

Spring 2021

## **PHYS 641-102: Statistical Mechanics**

Junjie Yang

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## Physics 641 Syllabus Spring 2021

Class meeting: KUPF104, Wednesdays, 6:00 pm-8:50 pm  
Jan 19, 2021 – May 4, 2020

**Instructor**  
Prof. Junjie Yang

**Email**  
[jyang@njit.edu](mailto:jyang@njit.edu)

**Office Location & Hours**  
Fridays 11 AM – 11:59 AM  
Webex or Canvas Chat (both available)

### General Information

#### Descriptions

This course provides an introduction to statistical mechanics, including the thermodynamics, classical and quantum statistical mechanics. The main goal of this course is to help students understand the key concepts of statistical physics. The course objective will be accomplished through lecture and problem solving. The class will also follow a question and answer approach. Students are encouraged to read the materials in textbooks before coming to class.

The Course Schedule below lists topics covered. Professors will make an effort to help the students succeed by using active learning. See: <https://physics.njit.edu/>

#### Learning Expectations, Goals and Outcomes

- 1) Demonstrate an understanding of terms such as equipartition theorem, entropy, fluctuations, heat capacities, Bose-Einstein distributions, Fermi-Dirac distributions and phase transitions and the ability to use them in the context of physical systems.
- 2) Utilize the laws of thermodynamics and statistical mechanics (in particular, ensembles and partition functions) to analytically describe various thermodynamics systems and processes.
- 3) To be able to solve problems for equilibrium properties of simple quantum systems.

Professors and students will measure Outcomes by the performance on assessments as listed below under final grade calculations.

### Course Materials

#### Text (optional)

Keith Stowe, *An Introduction to Thermodynamics and Statistical Mechanics*,

Kerson Huang, *Statistical Mechanics*.

Mehran Kardar, *Statistical Physics of Particles*,

Mehran Kardar, *Statistical Physics of Fields*

\*Canvas is required for this course and supplements the text. Some quizzes may be online via Canvas> Assignments, information and grades will be on Canvas.

#### Final Grade Calculation:

The Weights for parts of the course are as follows:	
Class Participation	5%
Homework	30%

Oral presentation	10%
Exams (Mid Exam = 25%, Final Exam = 30%)	55%
	100%

**Class Participation:** (5% of grade) Students are expected to participate regularly in class discussions by asking and answering questions, volunteering to solve problems, and working actively with others during in-class group assignments. When all students participate in each class, it creates an active learning environment that will help you understand the materials and be more successful in the class.

**Oral presentation:** (10% of grade) A research-based project will be assigned to each student. Each student will do a 20-min oral presentation.

**Homework:** (30% of grade) Homework questions are closely related to previous exams, so the understanding you gain from doing them is an added benefit. The homework is the greatest help for yourself if you figure it out by yourself.

**Exams:** (55% of grade) The amount of new material covered determines the exam weight, unless otherwise specified. The professors will help you as much as possible by covering all concepts and all settings of exam questions in class and with special review sessions. Make-ups for missed exams are only with advance permission from both your instructor and the Dean of Students. The Final will emphasize the weeks of work after mid exams, plus an overview of the whole course.

**The conversion of numerical to letter grades** is as follows: > 85% A; >80 to 85 B+; >70 to 80 B; >65 to 70 C+; >55 to 65 C; >50 to 55 D and <50 F

If you need any extra information about class, or exam questions, ask Prof. Junjie Yang. After the Final exam, the course ends, and questions and grades are not open to discussion.

## Course Policies

**Honor Code:** The NJIT Student Council dictates: “NJIT has a zero-tolerance policy for cheating of any kind and for student behavior that disrupts learning by others.” The NJIT Student Senate has requested a zero-tolerance policy for cheating of any kind and for behavior that disrupts learning. The Senate wants fairness for all students. The Dean of Students determines punishments and requires professors to report any incidents. The penalties include failure in the course plus disciplinary probation up to expulsion from NJIT. Avoid situations where anyone could misinterpret your behavior as dishonorable. Students are required to agree to the NJIT Honor Code on each exam, assignment, quiz, etc. for the course. Turn off all cellular phones, wireless devices, computers, and messaging devices of all kinds during classes and exams. Please do not eat, drink, or create noise in class that interferes with the work of other students or instructors.

**Missed exams:** There are *no make-ups* for in-class activities. If you miss an exam and the make-up time, you will receive a score of zero for that Exam. That score will be included in the

calculation of your final grade. If you miss two exams, you will automatically fail the course. To get credit for an exam, you must notify your instructor PRIOR TO the exam you will miss, as above. In order to be qualified to receive a "make-up" exam score (a very rare occurrence), the student should present documentation for not being able to take the test as scheduled. As is the standard policy of NJIT, this documentation should be presented to the student's to the **Dean of Students - (973) 596-3466, Room 255 Campus Center**. BOTH the instructor and Dean of Students must concur in permitting a "make-up" exam. Students who miss exams that do not present documentation within 7 days of the exam will receive a score of zero for the exam.

Late work: Homework is due by times and dates indicated in the homework.

**Class attendance:** The NJIT attendance policy is the following: "It is expected that students will attend all classes. Your teacher will take attendance at all classes and exams. More than 3 unexcused absences (in total) are excessive." If you have excusable absences, contact your instructor or the Dean of Students - (973) 596-3466, Room 255 Campus Center. If you have to miss class, let your professor know.

**Withdrawal:** If you must withdraw from the course, do it officially through the Registrar, otherwise your course grade will be F.

**Electronics:** Cell phones and laptops must be off during classes and exams, except as indicated by the instructor.

## Course Schedule

Classes start Wednesday Jan 20th;

We recommend that you read all chapters in our textbook as indicated below before class. The combination of reading and discussion helps learning.

*Week 1 to 3:* Introduction

Probabilities, Fluctuations and Distributions

Degree of freedom and Equipartition theorem

First Law, Second Law and Third Law

Temperature, Heat Capacity, Entropy, Free Energy and Special Processes

*Week 4 to 6:* Classical Statistics

Ensembles: Micro-canonical, Canonical, Grand canonical, Gibbs

Occupation number, Partition Functions

Maxwell-Boltzmann Statistics and distribution

*Week 7:* Mid-Exam.

*Week 8 to 14:* Quantum Statistics

Bose-Einstein statistics, Fermi statistics

Photons, Phonons, Spins and Magnetism

Phase Transitions, Landau theory

Introduction to Statistics of Fields

Kinetic theory, Transport phenomena

*Week 15: Oral presentation*

*Week 16: Final Review*

### **Exams:**

**Mid exam:** March/03/2021, Weeks 1-6

**Final exam:** May/12/2021, some coverage of Weeks 1-6; more coverage of Weeks 8-14.

### **Additional Information and Resources**

#### **Resources for NJIT Students**

Academic Advising Success Center “...assist in the advisement of students who are undecided in their major, transitioning into another major at NJIT, and those students who need additional support to graduate successfully and in a timely manner.”

Academic Support and Student Affairs “From questions about becoming a student at NJIT – to student engagement – to searching for information on career development, the Division of Academic Support and Student Affairs Staff is here to help.”

Additional Tutoring Centers Physics Learning Center; Math Learning Center; Chemistry Learning Center; The Writing Center; ECE Study Groups Center for Counseling and Psychological Services “The NJIT Center for Counseling and Psychological Services (C-CAPS) is committed to assisting students in the achievement of their academic goals as well as benefiting from their personal experience on campus. College life can be personally challenging and stressful at times. We believe that the educational process is an important component of the development of the individual as a whole person. Our goal is to optimize the college experience and improve the quality of the lives of our students by promoting their mental health and facilitating students’ personal, academic and professional growth.”

Department of Public Safety “The Department of Public Safety, conveniently located at 154 Summit St. on the first level of the Parking Deck, provides police protection 24 hours a day, 7 days a week.”

Disability Support Services “If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.”

Health Services “To ensure the good health of our students, the NJIT Student Health Service provides quality healthcare to all eligible NJIT registered students.”

IST Service Desk “The IST Service Desk is the central hub for computing information and first point of contact for getting help and reporting issues related to computing technology at NJIT. There is much technology here at NJIT, and many ways to find information or get help with it.” The Learning Center “Our mission is to assist students both in the classroom and beyond by providing tutorial services, academic coaching, academic and personal enrichment workshops and staff and peer support so students can meet the demands of their coursework and are prepared for life after graduation.”

NJIT/Rutgers Shuttle Service “The shuttle bus is operated jointly with Rutgers-Newark and provides transportation for the University community between the two campuses, major mass transit systems, and Harrison and Kearny. As a courtesy, shuttle service is free to the Rutgers/NJIT community who present identification.”

Office of Global Initiatives Resources for international students and study abroad programs. Robert W. Van Houten Library “The Van Houten Library offers electronic and print resources essential to the mission of New Jersey's science and technology university, including a core collection of academic books, databases, and journals, as well as research and consultation services.”

Student Financial Aid Services “Student Financial Aid Services (SFAS) at NJIT is committed to providing you with every opportunity to obtain funding to support your educational costs at NJIT.”

### Spring 2021 Academic Calendar

January	18	Monday	Martin Luther King, Jr. Day
January	19	Tuesday	First Day of Classes
January	23	Saturday	Saturday Classes Begin
January	25	Monday	Last Day to Add/Drop a Class
January	25	Monday	Last Day for 100% Refund, Full or Partial Withdrawal
January	26	Tuesday	W Grades Posted for Course Withdrawals
February	2	Tuesday	Last Day for 90% Refund, Full or Partial Withdrawal - No Refund for Partial Withdrawal after this date
February	15	Monday	Last Day for 50% Refund, Full Withdrawal
March	9	Monday	Last Day for 25% Refund, Full Withdrawal
March	14	Sunday	Spring Recess Begins - No Classes Scheduled - University Open
March	21	Sunday	Spring Recess Ends
April	2	Friday	Good Friday - No Classes Scheduled - University Closed

April	5	Monday	Last day to withdraw
May	4	Tuesday	Friday Classes Meet
May	4	Tuesday	Last Day of Classes
May	5	Wednesday	Reading Day 1
May	6	Thursday	Reading Day 2
May	7	Friday	Final Exams Begin
May	13	Thursday	Final Exams End
May	15	Saturday	Final Grades Due