PHS3042
Fundamentals of Condensed Matter Physics

This unit provides part of a major in experimental physics. It consists of thee sub-units and laboratory work. Key areas are:

1. Condensed Matter Physics: the concept of reciprocal space, the basic theory for the behaviour of electrons and phonons in solid crystalline materials, band theory, phonons, electronic properties of semiconductors, superconductivity, superfluidity, low dimensional materials.

2. Scattering and Spectroscopy: principles of magnetic resonance, Mossbauer, IR and Raman, XPS and X-ray absorption spectrosocopies, fundamentals of diffraction theory, diffraction from crystals and amorphous materials, scattering of neutrons, x-rays and synchrotron radiation.

3. Laboratory work: experimental laboratory work on relevant topics.

<table>
<thead>
<tr>
<th>Mode of Delivery</th>
<th>On campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload requirements</td>
<td>Two 1-hour lectures, one 1-hour tutorial class, an average of 2 hours of laboratory work and 6 hours of private study per week</td>
</tr>
<tr>
<td>Unit Relationships</td>
<td>Prerequisites</td>
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<tr>
<td></td>
<td>PHS2011, PHS2022, MTH2010, MTH2032</td>
</tr>
<tr>
<td>Chief Examiner</td>
<td>Dr. Alexis Bishop</td>
</tr>
<tr>
<td>Unit Coordinator</td>
<td>Dr. Alexis Bishop</td>
</tr>
<tr>
<td>Lecturer(s)</td>
<td>Dr. Scott Findlay, Prof. Michael Fuhrer, Dr. Daniele Pelliccia, A/Prof John Cashion</td>
</tr>
<tr>
<td>Campus:</td>
<td>Clayton</td>
</tr>
<tr>
<td>Phone:</td>
<td>03 990 55936</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:Alexis.Bishop@monash.edu">Alexis.Bishop@monash.edu</a></td>
</tr>
<tr>
<td>Office hours:</td>
<td>9 am – 5pm Monday - Friday</td>
</tr>
<tr>
<td>Tutor(s)</td>
<td>Laboratory tutors see Level 3 Physics Moodle page: <a href="http://moodle.vle.monash.edu/course/view.php?id=18134">http://moodle.vle.monash.edu/course/view.php?id=18134</a></td>
</tr>
<tr>
<td>Campus:</td>
<td>Clayton</td>
</tr>
<tr>
<td>Consultation hours:</td>
<td>9 am – 5 pm Monday - Friday</td>
</tr>
</tbody>
</table>

SEMESTER 2
2014

http://moodle.vle.monash.edu/course/view.php?id=17230
Your Feedback to Us
Monash is committed to excellence in education and regularly seeks feedback from students, employers and staff. One of the key formal ways students have to provide feedback is through the Student Evaluation of Teaching and Units (SETU) survey. The University’s student evaluation policy requires that every unit is evaluated each year. Students are strongly encouraged to complete the surveys. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied and areas for improvement.

For more information on Monash’s educational strategy, see: www.monash.edu.au/about/monash-directions/directions.html and on student evaluations, see: www.policy.monash.edu/policy-bank/academic/education/quality/student-evaluation-policy.html

Previous Student Evaluations of this Unit
If you wish to view how previous students rated this unit, please go to: https://emuapps.monash.edu.au/unitevaluations/index.jsp

ACADEMIC OVERVIEW
Learning Outcomes
On completion of this unit students will be able to:


2. Recall fundamental concepts from the sub-units of Spectroscopy, which include: Interactions of photons and particles with matter, Absorption and scattering cross-sections, Elastic and inelastic scattering, Principles and applications of each of the following: electron spin resonance, nuclear magnetic resonance, Mössbauer spectroscopy, infrared and Raman spectroscopy, X-ray absorption spectroscopy and X-ray photoelectron spectroscopy.

3. Recall fundamental concepts from the sub-unit of Condensed Matter Physics, which include: Crystal Structures, Reciprocal lattice, Quasicrystals, Phonons and phonon dispersion, Einstein and Debye models of specific heat, Energy bands and electron dispersion, Superfluidity and superconductivity, Derivation of critical temperature, Two-fluid model for superfluid He-4, Macroscopic wavefunction, Vorticity, Quantization of circulation, Meissner effect, London equations, superconducting gap, Cooper pairs, Type I and Type II superconductors, Flux quantization, Systems with reduced dimensions, Derivation of 0-D, 1-D, 2-D density of states, Conduction in 1-D, Properties of graphene and carbon nanotubes,
4. Solve new problems in physics related to the core concepts of the unit by drawing on the theoretical underpinnings that have illustrated the physics.

5. Perform measurements and analysis on experiments that demonstrate the theoretical physics described in this and other Physics units.

6. Write up experimental reports that present results, analyse and discuss the implications and outcomes of experimental work.

**UNIT SCHEDULE**

<table>
<thead>
<tr>
<th>Week</th>
<th>Activities</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Condensed Matter</td>
<td></td>
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<tr>
<td>2</td>
<td>Condensed Matter</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Condensed Matter</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Condensed Matter</td>
<td>Condensed Matter Assignment 1 due: Mon 18 Aug</td>
</tr>
<tr>
<td>5</td>
<td>Condensed Matter</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; laboratory logbook due: Mon 25 Aug</td>
</tr>
<tr>
<td>6</td>
<td>Condensed Matter</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Spectroscopy</td>
<td>Condensed Matter Assignment 2 due: Mon 8 Sept</td>
</tr>
<tr>
<td>8</td>
<td>Spectroscopy</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Spectroscopy</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; lab logbook &amp; 1&lt;sup&gt;st&lt;/sup&gt; report due: Mon 22 Sept</td>
</tr>
<tr>
<td>10</td>
<td>Scattering</td>
<td>Spectroscopy Assignment due: Mon 6 Oct</td>
</tr>
<tr>
<td>11</td>
<td>Scattering</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Scattering</td>
<td>Scattering assignment due: Thu 23 Oct</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; lab logbook &amp; 2&lt;sup&gt;nd&lt;/sup&gt; report due: Fri 24 Oct</td>
</tr>
<tr>
<td></td>
<td>SWOT VAC</td>
<td>No formal assessment is undertaken in SWOT VAC</td>
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</table>
Teaching Approach
Physics is a major branch of modern science that aims to develop an understanding of the physical world. The School of Physics offers a range of Level 3 units designed for students undertaking Physics as major or minor studies. It also provides a path to fourth year Physics (Honours) and postgraduate study.

PHS3042 is a six credit point unit offered only in Semester II at the Clayton Campus. It is often taken together with PHS3062, Fundamental Particle Physics, ASP3222, Physics for Astrophysics and/or PHS3142, Theoretical Physics II. The unit consists of three theory lecture sub-units, Condensed Matter Physics, Scattering and Spectroscopy and supporting Laboratory-based practical work.

Second semester Level 3 Physics builds on core knowledge presented in PHS3031, so prior completion of this unit is recommended, but is not a formal pre-requisite for PHS3042. The sub-units Condensed Matter Physics and Scattering and Spectroscopy have been designed to give students a quantitative understanding of the structure and behaviour of matter in the solid state. It also includes a set of independent laboratory experiments (for which attendance is compulsory) that involve acquiring data, analysis, critical discussion and the preparation of formal experimental reports.

The Third Year Laboratory offers a range of approximately 25 experiments that are offered in both semesters, with students electing which experiments they wish to undertake. The Third Year Physics Laboratory allows students to carry out a wide range of experiments, which cover major areas of General and Quantum Physics, Optics and Photonics, Nuclear and Particle Physics, Low Temperature Physics, Condensed Matter Physics, Synchrotron and X-ray Physics. Many of the experiments allow students access to "state of the art" instrumentation and equipment in which they can explore fundamental aspects of modern physics.

Mini-projects, which will be assessed as equivalent to 2 laboratory experiments, can also be taken (after a discussion and approval by the laboratory coordinator) with any member of academic staff within the School.

For further details on the 3rd Year Physics Laboratory please read carefully the Laboratory Manual at: http://moodle.vle.monash.edu/course/view.php?id=18134

Lecturing Staff Contact Details

<table>
<thead>
<tr>
<th>Subunit</th>
<th>Staff</th>
<th>Email</th>
<th>Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensed matter</td>
<td>Dr. Scott Findlay</td>
<td><a href="mailto:Scott.Findlay@monash.edu">Scott.Findlay@monash.edu</a></td>
<td>27-215</td>
</tr>
</tbody>
</table>
Condensed matter (Wk 5)  |  Prof. Michael Fuhrer  | Michael.Fuhrer@monash.edu  | 19-142
Scattering          |  Dr. Daniele Pelliccia | Daniele.Pelliccia@monash.edu | 82-G11
Spectroscopy       |  A/Prof John Cashion   | John.Cashion@monash.edu      | 27-216b

**Assessment Summary**

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Value</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Condensed Matter Assignment 1</td>
<td>4.95 %</td>
<td>5pm Mon 18 Aug</td>
</tr>
<tr>
<td>2. First Laboratory logbook</td>
<td>7.39 %</td>
<td>5pm Mon 25 Aug</td>
</tr>
<tr>
<td>3. Condensed Matter Assignment 2</td>
<td>4.95 %</td>
<td>5pm Mon 8 Sept</td>
</tr>
<tr>
<td>4. Second Laboratory logbook</td>
<td>7.39 %</td>
<td>5pm Mon 22 Sept</td>
</tr>
<tr>
<td>5. First Laboratory report</td>
<td>5.91 %</td>
<td>5pm Mon 22 Sept</td>
</tr>
<tr>
<td>6. Spectroscopy Assignment</td>
<td>4.95 %</td>
<td>5pm Mon 6 Oct</td>
</tr>
<tr>
<td>7. Scattering Assignment</td>
<td>4.95 %</td>
<td>5pm Thursday 23 Oct</td>
</tr>
<tr>
<td>8. Third Laboratory logbook</td>
<td>7.39 %</td>
<td>5pm Friday 24 Oct</td>
</tr>
<tr>
<td>9. Second Laboratory report</td>
<td>5.91 %</td>
<td>5pm Friday 24 Oct</td>
</tr>
<tr>
<td>10 Exam</td>
<td>46.2%</td>
<td>In examinations period</td>
</tr>
</tbody>
</table>

**ASSESSMENT REQUIREMENTS**

Students are required to complete three laboratory experiments and produce two formal reports. **Failure to do so results in automatic failure of the Unit** and will result in a final mark for the unit no higher than 44%.

**Assessment Tasks**

**Assessment Task 1:** Condensed Matter Assignment 1  
**Due Date:** 5 pm Monday 18 August  
**Mode of Delivery:** Written assignment  
**Details of task:** Provide written answers to the assignment questions  
**Value:** 4.95 %  
**Presentation requirements:** Printed copy submitted for grading  
**Estimated return date:** 26 August  
**Criteria for Marking:** For marking rubric see:  
http://moodle.vle.monash.edu/course/view.php?id=17230

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Assessment Task 2: First Laboratory Logbook  
**Due Date:** 5pm Monday 25 August  
**Mode of Delivery:** Written laboratory Logbook  
**Details of task:** written description of the execution of a laboratory experiment  
**Value:** 7.39%  
**Presentation requirements:** written logbook  
**Estimated return date:** 2 September  
**Criteria for Marking:** For marking rubric see:  
http://moodle.vle.monash.edu/course/view.php?id=18134

Assessment Task 3: Condensed Matter Assignment 2  
**Due Date:** 5 pm Monday 8 September  
**Mode of Delivery:** Written assignment.  
**Details of task:** Provide written answers to the assignment questions.  
**Value:** 4.95%  
**Presentation requirements:** Printed copy submitted for grading.  
**Estimated return date:** 16 September  
**Criteria for Marking:** For marking rubric see:  
http://moodle.vle.monash.edu/course/view.php?id=17230

Assessment Task 4: Second Laboratory Logbook  
**Due Date:** 5 pm Monday 22 September  
**Mode of Delivery:** Written laboratory Logbook  
**Details of task:** written description of the execution of a laboratory experiment  
**Value:** 7.39%  
**Presentation requirements:** written logbook  
**Estimated return date:** 7 October  
**Criteria for Marking:** For marking rubric see:  
http://moodle.vle.monash.edu/course/view.php?id=18134

Assessment Task 5: First Laboratory Report  
**Due Date:** 5 pm Monday 22 September  
**Mode of Delivery:** Written report  
**Details of task:** Produce a written report on the execution of a laboratory experiment  
**Value:** 5.91%  
**Presentation requirements:** Printed copy submitted for grading  
**Estimated return date:** 7 October  
**Criteria for Marking:** For marking rubric see:  
http://moodle.vle.monash.edu/course/view.php?id=18134

Assessment Task 6: Spectroscopy Assignment  
**Due Date:** 5 pm Monday 6 October  
**Mode of Delivery:** Written assignment.  
**Details of task:** Provide written answers to the assignment questions.  
**Value:** 4.95%  
**Presentation requirements:** Printed copy submitted for grading.
Estimated return date: 31 October (after end of semester)
Criteria for Marking: For marking rubric see:
http://moodle.vle.monash.edu/course/view.php?id=17230

Assessment Task 7: Scattering Assignment
Due Date: 5 pm Thursday 23 October
Mode of Delivery: Written assignment
Details of task: Provide written answers to the assignment questions
Value: 10%
Presentation requirements: Printed copy submitted for grading
Estimated return date: 31 October (after end of semester)
Criteria for Marking: For marking rubric see:
http://moodle.vle.monash.edu/course/view.php?id=17230

Assessment Task 8: Third Laboratory Logbook
Due Date: 5 pm Friday 24 October
Mode of Delivery: Written laboratory Logbook
Details of task: written description of the execution of a laboratory experiment
Value: 7.39 %
Presentation requirements: written logbook
Estimated return date: 6 November (after end of semester)
Criteria for Marking: For marking rubric see:
http://moodle.vle.monash.edu/course/view.php?id=18134

Assessment Task 9: Second Laboratory Report
Due Date: 5 pm Friday 24 October
Mode of Delivery: Written report
Details of task: Produce a written report on the execution of a laboratory experiment
Value: 5.91 %
Presentation requirements: Printed copy submitted for grading
Estimated return date: 6 November (after end of semester)
Criteria for Marking: For marking rubric see:
http://moodle.vle.monash.edu/course/view.php?id=18134

Assessment Task 10: Exam
Due Date: Examinations Period
Mode of Delivery: Written examinations
Details of task: Provide written answers to the exam questions.
Value: 46.2 %
Presentation requirements: written examination
Estimated return date: N/A
Criteria for Marking: For marking rubric see:
http://moodle.vle.monash.edu/course/view.php?id=17230

Hurdle requirements: Must be completed. Failure to submit a logbook or report results in automatic failure of the unit.
Individual Assessment in Group Tasks: Students must submit an individual logbook and report for group laboratory activity.

Criteria for Marking: For marking rubric see the laboratory guide at:
http://moodle.vle.monash.edu/course/view.php?id=18134

Examination(s)
3 Hours in examinations period
Value: 46.2%

Learning resources
Recommended texts (*) and readings

Condensed Matter Physics:

Scattering Theory:
M. Born and E. Wolf, “Principles of Optics” Cambridge University Press (Chapter 13)
J.M. Cowley, "Diffraction Physics" 3rd ed. Elsevier. (Chapter 4) – available online
(Chapters 1,4 and 5) – available online

Monash Library Unit Reading List
http://readinglists.lib.monash.edu/index.html

Feedback to you
Lectures will often have short questions for you to gauge your progress. Your written assignments are mainly to help develop your skills, focus your attention on key knowledge and skills, and to indicate your progress. You will receive comments on your work when it is returned, in time for you to make improvements for the next assessment where appropriate. Laboratory demonstrators are available during sessions to give feedback on your findings and analysis in the laboratory. On the marking rubric you will receive indications of your performance in key areas. You will receive written comments that deal with specific areas of demonstrated difficulty, suggesting methods of improvement.

Extensions and penalties
Work submitted late is subject to a penalty of 10% per day (or part of day) of the maximum value of the assessment. Late work will not be accepted after the time when assignments are returned to the class. Extensions are only granted under the Special Considerations provisions. All laboratory work must be submitted by the end of week 12. See:
http://sci.monash.edu/policies/late-submission.html.

Returning assignments
All work should be assessed within 10 days during semester.
Assignments can be collected from the PACE enquiries counter, ground floor, building 27. Laboratory work can be collected from the Third Year Laboratory office. Should you have any concerns about the marking and return of the marks, please contact the lecturer involved and the unit coordinator.

**Resubmission of assignments**
Resubmission of assignments is not permitted unless authorised by the sub-unit lecturer and unit coordinator.

**Referencing requirements**
All sources of information and ideas must be acknowledged in the body of the text (including logbooks, assignments and reports) e.g., "Smith (1990) suggested that .....", A.B. Smith, 1990. Phys. Rev. B100, 127; or "it has been suggested\(^1\) that"; or "it has been suggested\([1]\) that" 1. A.B. Smith, Phys. Rev. B100, 127 (1990).

To build your skills in citing and referencing, and using different referencing styles, see the online tutorial Academic Integrity: Demystifying Citing and Referencing at [www.lib.monash.edu.au/tutorials/citing/](http://www.lib.monash.edu.au/tutorials/citing/)

**Assignment submission**

**Hard Copy Submission:** Assignments must include a cover sheet. The coversheet is accessible via the unit Moodle page for assignments and the Laboratory webpage in the case of experimental work. Assignments and laboratory work must be submitted to the appropriate drop box adjacent to the PACE enquiries counter, ground floor, building 27. Please keep a copy of tasks completed for your records.

**Required Resources**
Students generally must be able to complete the requirements of their course without the imposition of fees that are additional to the student contribution amount or tuition fees. However, students may be charged certain incidental fees or be expected to make certain purchases to support their study. For more information about this, go to Administrative Information for Higher Education Providers: Student Support, Chapter 21, Incidental Fees at: [http://www.innovation.gov.au/HigherEducation/TertiaryEducation/ResourcesAndPublications/Pages/default.aspx](http://www.innovation.gov.au/HigherEducation/TertiaryEducation/ResourcesAndPublications/Pages/default.aspx)

**Technological Requirements**
Students are will be contacted with important information by email via the unit Moodle site. You are expected to confirm your in-semester assessment marks before the end of the examination period by viewing the Grader report for the unit.

**Examination material or equipment**
Only scientific calculators may be used in the Examination: calculators may not have any programming or graphing capability. For use in the Examination, a Faculty of Science authorization label must be attached to your calculator by any of the School of Physics, Chemistry or Mathematical Sciences.
OTHER INFORMATION

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University’s academic standards, and to provide advice on how they might uphold them. You can find Monash’s Education Policies at: www.policy.monash.edu.au/policy-bank/academic/education/index.html

Key educational policies include:

- Student Academic Integrity Policy and Student Academic Integrity: Managing Plagiarism and Collusion Procedures;
- Assessment in Coursework Programs;
- Special Consideration;
- Grading Scale;
- Discipline: Student Policy;
- Academic Calendar and Semesters;
- Orientation and Transition; and
- Academic and Administrative Complaints and Grievances Policy.

Graduate Attributes Policy

http://www.policy.monash.edu/policy-bank/academic/education/management/monash-graduate-attributes-policy.html

Student Services

The University provides many different kinds of services to help you gain the most from your studies. Contact your tutor if you need advice and see the range of services available at www.monash.edu.au/students

Monash University Library

The Monash University Library provides a range of services, resources and programs that enable you to save time and be more effective in your learning and research. Go to www.lib.monash.edu.au or the library tab in my.monash portal for more information.

Disability Liaison Unit

Students who have a disability or medical condition are welcome to contact the Disability Liaison Unit to discuss academic support services. Disability Liaison Officers (DLOs) visit all Victorian campuses on a regular basis.

- Website: www.monash.edu/equity-diversity/disability/index.html
- Telephone: 03 9905 5704 to book an appointment with a DLO
- Email: dlu@monash.edu
- Drop In: Equity and Diversity Centre, Level 1, Building 55, Clayton Campus.