PHYS2010

Classical and Quantum Oscillations and Waves

Session 1, In person-scheduled-weekday, North Ryde 2022

School of Mathematical and Physical Sciences

Contents

General Information

Unit convenor and teaching staff Unit Convenor, Lecturer, and Python Lab Tutor Mark Wardle mark.wardle@mq.edu.au 7WW 2.702 Lecturer Alexei Gilchrist alexei.gilchrist@mq.edu.au 7WW 2.610 Python Lab Manager and Tutor Michael Steel michael.steel@mq.edu.au 7WW 2.713 Experimental Laboratory Manager Adam Joyce adam.joyce@mq.edu.au 14SCO 214 Experimental Lab Director Helen Pask helen.pask@mq.edu.au 7WW 2.607 Experimental Lab Tutor Lee Spitler lee.spitler@mq.edu.au 7WW 2.605
Credit points 10
Prerequisites (PHYS106 or PHYS1020 or PHYS143 or PHYS1520) and (MATH133 or MATH136 or MATH1020 or MATH1025)
Corequisites MATH2010 or MATH2055 or MATH235

Co-badged status
Unit description Harmonic oscillation and wave motion are central to many areas of physics, ranging from the mechanical vibrations of machinery and nanoscale springs, to the propagation of sound and light waves, and the probability-amplitude waves encountered in quantum mechanics. This unit is concerned with describing the properties of harmonic oscillations and wave motion. The first half of the unit covers such topics as resonance, transients, coupled oscillators, transverse and longitudinal waves. The second half looks at interference and diffraction, firstly as important properties of waves in general, and then using the interference of matter waves as the starting point in studying the dual wave-particle nature of matter and the wave mechanics of Schrodinger, the basis of modern quantum mechanics. The laboratory program combines development of experimental skills such as problem solving, data analysis and report writing with a first course in computational physics (conducted in the python programming language) as well as techniques in electronic data acquisition widely used in industry and research.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: discuss 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.

ULO2: derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.

ULO3: explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.

ULO4: demonstrate 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.

ULO5: demonstrate skill in undertaking detailed experimental investigations, presenting and analysing results and drawing conclusions based on the results.

ULO6: demonstrate programming skill in the Python language and apply it in a laboratory setting.

General Assessment Information

This unit has a hurdle requirement, specifying a minimum standard that must be attained in the final exam. To pass this unit you must obtain a mark of at least:

- 50% in the unit overall, as well as

- 40% in the final examination, and

- 40% in **each individual assessable task** in the laboratory (practical and numerical), and

- must not miss more than four in-tute quizzes.

Important information regarding the final exam:

If you receive special consideration for the final exam, a supplementary exam will be scheduled after the end of the normal exam period. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

If your mark in the final examination is between 30% and 39% inclusive, you may be a given a second and final chance to attain the required level of performance; the mark awarded for the second exam towards your final unit mark will be capped at 40%, and you will be allowed to sit the second exam only if this mark would be sufficient to pass the unit overall. If you are given a second opportunity to sit the final examination as a result of failing to meet the minimum mark required, you will be offered that chance during the same supplementary examination period and will be notified of the exact day and time after the publication of final results for the unit.

General Faculty Policy on assessment submission deadlines and late submissions:

Online quizzes, in-class activities, scheduled tests and exams must be undertaken at the time indicated in the unit guide. Should these activities be missed due to illness or misadventure, students may apply for Special Consideration.

All other assessments must be submitted by 5:00 pm on their due date.

Should these assessments be missed due to illness or misadventure, students should apply for Special Consideration.

Assessments not submitted by the due date will receive a mark of zero unless late submissions are specifically allowed as indicated in the unit guide or on iLearn.

If late submissions are permitted as indicated in the unit guide or on iLearn a consistent penalty will be applied for late submissions as follows:

A 12-hour grace period will be given after which the following deductions will be applied to the awarded assessment mark: 12 to 24 hours late = 10% deduction; for each day thereafter, an additional 10% per day or part thereof will be applied until five days beyond the due date. After this time, a mark of zero (0) will be given. For example, an assessment worth 20% is due 5 pm on 1 January. Student A submits the assessment at 1 pm, 3 January. The assessment received a mark of 15/20. A 20% deduction is then applied to the mark of 15, resulting in the loss of three

(3) marks. Student A is then awarded a final mark of 12/20.

Assessment Tasks

Name	Weighting	Hurdle	Due
Weekly quiz	30%	Yes	Weeks 2-13
Python labs	15%	Yes	See Unit Schedule on iLearn
Lab reports	10%	Yes	See Unit Schedule on iLearn
Final examination	45%	Yes	University Examination Period

Weekly quiz

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 0 hours
Due: **Weeks 2-13**
Weighting: **30%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

A series of short quizzes, taken in SGTAs.

On successful completion you will be able to:

- discuss 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.
- derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
- demonstrate 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.

Python labs

Assessment Type [1]: Programming Task
Indicative Time on Task [2]: 0 hours
Due: **See Unit Schedule on iLearn**
Weighting: **15%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

A series of computational tasks in the python language.

On successful completion you will be able to:

- demonstrate programming skill in the Python language and apply it in a laboratory setting.

Lab reports

Assessment Type [1]: Lab report
Indicative Time on Task [2]: 12 hours
Due: **See Unit Schedule on iLearn**
Weighting: **10%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Report for each experimental task.

On successful completion you will be able to:

- demonstrate skill in undertaking detailed experimental investigations, presenting and analysing results and drawing conclusions based on the results.
- demonstrate programming skill in the Python language and apply it in a laboratory setting.

Final examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **University Examination Period**
Weighting: **45%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Examination in the university exam period, covering all the content from the unit.

On successful completion you will be able to:

- discuss 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.
- derive and solve the mathematical description of oscillatory behaviour including damped, driven, and coupled systems.
- explain the continuum limit of discrete oscillators as the basis of wave motion, and to predict basic wave phenomena.
- demonstrate 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.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

Lectures will be recorded via the echo system (audio and slides only). The slides will also be available on iLearn.

Unit Schedule

Note: there will likely be adjustments to this schedule, particularly from Week 7 onwards.

Weeks	Lecturer	Topic
1-2	Mark Wardle	Examples of the use of the physics covered in this unit in modern contexts, including nanoscience. Simple harmonic motion, energy of oscillations, superposition.
2-3	Mark Wardle	Damped harmonic motion
3-4	Mark Wardle	Forced oscillation, resonance.
5	Mark Wardle	Coupled oscillations.
6-7	Mark Wardle	Transverse wave motion, wave equations and solutions, reflection and transmission at boundaries. Standing waves, wavegroups, group velocity, bandwidth theorem.
7	Mark Wardle	Interference from 2 sources, 2 slit interference (Young's interference), interference from a linear array of N equal sources.
8	Alexei Gilchrist	Huygens wavelets and Huygens-Fresnel Principle, Fraunhofer diffraction through a slit.
9	Alexei Gilchrist	Einstein-de Broglie equations, the wave function, Uncertainty principle, size of H atom
10	Alexei Gilchrist	2 slit interference and wave-particle duality, the Born probability interpretation of the wave function, probability theory interlude.

11	Alexei Gilchrist	Infinite 1-D potential well, Schrödinger's wave equation.
12-13	Alexei Gilchrist	Harmonic oscillator, evolution of quantum states in the Harmonic Oscillator and the potential step.

Tutorials start in Week 2 and are held every week of semester. From Week 3 onwards they include a 20-minute written test.

Laboratories

Python numerical lab classes are held in 14SCO 209 during weeks 2-5 and 10-12.

Python is a modern programming language that is incredibly useful for scientific, engineering, and data analysis tasks. The first four weeks of labs will introduce Python's syntax and structure as well as some of its numerical and scientific libraries. The final three weeks of labs will make use of Python skills developed earlier to tackle case studies in modelling oscillatory and quantum systems.

Experimental laboratory sessions are held in 14SCO 217 in weeks 6, 7, 8, and 9. The experiments are:

- Coupled oscillators (2 weeks) - The mechanical oscillator (1 week) - Resonance and Q in electric circuits (1 week)

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.e du.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

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

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support

- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.