School of Information and Physical Sciences

PHYS3111: Biophysics

Callaghan
Semester 1 - 2024

COURSE OUTLINE

OVERVIEW

Course Description

Biophysics deals with the application of physics to biological systems, from the first picture of the structure of DNA, to the treatment of cancer, and the understanding of allergic reactions. The concepts and techniques of biophysics find applications in bioelectronics, medicine/health, and population dynamics and are closely related to statistical mechanics and transport processes. Interdisciplinary skills and knowledge have heralded novel scientific outcomes with benefits to society. As such, this course develops foundational thinking and methods that are fundamental to an effective interdisciplinary STEMM workforce.

Specifically, this course provides an introduction to the physics of many body systems, transport phenomena and biological systems.

Blended problem-based conceptual learning (lectorials) will be used to gain an understanding of key developments, ideas and theories covered in Biophysics. Blended problem-based, hands-on learning (computational and laboratory workshops) will be used to gain an understanding of key concepts.

Academic Progress Requirements

Nil

Requisites

Students must have successfully completed MATH2310, and either PHYS2111 or PHYS2250 to enrol in this course. Students cannot enrol in this course if they have previously successfully completed PHYS3375.

Assumed Knowledge

PHYS2112 or PHYS2160 and/or PHYS2260

Contact Hours

Callaghan
Laboratory
Face to Face On Campus
3 hour(s) per week(s) for 7 week(s) starting Week 1
and
3 hour(s) per week(s) for 4 week(s) starting Week 9

Lectorial
Face to Face On Campus
2 hour(s) per week(s) for 12 week(s) starting Week 1

Unit Weighting Workload

10
Students are required to spend on average 120-140 hours of effort (contact and non-contact) including assessments per 10 unit course.

CONTACTS

Course Coordinator

Callaghan
Dr Karen Livesey
Karen.Livesey@newcastle.edu.au
(02) 4055 7559

Consultation: Tuesdays 1:30-2:30pm, or by appointment

Teaching Staff

Dr Renee Goreham (Weeks 9-12)
Renee.Goreham@newcastle.edu.au
Room P111

School Office

School of Information and Physical Sciences
SR233, Social Sciences Building
Callaghan
CESE-SIPS-Admin@newcastle.edu.au
+61 2 4921 5513
9am-5pm (Mon-Fri)

SYLLABUS

Course Content

Statistical mechanics
- Review of classical thermodynamics, equilibrium statistical mechanics and ensemble theory
- Boltzmann factor
- Applications to ideal gas, Einstein solid, two-state paramagnet, haemoglobin, DNA compaction, Bose-Einstein condensation and Fermi-Dirac gases

Transport processes
- Random walks and diffusion with application to biological macromolecules
- Brownian motion of nanoparticles and viruses
- Langevin equation and fluctuation-dissipation theorems
- Driven diffusion of oxygen to cells, and receptors on a cell surface
- Cell membrane potential

Biosystems
- Biological terminology for physicists
- Neuron function
- Microscopy and its application to biology
- Bio-electronics used to detect cells and viruses for medicine

Course Learning Outcomes

On successful completion of this course, students will be able to:

1. Explain models of biological systems and models dealing with statistical mechanics and transport phenomena.

2. Solve qualitative and quantitative problems, using appropriate statistical mechanics and computing techniques.

3. Perform experiments which involve making correct and appropriate use of a range of scientific equipment, keeping an accurate record of experimental work and analysing results and reaching non-trivial conclusions from them.

4. Communicate at an advanced level the results of both theoretical and experimental work in various forms including written reports, oral presentations and poster presentations.

5. Collaborate effectively with team members for scientific investigations and for the process of learning.

Course Materials

Recommended Text:

- "An Introduction to Thermal Physics" by D. Schroeder (not required). Available online through the UON library: https://go.exlibris.link/MtNyLCr0
- "Physical Biology of the Cell" by R. Phillips et al (not required). Physical copy in the library: Q571.6 PHIL 2013

Other Resources:

- Other course materials will be available via Canvas

A scientific (non-programmable) calculator is permitted in the final exam.

SCHEDULE

Week	Week Begins	Topic	Learning Activity	Assessment Due
1	26 Feb	Statistical Mechanics: Review and Boltzmann Factor	Lectorial 1 Lab 1: Boltzmann Factor (computer)	
2	4 Mar	Statistical Mechanics: Boltzmann statistics	Lectorial 2 Lab 2: Ideal gas (computer)	Week 1 docs due: Tuesday 11:59pm
3	11 Mar	Statistical Mechanics: Bosons and Fermions; Blackbody radiation	Lectorial 3 Lab 3: Blackbody radiation	Week 2 docs due: Tuesday 11:59pm
4	18 Mar	Statistical Mechanics: Phase transitions	Lectorial 4 Lab 4: Ising model and Monte Carlo methods (computer)	Week 3 docs due: Tuesday 11:59pm **End of topic 1 test due: Sunday 11:59pm**
5	25 Mar	Transport: Random walk and diffusion	Lectorial 5 Lab 5: Diffusion (computer)	Week 4 docs due: Tuesday 11:59pm
6	1 Apr Easter		Lectorial 6 cancelled (Easter) Lab 6: Brownian motion and particle tracking	Week 5 docs due: Tuesday 11:59pm
7	8 Apr	Transport: Brownian motion and Langevin's equation	Lectorial 7 Lab 7: Brownian motion -- your choice of project (computational or experimental)	Week 6 docs due: Tuesday 11:59pm
Mid-Semester Recess				
Mid-Semester Recess				
8	29 Apr	Transport: Biological calculations	Lectorial 8 No lab	Week 7 docs due: Tuesday 11:59pm **End of topic 2 test due: Sunday 11:59pm**
9	6 May	Biophysics: Background and terminology of biological systems for physics	Lectorial 9 Laboratory: Brain Box	
10	13 May	Biophysics: Understand nerve conduction	Lectorial 10 Laboratory: Cable Equation	Week 9 docs due: Tuesday 11:59pm
11	20 May	Biophysics: Microscopy and the many applications in science	Lectorial 11 Workshop: ChatGPT Research	Week 10 docs due: Tuesday 11:59pm
12	27 May	Biophysics: Applications in bioelectronics and bio-related research.	Lectorial 12 Presentation to be done during laboratory time (counts as part of lab mark)	Week 11 docs due: Tuesday 11:59pm **End of topic 3 test due: Sunday 11:59pm**
13	3 Jun			
Examination Period				
Examination Period				

ASSESSMENTS

This course has 3 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	3 In Term Tests	Sunday 11:59pm at the end of Weeks 4, 8 and 12	Individual	18%	1, 2
2	11 Weekly Tasks	Tuesdays 11:59pm (Weeks 2-8, 10-12) plus in-lab during Week 12	Individual	42%	1, 2, 3, 4, 5
3	Formal Examination	During formal exam period	Individual	40%	1, 2

Late Submissions The mark for an assessment item submitted after the designated time on the due date, without an approved extension of time, will be reduced by 10% of the possible maximum mark for that assessment item for each day or part day that the assessment item is late. Note: this applies equally to week and weekend days.

Assessment 1 - 3 In Term Tests

Assessment Type In Term Test
Purpose The three in-term tests are designed to test the individual student's knowledge of the course material and their ability to describe, analyse and hypthesise from this material. They occur at the end of each 4-week module, to keep students up-to-date in the course and ready to tackle the next module.
Description The tests will contain multiple choice and long answer questions. Each test is worth 6% of the course.
Weighting 18%
Length One hour plus upload time
Due Date Sunday 11:59pm at the end of Weeks 4, 8 and 12
Submission Method Online via Canvas
Assessment Criteria Sunday 11:59pm at the end of Weeks 4, 8 and 12
Return Method Online
Feedback Provided Online
Opportunity to Reattempt Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 2 - 11 Weekly Tasks

Assessment Type Tutorial / Laboratory Exercises
Purpose Designed so that students learn the material introduced in lectorials and in laboratories each week, plus gain feedback on their progress in the course.
Description Weekly computer-based exercises, written problems, talks and/or laboratory reports.
Weighting 42%
Due Date Tuesday 11:59pm (Weeks 2-8, 10-12), plus in lab during Week 12
Submission Method Online and in-person for talk
Assessment Criteria Demonstrate a level of conceptual understanding of course content, and quantitative problem solving abilities. Communicate effectively. Demonstrate competency in performing experiments, keeping records, running/writing computer codes, synthesizing scientific information, and analysing results.
Return Method Online
Feedback Provided Online and in-person
Opportunity to Reattempt Students WILL NOT be given the opportunity to reattempt this assessment.

Assessment 3 - Formal Examination

Assessment Type Formal Examination
Purpose The final formal examination is designed to test the individual student's knowledge of the course material and their ability to describe, analyse and work problems from this material. See the UoN Course Management and Assessment Procedure Manual for more information:https://policies.newcastle.edu.au/document/view-current.php?id=183&version=6

Description	The exam will contain a multiple choice and a long answer section. A scientific (non-programmable) calculator is permitted in the final exam.
Weighting	40%
Length	2 hours
Due Date	During formal exam period
Submission Method	Formal Exam
Assessment Criteria	Demonstrate a level of conceptual understanding of course content, and quantitative problem solving abilities.
Return Method	Not returned
Feedback Provided	No feedback
Opportunity to Reattempt	Students WILL NOT be given the opportunity to reattempt this assessment.

ADDITIONAL INFORMATION

Grading Scheme

This course is graded as follows:

Range of Marks	Grade	Description
85-100	High Distinction (HD)	Outstanding standard indicating comprehensive knowledge and understanding of the relevant materials; demonstration of an outstanding level of academic achievement; mastery of skills*; and achievement of all assessment objectives.
75-84	Distinction (D)	Excellent standard indicating a very high level of knowledge and understanding of the relevant materials; demonstration of a very high level of academic ability; sound development of skills*; and achievement of all assessment objectives.
65-74	Credit (C)	Good standard indicating a high level of knowledge and understanding of the relevant materials; demonstration of a high level of academic achievement; reasonable development of skills*; and achievement of all learning outcomes.
50-64	Pass (P)	Satisfactory standard indicating an adequate knowledge and understanding of the relevant materials; demonstration of an adequate level of academic achievement; satisfactory development of skills*; and achievement of all learning outcomes.
0-49	Fail (FF)	Failure to satisfactorily achieve learning outcomes. If all compulsory course components are not completed the mark will be zero. A fail grade may also be awarded following disciplinary action.

*Skills are those identified for the purposes of assessment task(s).

Communication Methods

Communication methods used in this course include:

- Email: Students will receive communications via their student email account.
- Canvas Course Site: Students will receive communications via the posting of content or announcements on the Canvas course site.
- Face to Face: Communication will be provided via face to face meetings or supervision.

Course Evaluation

Each year feedback is sought from students and other stakeholders about the courses offered in the University for the purposes of identifying areas of excellence and potential improvement.
As a result of student feedback, the following changes have been made to this offering of the course:

- In 2021, students felt like they did not stay current with the course content. As a result, we have introduced three end-of-module tests. In addition, students wanted changes to some of the labs, which have been implemented.

Oral Interviews (Vivas)

As part of the evaluation process of any assessment item in this course an oral examination (viva) may be conducted. The purpose of the oral examination is to verify the authorship of

	the material submitted in response to the assessment task. The oral examination will be conducted in accordance with the principles set out in the Oral Examination (viva) Procedure. In cases where the oral examination reveals the assessment item may not be the student's own work the case will be dealt with under the Student Conduct Rule.
Academic Misconduct	All students are required to meet the academic integrity standards of the University. These standards reinforce the importance of integrity and honesty in an academic environment. Academic Integrity policies apply to all students of the University in all modes of study and in all locations. For the Student Academic Integrity Policy, refer to https://policies.newcastle.edu.au/document/view-current.php?id=35.
Adverse Circumstances	The University acknowledges the right of students to seek consideration for the impact of allowable adverse circumstances that may affect their performance in assessment item(s). Applications for special consideration due to adverse circumstances will be made using the online Adverse Circumstances system where: 1. the assessment item is a major assessment item; or 2. the assessment item is a minor assessment item and the Course Co-ordinator has specified in the Course Outline that students may apply the online Adverse Circumstances system; 3. you are requesting a change of placement; or 4. the course has a compulsory attendance requirement. Before applying you must refer to the Adverse Circumstance Affecting Assessment Items Procedure available at: https://policies.newcastle.edu.au/document/view-current.php?id=236
Important Policy Information	The Help button in the Canvas Navigation menu contains helpful information for using the Learning Management System. Students should familiarise themselves with the policies and procedures at https://www.newcastle.edu.au/current-students/respect-at-uni/policies-and-procedures that support a safe and respectful environment at the University.

This course outline was approved by the Head of School. No alteration of this course outline is permitted without Head of School approval. If a change is approved, students will be notified and an amended course outline will be provided in the same manner as the original.