COURSE INFORMATION

PHYSICS 8702, (Statistical Mechanics and Transport Theory), 3 credits Course Prerequisites:

Instructor:Jorge VinalsOffice:Physics 346Contact information:vinals@umn.eduOffice hours:MW 3:20 p.m. - 4:30 p.m. F 1:30 - 2:30 p.m.

Lecture schedule: MWF 2:30 – 3:20 p.m. Physics 143.

TA office hours: There is no TA for this class.

EXAMS AND FINAL

There are no exams for this class. There will be several homework assignments during the semester. Typically, the homework will be due one week after being assigned, and may include reading of relevant material. There will be no credit for late homework.

Each student will also be required to give a brief (30 min) presentation on an appropriate topic. The topic will be chosen by the student, but must be approved by the instructor. The presentation can be lecture style (blackboard), or conference style (overhead projector). Students must submit a copy of the presentation for evaluation.

REQUIRED MATERIALS

There is no specific textbook for this class. It will be based on lecture notes (sometimes available online), supplemented by the textbooks below.

- D.Chandler, "Introduction to Modern Statistical Mechanics" (Oxford University Press, New York, 1997). Provides a useful introductory review of equilibrium statistical mechanics if needed.
- N. Goldenfeld, "Lectures on Phase Transitions and the Renormalisation Group". (Addison-Wesley, Reading, Mass., 1992). Covers in great detail the theory of equilibrium phase transitions and critical phenomena.
- P.M. Chaikin and T.C. Lubensky, "Principles of Condensed Matter Physics". (Cambridge University Press, New York, 1995). This will be the basic book for linear response theory and nonequilibrium phenomena. It is available in the bookstore if you wish to purchase it.

Online information for this class can be found at

http://homepages.spa.umn.edu/~vinals/classes/phys8702/

in addition to the departmental web site.

COURSE GOALS AND OBJECTIVES

This course is a continuation of PHYS 5201 (Thermal and Statistical Physics). It continues the treatment of phase transitions and critical phenomena, including the Renormalization Group. It introduces Linear Response theory and the basic concepts and tools of nonequilibrium physics. The goal is to reach a level that is sufficient to read, understand, and work on current research papers that address nonequilibrium phenomena. Specifically, the class will cover:

- 1. Review: Large systems, and independence of parts. Central Limit Theorem. Fluctuations and correlations in weakly coupled systems. Self-similarity and power law correlations. Fluctuations in equilibrium systems, fluctuationdissipation relations and thermodynamic sum rules.
- 2. Equilibrium phase transitions and Critical Phenomena. Ising model. Mean field, Landau, and Ornstein-Zernike theories. Scaling near a critical point, Renormalization Group Theory: fixed points, epsilon expansion and critical exponents. Kosterlitz-Thouless transition.
- 3. Fluctuations near equilibrium: Linear Response Theory. Correlation functions and measurement through scattering experiments. Response functions and examples. Symmetries and analytic properties of response functions, Kramers-Kronig relations. Green-Kubo formulae.
- 4. Generalized Transport Theory. Reversible and dissipative modes, transport coefficients and Kubo formulae.
- 5. Hydrodynamics of simple fluids. Conservation laws, variables and currents. Reversible and dissipative motion, constitutive laws, and linear modes. Hydrodynamics of a simple system with a broken symmetry: the rigid rotor.
- 6. Systems far from equilibrium, generalized Langevin equation. Fokker-Planck equation. Nonlinear models.

GRADING

Homework	60 %
Class presentation	30 %
Class participation	10 %

ATTENDANCE POLICY

Class attendance is required.

DEPARTMENTAL POLICIES

ATHLETES must provide their official University of Minnesota athletic letter containing the approved competition schedule to their instructor and the staff in office 148. Away exams will be arranged with the athletic adviser traveling with the team. Accommodations will be made for official university sports only (i.e. no accommodations will be made for intramurals, club sports, etc.)

DISABILITY SERVICES: If you have accommodations for this course, please provide the staff in office 148 with a copy of your accommodation letter for the current semester. Exams will be arranged according to accommodations and sent to the testing center for administration.

MANDATORY POLICY INFORMATION

Student Conduct Code

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University you are expected adhere to Board of Regents Policy: *Student Conduct Code*. To review the Student Conduct Code, please see: <u>http://www1.umn.edu/regents/policies/academic/Student_Conduct_Code.html</u>.

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Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

Scholastic Dishonesty

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code:

<u>http://www1.umn.edu/regents/policies/academic/Student_Conduct_Code.html</u>) If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see:

http://policy.umn.edu/Policies/Education/Education/INSTRUCTORRESP.html. The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty:

<u>http://www1.umn.edu/oscai/integrity/student/index.html</u>. If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

Disability Accommodations

The University is committed to providing quality education to all students regardless of ability. Determining appropriate disability accommodations is a collaborative process. You as a student must register with Disability Services and provide documentation of your disability. The course instructor must provide information regarding a course's content, methods, and essential components. The combination of this information will be used by Disability Services to determine appropriate accommodations for a particular student in a particular course. For more information, please reference Disability Services: http://ds.umn.edu/student-services.html.

Use of Personal Electronic Devices in the Classroom

Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each faculty member to

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determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference: <u>http://policy.umn.edu/Policies/Education/Education/CLASSROOMPED.html</u>.

Makeup Work for Legitimate Absences

Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: <u>http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html</u>.

Appropriate Student Use of Class Notes and Course Materials

Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see:

http://policy.umn.edu/Policies/Education/Education/CLASSNOTESSTUDENTS.html.

Grading and Transcripts

The University utilizes plus and minus grading on a 4.000 cumulative grade point scale in accordance with the following:

- A 4.000 Represents achievement that is outstanding relative to the level necessary to meet course requirements
- A- 3.667
- B + 3.333
- B 3.000 Represents achievement that is significantly above the level
- ^D necessary to meet course requirements
- B- 2.667
- C 2.333
- C 2.000 Represents achievement that meets the course requirements in every respect
- C- 1.667
- D + 1.333
- D 1.000 Represents achievement that is worthy of credit even though it fails to meet fully the course requirements
- S Represents achievement that is satisfactory, which is equivalent to a Cor better.

For additional information, please refer to:

http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html

Sexual Harassment

"Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy:

http://www1.umn.edu/regents/policies/humanresources/SexHarassment.html

Equity, Diversity, Equal Opportunity, and Affirmative Action

The University will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy:

http://www1.umn.edu/regents/policies/administrative/Equity_Diversity_EO_AA.html.

Mental Health and Stress Management

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: <u>http://www.mentalhealth.umn.edu</u>.