PHYS201
Classical and Quantum Oscillations and Waves
S1 Day 2016

Dept of Physics and Astronomy

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Important Academic Dates
Information about important academic dates including deadlines for withdrawing from units are available at http://students.mq.edu.au/student_admin/enrolmentguide/academicdates/

Learning Outcomes

1. To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
2. To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
3. To explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
4. To gain of an understanding of the wave function formalism of quantum wave mechanics, the physical motivations behind this formalism, and its use to solve a range of basic problems.
5. To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results
6. To develop programming skills in Labview and Python languages

Assessment Tasks

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final exam</td>
<td>45%</td>
<td>University Examination Period</td>
</tr>
<tr>
<td>Mid-session exam</td>
<td>15%</td>
<td>Week 7, Wed, 27 April, 10 am</td>
</tr>
<tr>
<td>Laboratory workbook</td>
<td>15%</td>
<td>See Unit Schedule</td>
</tr>
<tr>
<td>Numerical lab</td>
<td>10%</td>
<td>See Unit Schedule</td>
</tr>
<tr>
<td>In-Tutorial tests</td>
<td>15%</td>
<td>See Unit Schedule</td>
</tr>
</tbody>
</table>

Final exam
Due: University Examination Period
Weighting: 45%

You should have a scientific calculator for use during the final examination. Note that calculators with text retrieval are not permitted for the final examination.

You are expected to present yourself for the final examination at the time and place designated in the University examination timetable (http://www.timetables.mq.edu.au/exam/). The timetable will be available in draft form approximately eight weeks before the commencement of examinations and in final form approximately four weeks before the commencement of examinations.

This Assessment Task relates to the following Learning Outcomes:

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- To explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
- To gain of an understanding of the wave function formalism of quantum wave mechanics, the physical motivations behind this formalism, and its use to solve a range of basic problems.
Mid-session exam
Due: Week 7, Wed, 27 April, 10 am  
Weighting: 15%

A 50 minute exam at the end of the first part of the unit on oscillations and waves

This Assessment Task relates to the following Learning Outcomes:
- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- To explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.

Laboratory workbook
Due: See Unit Schedule  
Weighting: 15%

Second Year Physics Laboratories are found in E7B217. You should enter from the northern veranda on the second level of E7B.

The laboratory component of this unit consists of four one-week experiments illustrating oscillations in mechanical and electrical systems, and a three week introduction to using LabVIEW, a commercial software package used for computer control and data logging in experimental contexts, followed by a LabVIEW project utilising the knowledge gained in the final week.

Completing all laboratory classes is a compulsory component of the unit. You are not required to attend the laboratory in weeks when no lab is scheduled. If you miss a laboratory experiment session due to illness or misadventure, and can substantiate this with a medical certificate or other formal documentation, it should be possible to arrange a make-up session for the laboratory. For the four weeks of LabVIEW exercises this is best done in the same week, as the whole class is working through the exercises in parallel, with an instructor.

Laboratory Experiments
Each experiment will be recorded in a laboratory notebook which you must provide for the first laboratory session and which will be left with the laboratory supervisor at the end of each session. This should have alternate pages for writing and graphical representations. The record of each experiment in this book will be marked each week and the marks from the first 4 week cycle will make up half of the grade for the laboratory section of the unit. The record in your laboratory notebook may be brief, but must include:

- Title of the experiment,
• Date performed and name of partner,
• Aims and Methods of the Experiment Results,
• Calculations, graphs, error estimates etc.,
• Comparison with theory, as necessary.
• The answers to any questions found in the notes and any comments that you think may help your report and clarify matters for the marker.

We ask you to write your reports with proper sentences and paragraphs. You should also pay special attention to details such as measurement uncertainties, labelling axes of graphs, using appropriate headings and tabulating results.

**LabVIEW exercises**

For the LabVIEW Exercises assessment will be based on:

• Activity (you work through the exercises as defined),
• Your written work to demonstrate understanding and knowledge of concepts and terms and
• Your LabVIEW program from the last week.

You will be given one overall mark for LabVIEW which will make up the other half of assessing the laboratory section of the unit.

The Laboratory demonstrators will also meet briefly, during the lab period, with each student every two weeks for a short period (~5-minutes), to discuss their progress, and in particular, to discuss their development in executing laboratory experiments and in their notebook writeups. This will help the student understand better any assessment comments made in their notebooks or advice on their performance of the experiments.

**Laboratory Safety**

A condition of entry to the laboratory is thorough knowledge of the safety requirements in the laboratory. Students should revise these and they should be observed during all laboratory sessions. The safety aspects of the laboratory can be found in the front of the PHYS 201 Laboratory Notes and also on posters in the laboratory.

This Assessment Task relates to the following Learning Outcomes:

• To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
• To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results
Numerical lab

Due: See Unit Schedule
Weighting: 10%

The numerical lab will introduce students to the modern programming language Python and to scientific numerical modelling. In each of four laboratory sessions the students will work through an interactive worksheet which will introduce them to various techniques and pose some exercises to complete. The completed worksheets are to be handed in for assessment at the end of each lab.

This Assessment Task relates to the following Learning Outcomes:
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results
- To develop programming skills in Labview and Python languages

In-Tutorial tests

Due: See Unit Schedule
Weighting: 15%

There will be a ten-minute test during each tutorial from week 3 to week 13. The tests will comprise a single question, based on the material covered in the tutorial of the previous week. The results of your best nine tests from the total of eleven will contribute 15% of your final mark.

This Assessment Task relates to the following Learning Outcomes:
- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- To explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
- To gain of an understanding of the wave function formalism of quantum wave mechanics, the physical motivations behind this formalism, and its use to solve a range of basic problems.
Delivery and Resources

Technology used and required

Unit web page

The web page for this unit can be found at http://ilearn.mq.edu.au

Please check this web page regularly for announcements and material available for downloading. Some learning resources for the unit will be provided in hardcopy rather on-line.

Required and Recommended Texts and/or Materials


There is no single text book for the second half of the course. Recommended reading includes, the above text, as well as


Teaching and Learning Strategy

This unit is taught through lectures and tutorials. We strongly encourage students to attend lectures because they provide a much more interactive and effective learning experience than studying a textbook. Questions during and outside lectures are strongly encouraged in this unit - please do not be afraid to ask, as it is likely that your classmates will also want to know the answer. You should aim to read the relevant sections of the textbook before and after lectures and discuss the content with classmates and lecturers.

You should aim to spend 3 hours per week working on tutorial problems and exercises. You may wish to discuss these problems with other students and the lecturers. This guided study in your own time is one of the key learning activities for this unit. It is by applying knowledge learned
from lectures and textbooks to solve problems that you are best able to test and develop your skills and understanding of the material.

The experimental aspects of the unit require students to attend laboratories where they will be expected to set up experiments, take data, analyse the data within the context of the physical phenomena that are being studied, maintain a laboratory log-book, and report on their findings in clearly written laboratory reports.

**Unit Schedule**

Schedule of assessable tasks and related materials

**Lecture schedule**

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Lecturer</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks 1-2</td>
<td>David Spence</td>
<td>Examples of the use of the physics covered in this unit in modern contexts, including nanoscience. General overview of weeks 1-4. Simple harmonic motion, energy of oscillations, superposition.</td>
</tr>
<tr>
<td>Weeks 2-3</td>
<td>David Spence</td>
<td>Damped harmonic motion</td>
</tr>
<tr>
<td>Weeks 3-4</td>
<td>David Spence</td>
<td>Forced oscillation, resonance.</td>
</tr>
<tr>
<td>Week 5</td>
<td>David Spence</td>
<td>Coupled oscillations.</td>
</tr>
<tr>
<td>Weeks 6-7</td>
<td>David Spence</td>
<td>Transverse wave motion, wave equations and solutions, reflection and transmission at boundaries. Standing waves, wavegroups, group velocity, bandwidth theorem.</td>
</tr>
<tr>
<td>Weeks 7-8</td>
<td>Jason Twamley</td>
<td>Interference from 2 sources, Polar plots, 2 slit interference (Young’s interference), interference from a linear array of N equal sources.</td>
</tr>
<tr>
<td>Week 9</td>
<td>Jason Twamley</td>
<td>Huygens wavelets and Huygens-Fresnel Principle, Fraunhofer diffraction through a slit.</td>
</tr>
<tr>
<td>Week 10</td>
<td>Jason Twamley</td>
<td>Einstein-de Broglie equations, the wave function, Uncertainty principle, size of H atom</td>
</tr>
</tbody>
</table>
Week 11
Jason Twamley
2 slit interference and wave-particle duality, the Born probability interpretation of the wave function, probability theory interlude.

Week 12
Jason Twamley
Infinite 1-D potential well, Schrödinger’s wave equation.

Week 13
Jason Twamley
Harmonic oscillator, potential step.

Mid-session exam
The mid-session exam will take place on Wednesday 22 April, Week 7, at 2 pm. It will be at the usual lecture venue.

Laboratories
The laboratory sessions are held in E7B217 in weeks 2 to 5 and weeks 10 to 13. The experiments are separated into two kinds, as described below.

First group of experiments

<table>
<thead>
<tr>
<th>Week</th>
<th>Exp 1 &amp; Exp 2</th>
<th>Coupled oscillators (2 weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2 &amp; 3</td>
<td>Exp 1 &amp; Exp 2</td>
<td>Coupled oscillators (2 weeks)</td>
</tr>
<tr>
<td>Week 4</td>
<td>Exp 3</td>
<td>The mechanical oscillator</td>
</tr>
<tr>
<td>Week 5</td>
<td>Exp 4</td>
<td>Resonance and Q in electric circuits</td>
</tr>
</tbody>
</table>

Second group of experiments
The LabVIEW software suite will be taught over a four week period. The first three weeks will introduce most the commonly used objects in LabVIEW with examples to help the students grasp the functionality of the software. The last week will be spent completing exercises on their own with help from the demonstrator.

<table>
<thead>
<tr>
<th>Week 10</th>
<th>Introduction and Data Acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 11</td>
<td>Using Loops and Analysing/Logging Data</td>
</tr>
<tr>
<td>Week 12</td>
<td>Waveforms, Error Clusters and Simple State Machine</td>
</tr>
<tr>
<td>Week 13</td>
<td>Exercises</td>
</tr>
</tbody>
</table>

Python numerical laboratory
The classes are held in E7B217 at the same time as the laboratory classes are scheduled. They will be held in weeks 6-9.
Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:


In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: [https://students.mq.edu.au/support/student_conduct/](https://students.mq.edu.au/support/student_conduct/)

Results

Results shown in iLearn, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit [http://students.mq.edu.au/support/](http://students.mq.edu.au/support/)

Learning Skills

Learning Skills ([mq.edu.au/learningskills](http://mq.edu.au/learningskills)) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
Graduate Capabilities

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- To explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
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- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results.

Assessment tasks

- Final exam
Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
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- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results
- To develop programming skills in Labview and Python languages

Assessment tasks

- Final exam
- Mid-session exam
- Laboratory workbook
- Numerical lab
- In-Tutorial tests

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.
This graduate capability is supported by:

**Learning outcomes**

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
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- To develop programming skills in Labview and Python languages.

**Assessment tasks**

- Final exam
- Mid-session exam
- Laboratory workbook

**Effective Communication**

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

**Learning outcome**

- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results.

**Assessment tasks**

- Final exam
- Mid-session exam
- Laboratory workbook
- In-Tutorial tests
Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

**Learning outcome**

- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results

**Assessment task**

- Mid-session exam

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

**Learning outcomes**

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
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- To develop laboratory skills, in undertaking experiments, presenting and analysing the results and drawing conclusions based on the results
Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- To appreciate how oscillatory dynamics is ubiquitous in the physical world and to be able to formulate a basic description of the oscillatory behaviour regardless of system.
- To derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
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Feedback

Student Liaison Committee

The Physics Department values quality teaching and engages in periodic student evaluations of its units, external reviews of its programs and course units, and seeks formal feedback from students via focus groups and the Student Liaison Committee. Please consider being a member of this committee, which meets once during the semester (lunch provided), with the purpose of improving teaching via student feedback. The class will be asked to nominate two students as representatives for the PHYS201 unit on the student liaison committee. This nomination process will be conducted during lectures and the lecturer will forward the names to the Head of Department. The SLC meetings are minuted and student representatives receive copies of the minutes from the two preceding SLC meetings prior to the meeting. An update on the responses that have been made by the department to the feedback obtained at the two preceding SLC meetings are reported by the Head of Department at the beginning of each SLC meeting. These responses are also minuted. The feedback is acted upon in a number of ways mostly initiated via Department of Physics and Astronomy meetings, where decisions on actions are taken.

Prizes

The Dick Makinson prize is awarded for proficiency in 200-level units in physics (including certain 200-level electronics units) totalling no less than 9 credit points. All students (day, part time or evening) are eligible for the prize. The Makinson prize takes the form of a certificate and cheque for $150.

Requirements in order to complete the unit satisfactorily

To pass the course unit you must:

- achieve a satisfactory standard overall
- achieve a satisfactory standard in each assessment type
- have complete attendance at laboratory sessions

Standards Expectation

Grading

An aggregate standard number grade (SNG) corresponding to a pass (P) is required to pass this unit.

High Distinction (HD, 85-100%): provides consistent evidence of deep and critical understanding in relation to the learning outcomes. There is substantial originality and insight in identifying, generating and communicating competing arguments, perspectives or problem solving approaches; critical evaluation of problems, their solutions and their implications; creativity in application.
Unit guide PHYS201 Classical and Quantum Oscillations and Waves

Distinction (D, 75-84%): provides evidence of integration and evaluation of critical ideas, principles and theories, distinctive insight and ability in applying relevant skills and concepts in relation to learning outcomes. There is demonstration of frequent originality in defining and analysing issues or problems and providing solutions; and the use of means of communication appropriate to the discipline and the audience.

Credit (Cr, 65-74%): provides evidence of learning that goes beyond replication of content knowledge or skills relevant to the learning outcomes. There is demonstration of substantial understanding of fundamental concepts in the field of study and the ability to apply these concepts in a variety of contexts; plus communication of ideas fluently and clearly in terms of the conventions of the discipline.

Pass (P, 50-64%): provides sufficient evidence of the achievement of learning outcomes. There is demonstration of understanding and application of fundamental concepts of the field of study; and communication of information and ideas adequately in terms of the conventions of the discipline. The learning attainment is considered satisfactory or adequate or competent or capable in relation to the specified outcomes.

Fail (F, 0-49%): does not provide evidence of attainment of all learning outcomes. There is missing or partial or superficial or faulty understanding and application of the fundamental concepts in the field of study; and incomplete, confusing or lacking communication of ideas in ways that give little attention to the conventions of the discipline.

Changes since First Published

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26/02/2016</td>
<td>Staff details edited</td>
</tr>
</tbody>
</table>

http://unitguides.mq.edu.au/unit_offerings/58682/unit_guide/print