

Course Overview

Statistical Mechanics

- **Course Number:** PHY 603
- **Semester:** Fall 2026
- **Course Meeting Time and Credit Hours:** [Tu/Th 11 am to 12:15 pm; 3 credits]

Contacting Your Instructor(s)

Instructor of Record

- **Instructor Name:** Prof. Partha Biswas
- **Office Address:** TEC 112A
- **Office Hours:** By appointment only; Online and in-office
- **Email:** partha.biswas@usm.edu
- **Phone:** None

Teaching Assistants (If Applicable)

- **TA Name:** None

Course Objectives

The main objective of the course is to study a statistical description of many-particle systems from classical and quantum-mechanical points of view. Unlike classical physics, where the focus is on particle and rigid-body dynamics, here we shall develop a probabilistic viewpoint of a collection of very many particles. The emphasis is on the collective motion and properties of a complex system -- consisting of an ensemble of interacting particles -- for which exact solutions are not possible. Instead of providing a deterministic solution of a problem, statistical mechanics aims to provide us with the information on the average behavior of a dynamical system (in equilibrium). The field is one of the most important branches of theoretical physics, supported by elegant mathematical methods and experimental results. As a part of the course, you will learn the key statistical ensembles and their applications to physics.

Course Description

Random variables and processes:

Random variables, moments, and characteristic function; Addition of random variables; Gaussian distribution; The central limit theorem; Random processes, Stationarity and Ergodicity

Classical Statistical Mechanics:

Phase-space density, ergodic hypothesis, Liouville's theorem, Microcanonical ensemble, Canonical Ensemble, Gibbs Paradox, Applications of Boltzmann statistics, Non-interacting system of particles, Fluctuations, Virial and Equipartition theorems, Concept of Entropy from the statistical point of view, Phase transitions, Ising models in 1- and 2-dimension

Basics of quantum statistical mechanics, Ideal Quantum Gases, Bose and Fermi gases, The Grand potential, Classical limits and the ideal Fermi and Bose gases; The Photon gas — the blackbody distribution; Phonons in Solids, Specific heat of solids; Bose-Einstein condensation, Statistical mechanics of stars (optional).

Course Learning Outcomes

By the end of this course students will learn:

1) Basic applications of statistical mechanics; 2) Some mathematical methods in Physics; 3) Study a paper in statistical mechanics; 4) Present a talk on advanced topics on statistical mechanics; 5) Develop a firm understanding of many-particle systems

Course Materials

Since this is a graduate-level course, we will use a variety of sources including review articles, textbooks, and **mostly** class notes. The level of course materials will be based on the following books:

- 1) Thermodynamics and Statistical Mechanics by Walter Greiner, Springer ISBN-13: 978-0-387-94299-5
- 2) Thermal Physics by S. J. Blundell and K. Blundell, Oxford University Press, ISBN-13: 978-0-19-856769

Course Requirements

Students are expected to meet the following requirements in order to successfully complete and pass the course. See course evaluation below for how these requirements are satisfied.

1. Presentation of an assigned advance topic or project by doing literature survey and/or a problem;

2. Attending all regular tests and the final examination;
3. Attending regular classes. You are required to present in the class physically or online unless you have permission from the appropriate university authority. Please notify your instructor by email if you cannot attend a lecture;
4. Completion of home assignments in a timely manner;
5. A good knowledge of undergraduate (UG) Thermal Physics and Mathematics are needed for this course.

Class Schedule

***Note:** The following schedule is highly tentative as it depends to an extent on the progress of the students. Our focus will be on understanding of some key topics in statistical mechanics rather than an exhaustive coverage of all topics that we wish to cover.*

First and second weeks: Mathematical methods; Random variables and processes

Second and Third weeks: Introduction to classical statistical mechanics and its application to physical systems

Fourth and Fifth weeks: Ensemble theory and its applications

Sixth week: Mid-term Exam (Timed online and in-person exam under supervision)

Seventh and Eighth weeks: Applications of classical statistical mechanics and basic quantum statistical mechanics

Ninth and tenth weeks: Quantum statistics: Bose-Einstein and Fermi-Dirac Statistics

Eleventh and twelfth weeks: Review of some selected materials discussed in the class.

Course Communication

Online students may contact by email for an appointment for Team meeting. In-class students should schedule an office appointment for discussion. Course materials will be posted in the URL below, which will be activated in the first week of the class. Please check the link from time to time and notify your instructor if it is broken or dysfunctional.

<https://boson.usm.edu/teach.html>

Course Evaluation

During the semester, your performance in the course will be evaluated via:

- a) Mid-term Exam (25% of the total grade)
- b) Final Exam (25% of the total grade)
- c) Presentation of an assigned special topic at the end of the semester (25% of the total grade)
- d) Homework (20% of the total grade)
- e) Regular attendance (5%)

To obtain 5% credit via regular attendance, you must not miss more than 5 classes, excluding emergency. Please contact with the course instructor if you have any concerns and questions.

Course workload Statement

Students are expected to invest considerable time outside of class in learning the material for this course. The expectation of the University of Southern Mississippi is that each week students should spend approximately 3 hours outside of class for every hour in class working on reading, assignments, studying, and other work for the course. For online classes, the average amount spent on a three-credit course is roughly **12 hours per week**, including all assignments and interactions. *This estimate may depend on your earlier preparation and physics and mathematics background.*

We realize that most students work and have family or other obligations. Time management is thus critical for student success. All students should assess their personal circumstances and talk with their advisors about the appropriate number of credit hours to take each term, keeping in mind that 30 credit hours each year are needed to graduate in four years. Resources for academic, technical, self-help, social, and other needs can be found at the [USM Student Help Directory](#).

Grading Policies and Calculation

Your final grade will be issued in the following letter grade. See course evaluation for how to calculate this grade.

A 85 to 100

B 70 to 84

C 55 to 69

D 40 to 54

F < 40

A list of possible grades at the University can be found in the [USM Academic Bulletin](#). Note that students will receive an “interim grade” at the seven-week point to give them an indication of their performance at that point in the semester. Students may drop a course with no penalty in the first week of the semester. If students wish to leave a course with a grade of “W” (Withdrawal), they may request to do so before the 50th day. Specific deadlines can be found on the [USM Office of the Registrar Calendars](#).

Important Note: Students who receive a grade of W **do not receive a financial refund**, and the grade is permanently included on their transcripts. Students should also be aware that “Incompletes” can only be assigned in cases of extraordinary circumstances beyond the student’s control.

Academic Integrity Statement

Academic misconduct involves deception to improve a grade, earn course credit, complete a degree, or create an unfair academic advantage for oneself or disadvantage to another in the academic community. All students at the University of Southern Mississippi should familiarize themselves with the [Student Academic Integrity Policy](#) to become familiar with what actions constitute academic misconduct, a violation of that policy. Southern Miss values “an approach to academics, research, and personal conduct based on integrity and civility” and the Student Academic Integrity Policy supports that University value. Forms of academic misconduct may include, but are not limited to:

- **Cheating:** A broad category of academic misconduct characterized by an attempt to gain academic advantage through inappropriate means or impede the academic achievement of others.
- **Plagiarism:** The use of another person's or source's words, creative works, or ideas without appropriate quotation or attribution; claiming or submitting for academic credit the work of another.
- **Lying:** The misrepresentation of one's academic work, lying to an instructor to increase a grade, or lying to an instructor regarding an academic integrity violation.
- **Acquiring or Distributing Information Inappropriately:** The act of distributing or obtaining course assignments or examination questions or answers from sources not approved by the instructor or proctor (includes, but is not limited to, unauthorized use of the Internet, test banks associated with course text, and previous student work).
- **Fabrication or Falsification of Data:** Any statement of untruth in any matters related to the academic experience, including but not limited to forgery; false claims of authorship;

falsification of information, data, or results derived from or related to research or to laboratory experiments.

- **Stealing or Defacing:** The act of intentionally taking, transferring, defacing, or destroying, without right or permission, any property related to the academic mission of the University, including an attempt to impede others.
- **Multiple Submissions:** The submission, more than once, without authorization by any instructors involved, of substantial portions of the same work, including oral reports or work submitted for retaken courses.
- **Conspiracy:** The act of agreeing or planning with any person to commit any violation of the Student Academic Integrity Policy.
- **Unauthorized use of artificial intelligence:** See the artificial intelligence policy in this syllabus for allowable or non-allowable use of artificial intelligence.

If you commit an act of academic misconduct, sanctions ranging from resubmission of work to course failure may occur, up to the possibility of receiving a grade of “XF” for the course, which will be placed on the student’s transcript with the notation “Failure due to academic misconduct.” Per the Academic Bulletin, if the student is found responsible for an academic integrity violation with the sanction of an XF, the student may not withdraw from the course. Should you be accused of academic misconduct, please visit the [Academic Integrity Website](#) or email integrity@usm.edu for any questions you may have about your rights and about the academic integrity process. Southern Miss provides many campus resources that are detailed in this syllabus and will be discussed by your professors; please utilize those to help you learn. At Southern Miss, we care about your personal work and learning journey.

Artificial Intelligence Syllabus Statements

This section of the syllabus outlines the acceptable use of generative artificial intelligence (AI) tools in this course. Generative AI tools include types of artificial intelligence technology that are “capable of generating text, images, code or other types of content, often in response to a prompt entered by a user” (Hughes, 2023, TechRepublic).

Each instructor will determine the permitted use of artificial intelligence in each course to ensure that student work demonstrates academic rigor, creativity, original research, and other discipline-appropriate aspects. Students are responsible for understanding what, if any, artificial intelligence tools are permitted for use in each course.

This course only permits submitting student-generated work only. The “work” entails any written and oral materials, and exam papers that students produce for the purpose of evaluation and grading by the instructor for this course (PHY 603). This policy is consistent with Option 3 stated below by the USM

- **Option 3: Human-Generated Work Only**

The intention of this course is to develop your capacity for critical reasoning through the use of gained knowledge, experience, and perspective, and as such, the use of generative Artificial Intelligence (AI) is not permitted for classwork. Any use of AI tools for creation of content in this course may be considered a violation of the University of Southern Mississippi's Academic Integrity policy. Your instructor of this course should provide guidance regarding non-generative technologies, including translation and access software, spelling and grammar checkers, and may reserve the right to send any submitted work through AI detection software. The use of unauthorized AI tools will result in consequences deemed appropriate by the instructor and will be subject to the Academic Integrity Policy and the University of Southern Mississippi.

Student Accessibility Services

Student Accessibility Services (SAS) is Southern Miss’s designated office to assist the University in its commitment to protect the civil rights of students with disabilities. SAS protects students from discrimination and offers reasonable accommodations to give them equitable access to university courses and resources. Disabilities covered under the ADA may include but are not limited to ADHD, learning disabilities, psychiatric disabilities, physical disabilities, chronic health disorders, temporary injuries, and pregnancies. If a student feels that they need classroom or housing accommodations based on a disability they should contact SAS:

- **Phone:** 601-266-5024
- **Email:** sas@usm.edu
- **In Person:** McLemore Hall, Room 112
- **Online:** [Student Accessibility Services Website](#)

Additional Institutional Statements

Exam Proctoring

Students who require exam proctoring have several options available through the University of Southern Mississippi.

- **Hattiesburg Campus:** Students may schedule a proctored exam with Student Accessibility Services (SAS) at least two (2) days before the scheduled exam date. Exams administered in Scianna Hall will continue to be proctored in Scianna Hall.
- **Gulf Park Campus:** Students may schedule a proctored exam with the Gulf Park Testing Center at least three (3) business days before the scheduled exam date.
- **ProctorU:** Students are encouraged to schedule their “Live Virtual Proctor” more than one (1) day in advance of the exam date to avoid additional fees. Regular fees are based on the amount of time instructors set for the exam: \$19.80 for the first hour, and \$11.00 for each sequential hour plus tax. Visit the USM Proctoring Policies module in this course for further guidance.

Students can access more information about exam proctoring and how to schedule proctored exams by visiting the [exam proctoring website](#).

Copyright Statement

My lectures and course materials, including PowerPoint presentations, tests, outlines, syllabus, handouts, recordings of my lectures, and similar materials, are protected by copyright. That means that I am the exclusive owner of those materials I create, and no one but me can edit them, give them to others, post them anywhere online, or copy them to distribute in any way. You may take notes and make copies of course materials for your own personal use, and you and other students in the class may share notes and materials when studying. Any other sharing of lecture notes or any course materials cannot be done unless you have my permission in writing, whether you are paid for the materials or not.

Similarly, I will not share anything you submit to me unless I have your written permission. If you upload your notes or any materials from this class to any website or give them to anyone, this act is a violation of copyright and is considered academic misconduct. If you do that, you will be subject to the penalties outlined in the University’s Academic Integrity Policy. If you have any questions at all about copyright or academic integrity, please let me know.

Nondiscrimination Statement

The University of Southern Mississippi offers to all persons equal access to educational, programmatic and employment opportunities without regard to age, sex, sexual orientation, disability, pregnancy, gender identity, genetic information, religion, race, color, national origin, and/or veteran status pursuant to applicable state and federal law.

Confidentiality and Mandatory Reporting

As an instructor, one of my responsibilities is to help create and maintain a safe learning environment on our campus. I also have a mandatory reporting responsibility related to my role as a faculty member. I am required to share information regarding sexual misconduct or information about a crime that may have occurred on USM's campus with certain University officials responsible for the investigation and remediation of sexual misconduct. The information will remain private and will only be shared with those officials necessary to resolve the matter.

The sharing of information to the Title IX Office does not initiate a Title IX investigation or the criminal investigation process. Reporting to the Title IX Office initiates office outreach to those impacted by the alleged behavior to discuss available resolution options and supportive measures. You do not have to file a formal complaint with the Title IX Office in order to access on and off campus supportive measures.

If you would like to speak in confidence, resources available to students include Confidential Advisors with the Shafer Center for Crisis Intervention, the Counseling Center, Student Health Services, and Clergy. More information on these resources and University Policies is available at the [USM Title IX Office Website](#).

Student Support Resources

Student Support Portal

Our goal is to ensure students have the resources that they need to be successful. Students needing support for academics, financial assistance, technical assistance, or mental, emotional, recovery, or other needs can use the [USM Help Guide](#) to navigate available campus resources and self-help options.

Student Rights and Consultation

[The Dean of Students Office](#) can help you if you need information about your rights and responsibilities as a student, guidance in navigating university policies and procedures, need consultation on or to report a concern, referrals to campus resources, assistance with an academic notification to instructors about an extended absence, or to initiate a late withdrawal from a course or the university.

Academic Notification Policy

The Dean of Students Office will support students experiencing a crisis and/or medical emergency that causes the student to miss more than three consecutive days of classes and can provide documentation to a faculty member regarding the validity of the absence. However, the documentation provided by this office does not "excuse", nor does it guarantee, that the student will be permitted to make up tests or other missed assignments; it simply documents that the student's circumstance(s) indicates that the student is/was unable to participate in class for the designated period of time. At their discretion, the instructor will make the final decision about the opportunity to complete missed course work. Students are encouraged to reach out to their instructors as soon as possible before or after any absence.

The Academic Success Center at Gulf Park

The Academic Success Center is located on the second floor of the Gulf Coast Library on the Gulf Park campus in Long Beach. Through peer tutors and professional support staff, the Academic Success Center offers a broad range of services including academic coaching; learning materials and electronic resources; individual and small group tutoring offered both online and in-person; whole class support; IVN testing proctoring; in-person proctoring at the Testing Center in the Gulf Coast Library; workshops and seminars.

- **Online Portal:** [Academic Success Center Website](#)
- **Appointments:** [Gulf Park WOnline Booking](#)
- **Phone:** 228-214-3346 or 228-214-3467
- **Email:** academic.success@usm.edu

Speaking and Writing Centers

The [Writing Center](#) and the [Speaking Center](#) are friendly spaces that provide individualized feedback and support to help Southern Miss students succeed with writing and speaking assignments for any class. The Centers offer one-to-one consultations for any stage of the process, including brainstorming, creating an outline, revising, learning editing strategies, and developing presentation skills. In-person and online appointments are available.

- **Appointments:** [USM WOnline Booking](#)
- **Information:** [Writing Center Website](#) | [Speaking Center Website](#)

- **Writing Center (Cook Library 112):** writingcenter@usm.edu | 601-266-4821
- **Speaking Center (Cook Library 117):** speakingcenter@usm.edu | 601-266-4965

Career Services

Career Services staff strive to assist students in finding meaningful career paths, developing job-seeking skills and connecting with employment opportunities. Students will find assistance through personal meetings, on-line resources and attending events such as the Career and Internship Expos. Students are encouraged to attend the Career and Internship Expo each semester to explore potential career paths, identify internships, discover job opportunities, and build professional connections with employer contacts. 80 to 100 employers and graduate school representatives attend each semester. Dates and additional information on the [Career Services website](#) or check out the events section in your [Handshake](#) account.

- **Website:** [USM Career Services](#)
- **Events:** Accessible via your student [Handshake account](#).
- [Connect with a Career Advisor](#)

University Libraries

Southern Miss Libraries provide students with individualized assistance using library resources for coursework and scholarly research. Questions may be asked in person or by live chat, telephone, or email. Students may request a research consultation with a librarian to get help at any stage of the research process. Research consultations, available in-person and online, provide personalized assistance that is tailored to a class assignment or project. Librarians can help students search for, find, and obtain sources for their research projects.

The [University Libraries' website](#) (www.lib.usm.edu) provides information about conducting academic research, as well as links to the Libraries' search tool (Seymour Info), databases, and other resources. Library research guides are available through Canvas, as well as the library website. University Libraries also have a robust interlibrary loan (ILL) service which provides access to resources not available in our current collections or subscriptions. The Libraries at Southern Miss provide access to both print and electronic resources, including books, journal articles, newspapers, digital media, and more. University Libraries also include Special Collections which offer a variety of historical resources, such as rare books and historical artifacts, in addition to University Archives which offer documents and memorabilia from our University's rich history. Visit your campus library or the University Libraries' website to get started!

- **Website:** [University Libraries Home](#)

Financial Management Resources

The University of Southern Mississippi recognizes that students, faculty, and staff members may experience financial challenges beyond their control that impact their ability to finance their education or establish a work-life balance that fosters academic success. If you find yourself in need of financial education, resources, or professional services, please visit the Office of Undergraduate Scholarships' [Financial Management Resource Center Site](#) or access financial tools using your USM credentials via [iGrad Southern Miss](#).

Food Insecurity and Student Homelessness Support

Food Insecurity and Student Homelessness Support (Hattiesburg Campus)

The University of Southern Mississippi recognizes that students and staff members may experience challenges beyond their control that impact their ability to take care of their essential needs, such as having food or a safe place to sleep. If you find yourself in need of food or shelter, please consider contacting the Eagle's Nest Food Pantry on the Hattiesburg campus at 601-266-4025 or eaglesnest@usm.edu. All students, faculty, and staff are welcome to come to the Eagle's Nest Food Pantry and utilize the available resources free of charge.

Food Insecurity and Student Homelessness (Gulf Park Campus)

The University of Southern Mississippi recognizes that students and staff members may experience challenges beyond their control that impact their ability to care for their essential needs, such as having food or a safe place to sleep. If you find yourself in need of food, please consider contacting the Long Beach Community Food Pantry at 21801 Johnson Road, Long Beach, MS.

- **Hattiesburg Campus (Eagle's Nest Food Pantry):** Available free of charge to all students and staff. Contact via 601-266-4025 or eaglesnest@usm.edu.
- **Gulf Park Campus Support:** Assistance is available via the Long Beach Community Food Pantry located at 21801 Johnson Road, Long Beach, MS.

Mental Well-Being

USM recognizes that students sometimes experience challenges that make learning difficult. If you find that life stressors such as anxiety, depression, relationship problems, difficulty concentrating, alcohol/drug problems, or other stressful experiences are interfering with your academic or personal success, consider contacting [Student Counseling Services \(SCS\)](#) on campus at 601-266-4829. More information is also available at <https://www.usm.edu/student-counseling-services>, or [The USM Help Website](#) ([usm.edu/help](https://www.usm.edu/help)). Student Counseling Services offers currently enrolled students free, confidential counseling services and can provide referrals to campus and community resources. Currently enrolled students living outside Mississippi can receive a one-time consultation to assure they are informed about available resources in their community. Students on the Gulf Park campus also can receive services from SCS or speak with someone at the Gulf Park Health Center for a referral.

In the event of emergency, please call 911 or if there is a mental health crisis after business hours, call or text the National Suicide Hotline at 988 (988lifeline.org).

- **Contact Number:** 601-266-4829
- **Web Resources:** [Student Counseling Services](#)

- **Crisis Line:** In an emergency call 911. For an after-hours mental health crisis, call or text the National Suicide Prevention Lifeline at **988** or visit [988 Lifeline Website](https://988lifeline.org) (988lifeline.org).