The final marks and merit grades are determined, allowing scaling of marks from separate modules, to take into account the class average of Annual Average Mark (AAM). The minimum Pass mark is never more than 50% of the final scaled mark.

3.2 ASSIGNMENTS

There will be four assignment questions from each of the two lecture modules, given either as one assignment or two smaller assignments. Assignment questions will be handed out in lectures. All questions may be marked. 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 page, which may be obtained from the Physics Student Support office (Room 202, Physics building). In signing the cover sheet, each student is confirming awareness of the University’s policy on plagiarism and academic honesty\(^8\), and agreement to comply with that policy.

Assignments will be handed in at the Student Support Office. **Late assignments will not be marked.**

Your answers must identify the key physical principles; marks will not be awarded for simply putting numbers into formulae without explanation. Model solutions to all the questions or problems will be posted on the unit WebCT pages when the marked assignments are returned.

Assignments will be handed back in laboratory sessions, with uncollected papers being placed for collection in the Physics Student Support Office (Room 202, Physics Bldg).

3.3 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 Student Information 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 Student Information 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 Office (room 202 in the Physics building) beforehand (or at the latest within 7 days afterwards), by completing an Application for Consideration of Special Circumstances by Physics with accompanying documentation.

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.

3.3.1 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\(^9\), or the Physics Student 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.

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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 Office. Keep one copy yourself. A formal decision on your application will be sent to your university email address within 14 days.

Further details on University policy regarding Considerations can be found in policy documents entitled Assessment and Examination at the University Policy web site\textsuperscript{10}.

3.3.2 CONSIDERATION BY PHYSICS

An application for Consideration by Physics requires you to:

1. Obtain an Application for Consideration of Special Circumstances by Physics from the School of Physics Student Office or the Physics web page\textsuperscript{11}.

2. Complete the form and obtain whatever original documentary evidence is appropriate.

3. Take the original copy of the form and supporting documents, plus a copy for yourself, to the Physics Student Office. They will sign/stamp both the original application form and the copy. 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 Office.

It is important to realise that the policies on Special Consideration apply throughout the University. Policies on other forms of Consideration are specific to Physics and may be different in Departments responsible for your other units of study.

\textsuperscript{10} http://sydney.edu.au/policy/
\textsuperscript{11} http://sydney.edu.au/science/physics/pdfs/local/consideration.pdf
4 TIMETABLE PHYS 2911 PHYSICS 2A (Advanced)
Semester 1 2010

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tues 10 am</td>
<td>Thurs 10 am</td>
<td>Mon, Thurs, Fri 2 – 4 pm, Tues 3 – 5 pm</td>
</tr>
<tr>
<td>1 Mar 2010</td>
<td>OPT 1</td>
<td>OPT 2</td>
<td>No Class</td>
</tr>
<tr>
<td>8 Mar 2010</td>
<td>OPT 3</td>
<td>OPT 4</td>
<td>MATLAB tute</td>
</tr>
<tr>
<td>15 Mar 2010</td>
<td>OPT 5</td>
<td>OPT 6</td>
<td>Set 1</td>
</tr>
<tr>
<td>22 Mar 2010</td>
<td>OPT 7</td>
<td>OPT 8</td>
<td>Set 1</td>
</tr>
<tr>
<td>29 Mar 2010</td>
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<td>No Class</td>
<td>No Class</td>
</tr>
<tr>
<td>5 Apr 2010</td>
<td>MSB</td>
<td>MSB</td>
<td>MSB</td>
</tr>
<tr>
<td>12 Apr 2010</td>
<td>OPT 9</td>
<td>OPT 10</td>
<td>Set 2</td>
</tr>
<tr>
<td>19 Apr 2010</td>
<td>OPT 11</td>
<td>OPT 12</td>
<td>Set 2</td>
</tr>
<tr>
<td>26 Apr 2010</td>
<td>NP 1</td>
<td>NP 2</td>
<td>No Class</td>
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<tr>
<td>3 May 2010</td>
<td>NP 3</td>
<td>NP 4</td>
<td>Set 3</td>
</tr>
<tr>
<td>10 May 2010</td>
<td>NP 5</td>
<td>NP 6</td>
<td>Set 3</td>
</tr>
<tr>
<td>17 May 2010</td>
<td>NP 7</td>
<td>NP 8</td>
<td>Set 4</td>
</tr>
<tr>
<td>24 May 2010</td>
<td>NP 9</td>
<td>NP 10</td>
<td>Review</td>
</tr>
<tr>
<td>31 May 2010</td>
<td>No Class</td>
<td>No Class</td>
<td>Exam</td>
</tr>
</tbody>
</table>

MSB       Mid-semester break
OPT       Optics
NP        Nuclear Physics
** Note holidays Friday 2 April, Monday 26 April

Assignment dates:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Issued</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optics (first 2 questions)</td>
<td>Tues 16 Mar</td>
<td>Fri 26 March</td>
</tr>
<tr>
<td>Optics (last 2 questions)</td>
<td>Tues 13 April</td>
<td>Fri 30 April</td>
</tr>
<tr>
<td>Nuclear Physics</td>
<td>Tues 11 May</td>
<td>Fri 4 June</td>
</tr>
</tbody>
</table>

Lecture Theatre:

Note that lectures on Optics will be separate for PHYS 2911, but lectures on Nuclear Physics will be held in common with PHYS 2011. These lectures will take place in the designated PHYS 2911 lecture theatre.
5 PHYS 2911 MODULE DESCRIPTIONS

5.1 INTRODUCTION

For each module we have defined broadly what we expect you to learn and understand. Understanding implies that you should be able to discuss and explain fundamental concepts and principles including examples of their application.

Understanding in the lecture modules on Optics and Nuclear Physics will be tested in the end-of-semester examination by asking you to write descriptive answers to qualitative questions and by evaluating your explanations of physical principles and reasoning in answers to quantitative questions. Ability to memorise formulae and manipulate them without understanding the associated physics will not be rewarded.

Specific objectives define what you should learn and understand about the detailed content of each part of the module. Understanding a term or concept means that you should be able to:

- explain its meaning in writing and give examples,
- interpret it correctly when you read or hear it,
- use it correctly in your own writing,
- apply it correctly to examples and problems.

5.2 OPTICS

The 12 lectures will be given by Prof. Tim Bedding.

Most of the commonly observed properties of light, such as image formation by lenses, can be understood by considering light to propagate in straight lines or rays. But for a full understanding of the rich variety of phenomena exhibited by light, we have to take its wave nature into account. It is this that occupies the majority of the module, with major topics being the interference and diffraction of light, and polarisation.

This module is closely linked in subject matter to the Computational Physics module. As far as possible, topics will be introduced in lectures before being encountered in the Computational Physics exercises.

5.2.1 TEXT

There is no assigned text for this module. There is useful material in ‘Optics’ by E. Hecht (Addison Wesley), and ‘Introduction to Modern Optics’ by G.R. Fowles (Dover). More elementary concepts are covered in ‘University Physics’ by Young and Freedman, 12th ed., chapters 33 – 36. Some printed notes will also be issued.

5.2.2 SPECIFIC OBJECTIVES

After studying the points listed below you should be able to:

Geometrical Optics – review of basic topics
- apply the laws of reflection and refraction
- define and use refractive index
- discuss total internal reflection
- explain and use the image-forming properties of lenses

Physical Optics - background
- discuss the wave nature of light
• understand the relationship between the amplitude and intensity of a light wave
• understand and discuss the Principle of Superposition
• explain Huygens’ Principle
• recognise and explain the distinction between Fresnel and Fraunhofer conditions for interference or diffraction

Two Source Interference
• apply the Principle of Superposition to the Fraunhofer interference of two waves to derive an expression for the resultant amplitude
• discuss and apply the expressions for the resultant amplitude and intensity for two source interference (e.g. Young’s double slit experiment)

Phasors and complex representations
• explain both the phasor and complex representations of waves, and use them to illustrate the combination of a number of wave motions, especially the cases of two waves (e.g two source interference) or a large number ‘n’ of waves (e.g. summation of contributions from across a slit, to give single-slit diffraction).
• show how a complex sum of waves can be used to derive the resultant amplitude and intensity

Diffraction
• apply Huygens’ Principle to diffraction from a single slit
• derive, discuss and apply the Fraunhofer diffraction pattern for a single slit, a double slit and a circular aperture
• define and apply Rayleigh’s criterion for resolution to single slits and circular apertures

Coherence of light
• explain the concept of spatial coherence, and use it to explain why fringes will not be seen from twin slits with unsuitable (incoherent) illumination
• explain the concept of the coherence length of light, and calculate the coherence length as a function of the centre wavelength and range of wavelengths detected

Diffraction by Multiple Slits
• derive and apply the Fraunhofer diffraction pattern for multiple slits
• describe transmission and reflection diffraction gratings and their use in spectrometers
• apply the equation for angle of diffraction as a function of diffraction order, wavelength, and slit separation
• understand and use the terms angular dispersion, chromatic resolving power and blazing as applied to diffraction gratings

Interference from Multiple Reflections
• discuss the formation of interference fringes in light reflected from thin films
• discuss the formation of fringes of equal thickness (contour fringes) in non-uniform thin films
• discuss the formation of fringes of equal inclination in uniform thin films
• derive the form of the transmitted intensity as a function of phase difference δ, and discuss how this gives rise to the observed ring systems in a Fabry-Perot interferometer
• define and apply the terms free spectral range and chromatic resolving power for a Fabry-Perot interferometer
Polarisation
• appreciate that the phenomena of polarisation show that light is a transverse wave
• discuss the use of polarising filters (such as Polaroid) to produce linearly polarised light
• apply Malus’ law
• appreciate the difference between linear, circular and elliptical polarisation and describe the properties of quarter- and half-wave plates
• understand and use the terms dichroic, birefringence, optical activity and photoelasticity
• describe the processes of polarisation by scattering and by reflection

5.3 NUCLEAR PHYSICS
The 10 lectures will be given by Dr. Reza Hashemi-Nezhad.

5.3.1 TEXT
This module does not have a set text as such, but the following two resources will be of use. University Physics (with Modern Physics) by Young and Freedman, 12th edition chapters 38, 43 and 44 contain material of relevance to this module. Modern Physics by Serway, Moses and Moyer, 3rd edition is a prescribed text for second semester modules and students may consider obtaining this book early for use in this module. Relevant chapters are 4, 13, 14 and 15. Other material will be provided by the lecturer as appropriate.

5.3.2 SPECIFIC OBJECTIVES
At the end of this module you should be able to:

Nuclear Physics
• Compare and contrast Thomson's and Rutherford's models of the atom and describe Rutherford's scattering experiments.
• Explain the meaning of the terms atomic number, neutron number, mass number, nuclide and isotope.
• Convert between atomic mass units and kg.
• Use the equation relating mass number and size of a nucleus.
• Discuss nuclear stability and the Segre plot.
• Explain what is meant by nuclear spin and nuclear magnetic moment.
• Calculate the binding energy of a nucleus given its proton and neutron content and mass.
• Discuss the gross features of the relationship between binding energy per nucleon and mass number.
• Describe how forces can be viewed as the exchange of “virtual” particles and the relationship of this picture to the uncertainty principle.
• Describe Yukawa's theory of the nuclear force.
• Describe qualitatively the essential features of the liquid drop and shell models of the nucleus.
• Explain what is meant by radioactivity.
• Explain the concepts of activity and half-life, and perform simple calculations involving these.
• Describe Alpha, Beta and Gamma decay.
• Describe natural radioactivity and radioactive decay chains.
• Describe conservation laws of nuclear reactions.
• Describe what is meant by the Q value of a nuclear reaction, and the concepts of exothermic and endothermic reactions, and reaction thresholds. Perform simple energy balance calculations.
• Explain the concept of a reaction cross section.
• Describe neutron absorption reactions, and what is meant by nuclear fission and chain reaction.
• Describe qualitatively how a nuclear reactor works.
• Describe what is meant by nuclear fusion.
• Explain what radiation dosimetry is, and the difference between absorbed dose and equivalent dose.
• Discuss qualitatively some hazards and benefits of radiation.
5.4 COMPUTATIONAL PHYSICS

The module is an introduction to the use of computers for investigating problems of physical interest. The course is built around the software package MATLAB, however no previous knowledge of computing is required.

The material covered in the computational physics course is coordinated with that in the Optics lecture module.

5.4.1 TEXT

The module is defined in terms of chapters of the Intermediate Physics Computational Physics Optics Notes, available from the University Copy Centre. Each student is expected to purchase the current edition of these notes.

5.4.2 SESSION ARRANGEMENTS

Students attend one 2-hour session per week in the Physics Computational Laboratory (room 359), in the time slot allocated by their timetable. Sessions begin in week 2 or 3 of the semester and run according to the timetable details in Section 4. Students work in pairs at the laboratory computers.

The sessions are run by a supervisor from the academic staff, and there are a number of tutors at each session. The coordinator for Intermediate Computational Physics is Assoc. Prof. Manjula Sharma.

5.4.3 ASSESSMENT

The total mark for this module is 50. Of these, 14 marks are awarded on the basis of effort and participation at the seven weekly sessions during which Exercise Sets 1-4 are done. The remainder of the assessment (worth 36 marks) will be a 1-hour, in-lab examination, undertaken by each student individually, in week 12.

5.4.4 SPECIFIC OBJECTIVES

The overall aims of the module are:

- to teach optics, particularly those parts of the subject which benefit from a computational approach;
- to support the lecture course by allowing students to explore some topics in detail;
- to allow students to become comfortable with using computers in solving physics problems;
- to allow students to become familiar with the use of MATLAB.

In greater detail, the goals of this module are:

(1) Optics is a subject well suited to the use of computer simulation. Simulations can be used to illustrate a number of topics, mainly in physical optics (interference, diffraction). The computer enables students to quickly and easily carry out 'virtual experiments', which illustrate the effects caused by changes in vital parameters such as wavelength, slit width and separation, screen position, etc. In this way students 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 themselves how the resulting image patterns depend on the relevant parameters, students will have the corresponding lecture content reinforced.
Through using software with a standardized user-interface, students will be able to concentrate the majority of their 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. Students 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 students will be asked to write small, straightforward scripts of their own. It is not the object of this component to teach MATLAB, since that is fully covered in a separate unit (COSC 1001). However it is important that students learn how generic computer mathematical packages can facilitate some of the mathematical aspects of physics problems. Students will gain further exposure to MATLAB in the computational physics unit in second semester in the Quantum Mechanics module of PHYS 2012/2912.

(3) Related to the above goals, but separate from them, is the idea that students will learn how to use computers in solving physics problems. The experience gained in the computer laboratory optics simulations will bring home to students the role of computers in conveniently and rapidly illustrating what would happen in a wide variety of different experimental setups. At the same time students 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 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 for a physicist to develop.
5.5 EXPERIMENTAL PHYSICS

5.5.1 INTRODUCTION

The coordinator of the laboratory is A/Prof. Kevin Varvell (Room 355 Physics Building; email k.varvell@physics.usyd.edu.au; tel 9351 2539)

Experimental Physics is a laboratory course based on a set of individual experiments which cover many different aspects of experimental physics. In this unit of study all students will spend three weeks on each of three experiments, selected according to the rules given in the Experimental Physics Notes. All work must be recorded in individual logbooks. These are A4 size 'science notebooks' supplied by the School.

Students work in a partnership; usually one pair of students works together.

Laboratory tutors will check your work. Unless one of the partners is away for that particular session, both students in a partnership must present their books to the tutor at the same time. If your work is unsatisfactory you will be asked to bring it up to the required standard and demonstrate that you have mastered the material, repeating parts of the experiment if necessary.

During the semester you work with the standard experiments described in the Experimental Notes. You and your partner will also have to write a report on one of the experiments you performed during the semester. Each team is also expected to make an oral presentation of the report work during the last session of the semester.

5.5.2 SESSION ARRANGEMENTS AND REGISTRATION

The Intermediate Physics Laboratory, (Rooms 419-423) is located at the western end (the end nearest to No.1 Oval) of the Physics Building on Level 4 (two floors above ground level). The laboratory sessions are from 2:00 pm to 5:00 pm on each of Wednesday and Thursday afternoons. Students will be assigned to one of these sessions by their timetable.

You must attend your first scheduled laboratory session, during the first week of the first semester, which is used for registration and for an introduction to the unit of study. The sessions start at 2:00 pm and will be held in one of the Physics Lecture Theatres or in Tutorial Room 320/321; a notice outside the laboratory will advise you which venue is being used. If you have not been assigned a time for laboratory work, attend the earliest session you can.

5.5.3 MISSED SESSIONS

Experimental Physics forms an important element of the Intermediate Physics course. Students who miss sessions or arrive late or leave early may be severely penalised. If you are unable to attend because of illness, misadventure or other difficulties you must submit a special consideration claim with supporting documentation (see Section 3.3).

5.5.4 TEXT

The module is defined in terms of the Intermediate Physics Experimental Notes, available at the University Copy Centre and on the web. (These notes contain descriptions of the experiments for both first and second semesters).
5.5.5 ASSESSMENT

Each of the three experiments is worth 15 marks and takes three weeks. The written report is worth 15 marks, and the oral presentation is worth 10 marks, making a total of 70 marks.

For more details of the assessment, see the Experimental Notes.

5.5.6 SPECIFIC OBJECTIVES

After studying this module, you should be able to:

- Perform physics experiments, analyse and interpret data and draw conclusions from your results
- Solve experimental problems in physics and link these to appropriate theories
- Work independently and in groups
- Present the results of physics experiments orally and in the form of a written report
- Appreciate the role of computers and other equipment in experimental physics
- Make effective records in a logbook, and calculate uncertainties when appropriate

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