# SYLLABUS

## STATISTICAL MECHANICS PHYS-4142 (FALL SEMESTER, 2026)

## Regents' & Institute Professor Uzi Landman

### GTA: TBA

## ASSIGNED BOOKS:

1. **Introduction to Modern Statistical Mechanics**

By: David Chandler

Oxford University Press

***This book will be referred to as: DC.***

2. **Concepts in Thermal Physics (Second Edition)**

By: Stephen J. Blundell and Katherine M. Blundell

Oxford University Press

***This book will be referred to as: BB.***

**ADDITIONAL RESOURCE MATERIALS WILL BE PROVIDED ON CANVAS,**

**THESE WILL INCLUDE REVIEW ARTICLES & ORIGINAL SCIENTIFC PAPERS,**

**INTENDED TO ENRICH THE UNDERSTANDING OF THE COURSE MATERIAL.**

**TIME: The course consists of Lectures (mostly, twice a week, Monday and Wednesday, 12:30-1:45 pm).**

**First lecture August 24 , 2026. Last lecture December 7, 2026.**

**STUENTS ARE ASKED TO ATTEND (IN PERSON) ALL THE LECTURES , AND CONTRIBUTE**

**BY ATTENTIVELY FOLLOWING THE LECTURES.**

***QUESTIONS & DISCOURSE ARE ENCOURAGED!!***

**IMPORTANT DATES:** Labor Day September 7 (no class); Withdrawal Date: October 30, 2026:; Fall Break: October 5-6, 2026 (no class); Midterm test: about a week before the withdrawal date; November 25-26 (No Class), Thanksgiving

## HOME WORKS & TESTS :

**6-8 Home-work sets will be distributed during the course. Each will be due (usually) up to a week after the problem-set distribution date.**

Students are encouraged to contact the TAs who serve as teaching assistants for this course. Their office hours will be announced in the first week of the course.

## In addition, there will be two tests:

(1) **A Midterm test** (about a week prior to the Withdrawal date).

(2**) A Final test**. Date to be announced

## GRADES:

The grades will be determined on the basis of: **(i)** scores earned by the Home-works (**65 %)**, and **(ii)** the scores obtained in the two tests **(Midterm 15% & Final 20%; combined: 35% ).**

**Letter grades** will be assigned as follows:

90-100% = **A**; 80-89 % = **B**; 70-79 % = **C**; 50-69 % = **D**; less than 50% = **F**.

# PLAN OF THE COURSE

## Week (1): Aug. 24, 26 (2026)

**Lectures 1, 2 –** Introductory remarks; Introduction to probability theory [BB Chap. 3]; Brownian motion and Langevin Equation [BB, CHAP. 33.1], and supplementary material.

## Week (2): Aug. 31, Sep.2

**Lecture 3,4 –** Velocity correlation function, Ficks law, diffusion equation [DC, CHAP. 8.4]. Probability distribution functions: Binomial, Gaussian, Poisson. [BB, Appendix C].

## Week (3): Sep. 9

**Lecture 5–** Continuation of Lecture # 4.

Temperature, Boltzmann factor, statistical definition of temperature, maxwell-Boltzmann distribution, Pressure , ideal gas law [ BB, Chaps. 4, 5, 6].

## Week (4): Sep. 14, 16

**Lecture 6 -** Brief review of Classical Thermodynamics: Thermodynamic Laws, Thermodynamic

potentials, Legendre transformations, Gibbs-Duham equation [DC CHAP 1].

**Lecture 7 -** Statistical Mechanics, Liouville theorem, Ensembles; Micro-canonical Ensemble;

Micro-canonical derivation of ideal gas law (counting states in phase-space) [DC CHAPS. 3.1-3.2].

## Week (5): Sep. 21, 23

**Lectures 8, 9–** Continuation of Lecture 7. Derivation of partition function for the Canonical ensemble.

Helmholtz free energy. Derivation of ideal gas law, and two-state system

[DC Chaps: 3.3, 3.4] [BB CHAPS: 20, 21].

## Week (6): Sep. 28, 30

**Lectures 10,11 –** Generalized Ensembles and the Gibbs Entropy formula. Fluctuations involving

uncorrelated particles. Another derivation of the ideal gas law [DC CHAPS. 3.5, 3.6]

## Week (7): Oct. 7

**Lecture 12 –** Alternative Development of the equilibrium functions . [DC CHAP 3.7],

Non-interacting (ideal) systems, introduction [DC CHAP. 4]

## Week (8): Oct. 12, 14

**Lecture 13 –** Equipartition of energy [BB 19], The partition function [BB CHAP 20]

Non-interacting (ideal) systems, introduction [DC CHAP. 4]

**Lecture 14 –** Photon gas [DC CHAP 4.2}, photons [BB CHAP. 23]. Phonons (introduction)

[DC CHAP. 4.3] ; Review of the 1st half of the course.

## Week (9): Oct. 19, 21

**Lecture 15, 16 –** Continue lecture 14, Phonons [DC CHAP 4.3] Einstein and Debye models, mono-atomic and diatomic phonon

dispersion relations [DC CHAP 4.3], [BB CHAP 24 ]

## Week (10): Oct. 26, 28

**Lecture 17, 18–** Bose and Fermi statistical distributions, Bose-Einstein Condensation

{DC CHAP. 4.4] [BB CHAP. 29]

## Week (11): Nov. 2, 4

**Lecture 19–** Electrons in metals [DC 4.5] [BB 30.2]

**Lecture 20 –** Classical ideal gases, the classical limit [DC CHAPS. 4.6, 4.7].

## Week (12):Nov. 9, 11

**Lecture 21 –** Quantum Gases [BB CHAP. 30].

**Lecture 22** – Statistical mechanics of phase transitions , Ising model 1D [ BB Chap. 28]

## Week (13): Nov. 16, 18

**Lecture 23, 24–** Continuation of Ising Model; mean-field {DC CHAP 6].

[DC CHAP 5.6, 5.7]

## Week (14): Nov. 23

**Lectures 25 -** Renormalization group 1D [DC CHAP 5.6, 5.7],

## Week (15) Nov. 30. Dec 2.

**Lecture 26 –** Symmetry breaking (spontaneous magnetization) in the 2D Ising model (the Peierls Proof)

**Lecture 27 –** continue lecture 26

## Week (16) Dec. 7 (LAST CLASS)

**Lecture 28 - Review of course**

## FINAL TEST -- To be Announced.