UNSW SYDNEY

Australia's Global University

School of Physics

Course Outline 2022

PHYS4142

Statistical Physics (Honours)

School of Physics

Faculty of Science

T1, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Coordinator	Oleg Sushkov	sushkov@phys.unsw.edu.au	Consultation times: by arrangement via email	(02)
Lecturer	Associate Professor Dimitrie Culcer	d.culcer@unsw.edu.au	Consultation times: by arrangement via email	(02)
Teaching Support Officer	Zofia Krawczyk-Bernotas	z.krawczyk-bernotas@unsw.edu.au	School of Physics office G06, Old Main Building	(02) 9065 5719

2. Course information

Units of credit: 6

Pre-requisite(s): PHYS3113 Thermal Physics and Statistical Mechanics

http://timetable.unsw.edu.au/2022/PHYS4142.html

2.1 Course summary

In this Honours course, students will be introduced to concepts and methods in advanced statistical physics which will allow them to understand a wide range of effects encountered in many-body systems. The course will cover the subjects of mean field theory, phase transitions, critical phenomena, the physics of non-equilibrium processes as well as a selection of more specialised topics.

2.2 Course aims

This is the highest undergraduate course in statistical physics and will provide students with a broad and comprehensive understanding and a foundation for further study and research.

2.3 Course learning outcomes (CLO)

1. Recall and demonstrate understanding of core principles of statistical physics.
2. Develop an understanding of, and ability to solve, a wide range of problems in statistical physics
3. Understand and develop facility with all syllabus material as a foundation for future research and professional activity

2.4 Relationship between course and program learning outcomes and assessments

Course learning outcomes 1-3 are assessed by the midsession test, assignment and final exam. These assessments are largely of a problem-solving nature designed to determine students' ability to deploy acquired knowledge to new situations, which is a key graduate attribute for successful physics-trained graduates.

3. Strategies and approaches to learning

3.1 Learning and teaching activities

Lecture

Day	*Time*	*Location*	*Weeks*
Wednesday	1100-1300	Old Main Building, G32	1-5, 7-10
Friday	1300-1400	Old Main Building, G32	1-5, 7-8,10

Seminar (Journal Club)

Day	*Time*	*Location*	*Weeks*
Friday	1400-1500	Old Main Building, G32	3,5,7

3.2 Expectations of students

Students are expected to attend at least 80% of all classes.

Academic misconduct will not be tolerated in any form in this course. Substantiated instances of cheating, plagiarism or copying of answers may result in a failure grade or significant deduction of marks. Please ensure you are fully familiar with the University's requirements and rules on plagiarism, which are detailed at http://student.unsw.edu.au/plagiarism. Claims of being unaware of the rules and/or the requirement for you to meeting them will not be accepted as mitigating circumstances.

The School endorses interactive group learning and fully understands that you may discuss the content of your courses including tutorial and assignment problems during your studies. However, submitted assignments should be your own work outlining your own reasoning and demonstrating your own knowledge related to the assessment. Copying will not be tolerated (we are good at spotting it); please ensure you know where the line between studying together and cheating on assessments lies. We will expect you to stay firmly on the correct side of that line.

4. Course schedule and structure

Detailed Syllabus

Part	Topic	Time
1. Basics	• Review of microcanonical, canonical, grand canonical distributions • Ideal Bose and Fermi gases	**2 hours**
2. Mean field theory, phase transitions and critical phenomena	• Heisenberg model of ferromagnetism; mean field theory for the Heisenberg model and Curie temperature • Landau theory of the order parameter; effective free energy and effective action • Classification of phase transitions • Mean field critical indices; • Fluctuations in the Landau approach; deviation of critical indices from mean field values • Magnous and Mermin-Wagner theorem • Temperature-driven vs quantum phase transitions • Landau-Ginzburg theory of superconductivity • Monte-Carlo methods • Black holes: Hawking temperature, entropy and evaporation	**6 hours**
3. Non-equilibrium statistical physics	• Boltzmann equation and the particle-particle collision integral • Relaxation time approximation • Electrical and thermal conductivities of solids • Generalised forces and entropy production • Onsager relations and examples, e.g., thermoelectricity • Spectral representation of fluctuations and correlation functions • Fluctuation-dissipation theorem • Brownian motion and the Langevin equation • The Fokker-Planck equation and diffusion • Noise: Johnson-Nyquist, random telegraph, 1/f	**10 hours**
4. Advanced topics	A selection from: • Black holes • Density matrix theory • Hydrodynamics	**6 hours**

5. Assessment

5.1 Assessment tasks

Assessment task	Length	Weight	Mark	Due date *(normally midnight on due date)*
Assignment 1:		20%		Friday 11 March (Week 4)
Assignment 2:		20%		Friday 22 April (Week 10)
Final Exam:	2 hours	60%		See Exam Schedule (TBA)

Journal Club

Each student will be assigned a paper (the papers will represent key advances in physics that will be of interest to any serious physicist.). Students will make a 20 minute presentation that covers the background, the advance and its implications. Every member of the class will be expected to at least read the paper. The presenter will then lead a discussion (~20 minutes) of the work. This component is compulsory but does not count towards the final grade.

Further information

UNSW grading system: student.unsw.edu.au/grades

UNSW assessment policy: student.unsw.edu.au/assessment

Information about Special Consideration is available from
https://student.unsw.edu.au/special-consideration

5.2 Assessment criteria and standards

Please see Moodle for a marking rubric for each assessment task

5.3 Submission of assessment tasks

Unless otherwise specified, assignments should be submitted to your lecturer or posted in the School of Physics assignment box by 5pm on the due date. Assignments will not be accepted by email. Marks will be deducted for late assignments, at a rate of 10% of the maximum possible mark for the assignment per day. A weekend will count as two days. An assignment submitted after the solutions have been posted will automatically receive 0%.

A downloadable assignment cover sheet is available from
https://www.physics.unsw.edu.au/current-students/cover-sheet

5.4. Feedback on assessment

Please see Moodle for details on how feedback will be provided for each assessment task

6. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage.[1] At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site student.unsw.edu.au/plagiarism, and
- The *ELISE* training site subjectguides.library.unsw.edu.au/elise

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: student.unsw.edu.au/conduct.

7. Readings and resources

Textbooks

S. J. Blundell and K. M. Blundell, Concepts in Thermal Physics, Oxford University Press 2006.

K. Huang, Statistical Mechanics, John Wiley and Sons, 1987.

L. D. Landau, E. M Lifshits. Statistical physics, 2d rev and enl ed., Oxford, New York, Pergamon Press, 1969.

E.M. Lifshitz, L. P. Pitaevskii. Statistical Physics: Theory of the Condensed State, part 2. Butterworth-Heinemann, revised edition, 1980. (ISBN-13: 978-0750626361)

F. Mandl. Statistical physics. 2nd ed., Chichester West Sussex ; New York : Wiley, c1988. eBook is available online on the UNSW library website.

J. J. Sakurai, Modern Quantum Mechanics, Addison Wesley, 1993. (Only for density matrix)

Other Resources

Lecture notes will be posted on Moodle.

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

8. Administrative matters

Communications

Students should check their UNSW email account regularly as all official university communication will be sent to that address. Students should use their university email account when writing to UNSW staff and should always include their name and student number.

Health and Safety

The School of Physics is actively committed to the health, safety and welfare of its staff and students. Information on relevant UNSW Occupational Health and Safety policies and expectations is available at: www.ohs.unsw.edu.au and https://www.physics.unsw.edu.au/about/safety

Recommended Internet Sites

The School of Physics website is www.physics.unsw.edu.au. Under the "Current Students" link students will find information about degrees, courses, and assessment.

The University website my.unsw.edu.au provides links to the UNSW Handbook, Timetables, Calendars and other student information.

Student Complaint Procedures

UNSW has procedures for dealing with complaints. These aim to solve grievances as quickly and as close to the source as possible. Information is available here: student.unsw.edu.au/complaints. Staff who can assist include:

School Contacts:

Zofia Krawczyk-Bernotas
Teaching Support Manager
School of Physics
Room G06, OMB
z.krawczyk-bernotas@unsw.edu.au
Tel: 9065 5719

Adam Micolich
Teaching Director
School of Physics
Room G57A, OMB
adam.micolich@gmail.com
Tel:

Prof Susan Coppersmith
Head of School
School of Physics
s.coppersmtih@unsw.edu.au
Tel:

A/Pof Julian Berengut
Honours Coordinator
School of Physics
julian.berengut@unsw.edu.au
Tel:

9. Additional support for students

- The *Current Students* Gateway: student.unsw.edu.au
- Academic Skills and Support: student.unsw.edu.au/skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: student.unsw.edu.au/disability
- UNSW IT Service Centre: www.it.unsw.edu.au/students