1 Introduction

This Unit of Study outline describes PHYS 2912, the second semester Advanced-level ‘core’ unit. This unit is intended for students with a strong interest in Physics. Hence this unit 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.

The unit is split into a number of modules, combining lectures on Quantum Physics and Electromagnetic Properties of Matter with sessions on computational physics in the Computational Science Laboratory on the topic of Quantum Physics. Some of these activities are in common with the unit of study PHYS 2012 Physics 2B (Normal).

1.1 Assumed Knowledge and Prohibitions

Prerequisites: Credit or better average in PHYS (1003 or 1004 or 1902) and PHYS (1001 or 1002 or 1901 or 2001 or 2901 or 2011 or 2911). Assumed Knowledge: MATH (1001/1901 and 1002/1902 and 1003/1903). MATH (1005/1905) would also be useful. Prohibition: HYS2102, PHYS2104, PHYS2902, PHYS2002, PHYS2012, PHYS2213, PHYS2203.

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 two foundation areas of physics - quantum physics and electromagnetic properties of matter;
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 2912. 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 (38 @ 1 hr each)</td>
<td>38</td>
</tr>
<tr>
<td>Computational lab sessions (10 @ 2 hrs each)</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58</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 (38 @ 0.5 hr each)</td>
<td>19</td>
</tr>
<tr>
<td>Reading of lecture notes after lectures (38 @ 0.5 hr each)</td>
<td>19</td>
</tr>
<tr>
<td>Revision and self assessment (13 @ 1 hr each)</td>
<td>13</td>
</tr>
<tr>
<td>Assignments (4 @ 5 hr each)</td>
<td>20</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>76</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
Class timetabling

All lectures are held in the Physics Building.

<table>
<thead>
<tr>
<th>Lecture Theatre</th>
<th>Tuesday 10am, Wednesday 12pm and Thursday 10am</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT2</td>
<td>1 August to 1 November</td>
</tr>
</tbody>
</table>

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

Week-by-week timetable

<table>
<thead>
<tr>
<th>Teaching Week Mon date</th>
<th>Lecture Tuesday 10 am</th>
<th>Lecture Wednesday 12 pm</th>
<th>Lecture Thursday 10 am</th>
<th>Computational Physics Lab Mon 1-3 pm or Wed 9-11 am or Fri 1-3 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1 – 30 Jul</td>
<td>No lecture</td>
<td>EMP1</td>
<td>EMP2</td>
<td>No lab</td>
</tr>
<tr>
<td>Week 2 – 6 Aug</td>
<td>EMP3</td>
<td>EMP4</td>
<td>EMP5</td>
<td>Lab set 1</td>
</tr>
<tr>
<td>Week 3 – 13 Aug</td>
<td>EMP6</td>
<td>EMP7</td>
<td>EMP8</td>
<td>Lab set 2</td>
</tr>
<tr>
<td>Week 4 – 20 Aug</td>
<td>EMP9</td>
<td>EMP10</td>
<td>EMP11</td>
<td>Lab set 3</td>
</tr>
<tr>
<td>Week 5 – 27 Aug</td>
<td>EMP12</td>
<td>EMP13</td>
<td>EMP14</td>
<td>Lab set 4</td>
</tr>
<tr>
<td>Week 6 – 3 Sep</td>
<td>EMP15</td>
<td>TEST</td>
<td>EMP16</td>
<td>Lab set 5</td>
</tr>
<tr>
<td>Week 7 – 10 Sep</td>
<td>EMP17</td>
<td>EMP18</td>
<td>QP1</td>
<td>Lab set 6</td>
</tr>
<tr>
<td>Week 8 – 17 Sep</td>
<td>QP2</td>
<td>QP3</td>
<td>QP4</td>
<td>Lab set 7</td>
</tr>
<tr>
<td>Mid-semester break</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 9 – 1 Oct</td>
<td>QP5</td>
<td>QP6</td>
<td>QP7</td>
<td>No lab</td>
</tr>
<tr>
<td>Week 10 – 8 Oct</td>
<td>QP8</td>
<td>QP9</td>
<td>QP10</td>
<td>Lab set 8</td>
</tr>
<tr>
<td>Week 11 – 15 Oct</td>
<td>QP11</td>
<td>QP12</td>
<td>QP13</td>
<td>Lab set 9</td>
</tr>
<tr>
<td>Week 12 – 22 Oct</td>
<td>QP14</td>
<td>QP15</td>
<td>QP16</td>
<td>Review</td>
</tr>
<tr>
<td>Week 13 – 29 Oct</td>
<td>QP17</td>
<td>QP18</td>
<td>QP19</td>
<td>Lab exam</td>
</tr>
</tbody>
</table>

**EMP Electromagnetic Properties of Matter; QP Quantum Physics**

Please consult your personal timetable on myUni for more details.

Computational Physics Laboratory Work

You will be scheduled into one two-hour laboratory session per week in the Computational Physics Laboratory, Room 177 of the Carslaw Building (F07).

**Computational Labs commence in the week of Mon 6 Aug and end in week of Mon 29 Oct.**

- **Stream 1** - Room 177 - 1-3pm Monday
- **Stream 2** - Room 177 - 9-11am Wednesday
- **Stream 3** - Room 177 - 1-3pm Friday

**Note:** No labs over mid-semester break and Labour Day holiday (Monday 24 September to Monday 1 October).
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>
<tbody>
<tr>
<td>Prof. Stephen Bartlett</td>
<td><a href="mailto:stephen.bartlett@sydney.edu.au">stephen.bartlett@sydney.edu.au</a></td>
<td>Physics, Room 351</td>
<td>9351 3169</td>
<td>Quantum Physics Lecturer</td>
</tr>
<tr>
<td>Prof. Martijn de Sterke</td>
<td><a href="mailto:martijn.desterke@sydney.edu.au">martijn.desterke@sydney.edu.au</a></td>
<td>Physics, Room 307</td>
<td>9351 2906</td>
<td>Electromagnetic Properties of Matter Lecturer</td>
</tr>
<tr>
<td>Dr Pulin Gong</td>
<td><a href="mailto:p.gong@physics.usyd.edu.au">p.gong@physics.usyd.edu.au</a></td>
<td>Physics, Room 374</td>
<td>9036 9368</td>
<td>Computational Physics Lab Coordinator</td>
</tr>
</tbody>
</table>

6 Learning Resources

Electromagnetic Properties of Matter

There is no single textbook that treats this subject at the appropriate level.

Reference Books:
Griffiths, Introduction to Electrodynamics, 3rd edition (Benjamin Cummings 2008) is more detailed than you need, but a good book to purchase if you continue onto Senior Physics.

Kip, A.F., Fundamentals of Electricity and Magnetism, 2nd edition is a useful reference and copies are available in the library. Further references will be given during lectures.

Quantum Physics

Reference Books: McIntyre, Quantum Mechanics (Pearson 2012)

Computational Physics Laboratory Sessions

A set of notes, entitled Computational Physics Quantum Mechanics Notes is available at the Co-op Bookshop. It is highly recommended that each student purchase the latest 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:
Module Descriptions

ELECTROMAGNETIC PROPERTIES OF MATTER
The 19 lectures will be given by Prof. Martijn de Sterke.

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

Electrostatics, Gauss’s Law, Electric Potential
Reference sections: course notes, Y&F 21-7, 23-5.
Specific Objectives - after studying this part you will be able to:

- explain Gauss’s law and use it to determine electric field in suitable circumstances
- determine electric potential from electric field and vice versa
- interpret the relation between electric field and electric potential written in terms of the vector differential operator, $\nabla$
- interpret the relationship between divergence of electric field and charge density
- explain the concept of electric dipole and electric dipole moment
- calculate the electric field for an electric dipole in the approximation $r >> d/2$
- calculate the electric potential for an electric dipole in the approximation $r >> d/2$
- generalise the concept of electric dipole to electric multipoles

Capacitance and Dielectrics
Reference sections: course notes, Y&F 24-4 to 24-6
Specific Objectives - after studying this part you will be able to:

- discuss the concept of polarization and define the polarization vector
- 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
- use the terms electric susceptibility, dielectric constant, and relative permeability
- perform calculations involving electric field, potential difference, charge density and stored energy for dielectric filled capacitors
- perform calculations of capacitors filled or partially filled with dielectric materials
- discuss the electric displacement vector and its relation to the electric field and polarization vector
- apply Gauss's law written in terms of the electric displacement vector to problems involving dielectric materials
- discuss the concept of polarizability of atoms and molecules
- use the Clausius-Mossotti equation, and its approximate form for dilute media
- use and explain in qualitative terms to Langevin equation for polar dielectric materials
- discuss the physical mechanisms of piezoelectricity, ferroelectrics and electrets

Conductors
Reference sections: Reference sections: course notes, Y&F 25-6
Specific Objectives - after studying this part you will be able to:

- use the concept of (vector) current density
- discuss the microscopic theory of conduction
- explain the difference conduction mechanisms in metals, plasmas and semiconductors
• explain the difference in temperature dependence of conductivity for metals and semiconductors

Magnetism and Magnetic Materials: Ferromagnetism, Paramagnetism, Diamagnetism
Reference sections: course notes, Y&F 28-2, 28-6 to 28-8
Specific Objectives - after studying this part you will be able to:

• explain the Hall effect
• calculate the magnetic field from the Biot-Savart law and Ampere's law
• interpret the differential form of 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 M and permeability
• explain the relationship between B, H and M
• perform calculations for electromagnets
• discuss the basis of ferromagnetism
• discuss hysteresis
• discuss the processes of magnetic recording
• discuss the physical mechanism of paramagnetism and diamagnetism

Non-uniform and non-linear dielectric materials
Reference sections: course notes
Specific Objectives - after studying this part you will be able to:

• describe non-uniform polarisation and its consequences
• discuss anisotropic dielectric materials and the use of tensors to describe their properties
• explain the concept of a non-linear dielectric
• describe the applications of non-linear dielectric materials to optics

The Laplace equation
Reference sections: course notes
Specific Objectives - after studying this part you will be able to:

• explain Laplace equation and dimensionality
• describe uniqueness
• use the method of images
• describe separation of variables
• describe multipole expansion

QUANTUM PHYSICS
The 19 lectures will be given by Prof. Stephen Bartlett.

Aims
The aims of this module are:

• To lay out the fundamental concepts underlying quantum mechanics, building on the ideas covered in Junior Physics;
• To develop competence in describing the quantum physics of two-level systems, such as the Stern-Gerlach experiment, single-photon interferometry, two-level atoms, and spin-1/2 particles in a magnetic field.
• To develop competence in the description of quantum measurement, and to appreciate the consequences of quantum measurement for non-classical behavior;
• To develop an appreciation and understanding of the non-classical properties of quantum entanglement, and the implications of Bell nonlocality;
• To develop an introductory understanding of wavefunction approaches to quantum mechanics, including the Schroedinger equation as a partial differential equation, and the quantum harmonic oscillator.
Part 1. 'Case Studies' of Two-Dimensional Quantum Systems
Specific objectives – after studying this material you will be able to:

- quantitatively describe single photon interference in a Mach-Zehnder interferometer, using complex amplitudes and matrix methods;
- quantitatively describe a single spin-1/2 particle in a Stern-Gerlach device, describing measurements in different bases;
- distinguish between 'single shot' measurements with probabilistic outcomes, and expectation values of observables;
- quantitatively describe a two-level atom, including time evolution, and describe the Schroedinger equation and its solution for this system;
- quantitatively describe the time evolution of a single spin-1/2 particle in a magnetic field, in analogy to the two-level atom.

Part 2. States, Observables, and Measurements
Specific objectives – after studying this material you will be able to:

- describe the formalism of quantum physics in terms of Hilbert space (complex vector space), linear operators, eigenvalues and eigenvectors, focusing on their formulation as 2x2 matrices for describing two-level systems;
- calculate expectation values of observables;
- calculate probabilities of measurement outcomes in a basis;
- describe the relationship between non-commutativity of operators and 'quantum uncertainty'.

Part 3. Quantum Dynamics
Specific objectives – after studying this material you will be able to:

- describe time evolution of quantum system using unitary transformations;
- relate unitary evolution to the Schroedinger equation and the Hamiltonian operator;
- appreciate the primary role of the energy eigenbasis, and directly describe time evolution in this basis using phases;
- calculate time evolution of expectation values of observables.

Part 4. Entanglement, Einstein’s Incompleteness and Bell’s Theorem
Specific objectives – after studying this material you will be able to:

- explain the EPR experiment as formulated by Bohm using spin-1/2 particles;
- describe multiparticle quantum systems using the tensor product;
- describe and manipulate entangled singlet states of two spin-1/2 particles, and calculate the outcomes of spin measurements;
- calculate the correlation coefficient that is used to test the existence of hidden variables;
- explain the significance of Bell's inequality to hidden variables;
- explain the significance of Aspect's experiment to hidden variable theories;
- explain entanglement and its physical significance.

Part 5. Particles in Space
Specific objectives – after studying this material you will be able to:

- qualitatively and quantitatively describe wave functions as quantum states in an infinite-dimensional Hilbert space;
- transform between position and momentum representation;
- express the Schroedinger equation for a particle in 1-D as a differential wave equation;
- solve the eigenstates of a particle in an infinite and finite quantum well;
- describe indistinguishable particles (both bosons and fermions) in terms of single-particle states.

Part 6. Quantum Harmonic Oscillator
Specific objectives – after studying this material you will be able to:

- Algebraically manipulate mathematical expressions for states and operators for the QHO in terms of
the Fock (number) states and the creation and annihilation operators;
• Calculate expectation values of operators for the QHO;
• Determine the time evolution and evolution of expectation values of the QHO;
• Interpret classical and non-classical states and behaviour of the QHO.

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 Quantum Physics lecture module.

Assessment
The total mark for this module is 50 marks. Of these, 14 marks are awarded for attending and completing the weekly labs. The other part of the assessment (worth 36 marks) will be an in-lab, open-book examination. You will do this exam individually, not in pairs. A specimen paper is to be found on pages 77 or 80 of the Computational Physics Quantum Mechanics Notes (with answers on succeeding pages).

General Aims

• to allow students to become comfortable with using computers in solving physics problems;
• to allow students to gain further experience in the use of MatLab to solve physics problems; and
• to teach quantum quantum physics, particularly those parts of the subject which benefit from a computational approach.

Quantum mechanics is a subject particularly well suited to the use of computer simulation, because analytic solutions to the Schrödinger equation can be difficult or impossible to find for even some simple physical systems. Computer simulations on the other hand, can readily find solutions, and graphically illustrate the results.

Sessions 1 and 2 - Solving differential equations
Specific Objectives - after working through this set you will be able to:

• Use MatLab as a programming language at a basic level
• Find traveling wave solutions for a one-dimensional second order differential equation.
• Display and interpret plots of complex traveling waves, with both transmission and reflection
• Discuss how complex traveling waves are reflected and/or transmitted at discontinuous potential barriers.

Session 3 - Standing waves
Specific Objectives - after working through this set you will be able to:

• Find the energy eigenfunctions and eigenvalues of Schrödingers Equation for a one-dimensional infinite square potential well.
• Find the energy eigenfunctions and eigenvalues of Schrödingers Equation for a one-dimensional finite square potential well.
• Display plots of the bound state eigenfunctions and probability distribution functions.

Session 4 - Matrix mechanics
Specific Objectives, after working through this set you will be able to:
Find the eigenvalues and eigen matrices of a square matrix.
Find the energy eigenfunctions and eigenvalues of Schrodinger’s Equation for a one-dimensional potential well by matrix methods.
Re-investigate the eigenvalues and eigenfunctions of square potential wells.

Session 5 and 6 - Other potential wells
Specific Objectives - after working through this set you will be able to:

- Find the energy eigenfunctions and eigenvalues of Schrodinger’s Equation for potentials of different shapes and sizes.
- Explain the behaviour and number of states for well-type potentials.
- Obtain and explain eigenfunctions and eigenvalues for a harmonic oscillator potential.
- Obtain and explain eigenfunctions and eigenvalues for a hydrogen atom potential.

Session 7 - Expectation values
Specific Objectives - after working through this set you will be able to:

- Find the uncertainties in position and momentum and relate these to the uncertainty principle
- Find expectation values of potential energy, kinetic energy and total energy

Session 8 and 9 - One-dimensional Lattices
Specific Objectives - after working through this set you will be able to:

- Find the eigenfunctions and eigenvalues of Schrodinger’s Equation for a number of potential wells arranged in line.
- Relate the energy eigenfunctions and eigenvalues to energy bands and energy gaps, and to the Bloch theorem.

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 - a Duty Tutor will be assigned for the unit and available for two one-hour slots per week. The times will be advised.
- email the relevant coordinator – Intermediate Physics Coordinator: A/Prof. Mike Wheatland (michael.wheatland@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.
- Revised Quantum Physics module
- 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 a 3-hour final examination, a 50-minute mid-term examination, assignments taken throughout the semester, participation in computational physics sessions and a project and computational test at the end of semester.

You must have your Student Identification Card for all examinations and tests.

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.

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

Assignments: There will be one or two assignments from each of the two lecture modules. Assignment questions will be handed out in lectures, and each assignment will normally contain four questions. 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 assignment must have a cover sheet, which may be obtained from the eLearning site or from Physics Student Services (Room 210, Physics Building). 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=PD02012/254&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>Electromagnetic Properties of Matter Assignment 1</td>
<td>2.3</td>
<td>Week 4 Friday, 24 August 2012</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Mid-term examination (50 minute paper)</td>
<td>13.6</td>
<td>Week 6 Wednesday, 05 September 2012</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Electromagnetic Properties of Matter Assignment 2</td>
<td>2.3</td>
<td>Week 7 Friday, 14 September 2012</td>
<td>3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Quantum Physics Assignment 1</td>
<td>2.3</td>
<td>Week 10 Friday, 12 October 2012</td>
<td>1, 2, 6, 7</td>
</tr>
<tr>
<td>Quantum Physics Assignment 2</td>
<td>2.3</td>
<td>Week 13 Friday, 02 November 2012</td>
<td>1, 2, 5, 7</td>
</tr>
<tr>
<td>Computational Physics</td>
<td>22.7</td>
<td>Weekly (weeks: 2, 3, 4, 5, 6, 7, 8, 10, 11, 12 and 13)</td>
<td>1, 2, 5, 7</td>
</tr>
<tr>
<td>Final examination (3 hour paper)</td>
<td>54.5</td>
<td>Exam Period</td>
<td></td>
</tr>
</tbody>
</table>

**Descriptions of Summative Assessments**

**Computational Physics**
The total mark for computational physics labs is out of 50 marks. 36 marks of the total assessment will be an in-lab examination to be held in the final weekly session. All codes you use in the labs will be provided in the exam and specimen examination papers will be available on the eLearning site.

**Final examination (3 hour paper)**
The final examination for the unit is a three hours long and closed book. It consists of two parts: Section A is on Quantum Physics and worth 60 marks; and Section B is on Electromagnetic Properties of Matter and is worth 60 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: http://www.sydney.edu.au/ab/policies/HESA_Grievance_Procedures.pdf and http://www.sydney.edu.au/senate/policies/Ac_Appeals_Rule.pdf

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