PHYS 427 Applications of Physics Summer 2021

Instructor: Subramanian Ramachandran

COURSE SYLLABUS AND GENERAL INFORMATION

Lectures:

Tues, Thu 10:20 – 11:50 AM on Zoom

- requires registration. Link to registration and other course information posted on:

PHYS427 Su2021 Canvas Course page

Prior registration is required to access the Zoom meetings.

Office hours:

Thu and Fri 3-4 pm on this PHYS427_Su2021_Office hour

Contact information:

Instructor:

Subramanian Ramachandran E_mail: **ramacs@uw.edu**

Course Objective:

This course will deal exclusively with a specific application of physics in the realm of cryogenics. The course will heavily rely on concepts learned in introductory thermal physics, and introductory quantum mechanics. We will try to understand the unique physical properties of cryogenic liquid and relevant physical properties of material at cryogenic temperature. We will apply such understanding to design experimental apparatus and storage containers for cryogenic fluid. We will consider thermodynamic cycles used to liquefy gases such as nitrogen, hydrogen and helium and several closed cycle refrigerators which are liquid cryogen-free. While such cycles may be adequate to achieve temperatures well below the normal boiling point of ^{4}He, a dilution refrigerator is required to achieve a temperature on the order of mK and an adiabatic demagnetization refrigerator to achieve μK or lower. Subject to availability of time, we will also discuss optional topics such as applications of superconductivity, and low temperature calorimetry.

Textbooks, lab manuals and lecture notes:

1. Matter and Methods and Low Temperatures, 3rd ed, Frank Pobell, Springer-Verlag

References (not required texts):

1. An Introduction to Thermal Physics by Daniel V. Schroeder
2. Introduction to Quantum Mechanics, David J. Griffiths

Week	Date	Topic	Read	HW
1	6/22	Introduction, Properties of LH_2	Pobell 2.2	HW 1 assigned
	6/24	LH_2 and LHe **(Quiz 1)**	Pobell 2.3	
2	6/29	LHe **(Quiz 2)**	Pobell 2.3	
	7/1	Discussion of relevant thermal, electrical, and magnetic properties	Pobell 3	Hw 1 due, HW 2 assigned
3	7/6	Discussion of relevant thermal, electrical and magnetic properties **(Quiz 3)**	Pobell 3	
	7/8	Thermal Contact and Thermal Isolation; He4 cryostat, He4 cryostat	Pobell 4.1 to 4.3 , 5.2	HW 3 assigned
4	7/13	Closed Cycle refrigerators **(Quiz 4)**	Notes, Pobell 5.3	HW2 due,
	7/15	Closed Cycle refrigerators **Review; Exam online**	Notes	
5	7/20	Helium 3 cryostat **(Quiz 5)**	Pobell 6.1 and 6.2	HW 3 due, HW 4 assigned
	7/22	3He-4He dilution refrigerator; phase diagram **(Quiz 6)**	Pobell 7.1-7.3	
6	7/27	3He-4He dilution refrigerator; building blocks	Pobell 7.3, 7.4	HW 4 due HW 5 assigned
	7/29	Pomeranchuck cooling **(Quiz 7)**	Pobell 8.1-8.3	
7	8/3	Refrigeration by adiabatic demagnetization of paramagnetic salt **(Quiz 8)**	Pobell 9.1- 9.4	HW 5 due, HW 6 assigned
	8/5	Adiabatic nuclear demagnetization **Review, Exam online**	Pobell 10.1-10.3	
8	8/10	Adiabatic nuclear demagnetization – heat load and heat leak **(Quiz 9)**	Pobell 10.4-10.5	HW 6 due, HW 7 assigned
	8/12	Nuclear refrigerants, hyperfine enhanced nuclear refrigeration, nuclear demagnetization refrigerator	Pobell 10.6-10.8	
9	8/17	Low temperature thermometry **(Quiz 10)**	Pobell 12.1-12.3	HW 7 due
	8/19	**Review, Exam online**		

Assessment:

This course will consist of

- three exams (multiple choice to be completed in class followed by open book/ notes take home long answer/ problem section)
- seven homework sets
- ten quizzes to be completed on PollEverywhere (while in class).

You are **required to take all the three exams and complete all the homework and quiz sets.**

Homework:

Homework assignments will be posted on the Canvas course page as outlined above.

Exams:

There will be **three exams. There will be no final exam**:

Exam 1	**Thursday, July 15, 2021**
Exam 2	**Thursday, Aug 5, 2021**
Exam 3	**Thursday, Aug 19, 2021**

Quizzes:

The twelve quizzes would be spread through out the class session and be accessible through Poll Everywhere. The content for the quiz will be based on assigned reading material and content covered during the lectures.

Scientific Paper:

Only those students who have enrolled for Writing credits will be required to submit a scientific paper on the final day of classes. The topic should be related to application of cryophysics, cryogenic technology or physical phenomena at cryogenic temperatures. Here are the milestones to be completed:

- Week 1 or 2: Topic selection in consultation with the instructor
- Week 7: Draft of the scientific paper (rubric/ guidelines will be provided)
- Week 9: Final paper submission

Credits:

- To qualify for credit in this course ***you must hand-in all eight*** homework assignments.
- **Homework turned in late will attract a penalty of 10%. It will not be accepted if it is more than two days late and there is no valid reason.**

- There will be **no make-up exams**, except in very special circumstances.

Component weighting and Grades:

Three exams	40 %
Homework:	40%
In-class Quizzes	20%

The final grade will be determined based on relative performance. However, there will be a certain minimum threshold performance expected to obtain an 'A' grade, typically securing over 90% of the total points possible.

Review of homework scores and exam scores:

In case you would like your homework answers or exam responses to be reviewed, please turn in your answers **within 24 hours**, as graded. Please be specific and identify which answer(s) needs to be reviewed and why?

Additional Resources:

Conduct:

The University of Washington Student Conduct Code (WAC 478-121) defines prohibited academic and behavioral conduct and describes how the University holds students accountable as they pursue their academic goals. Allegations of misconduct by students may be referred to the appropriate campus office for investigation and resolution. More information can be found online at https://www.washington.edu/studentconduct/

Disability Resource Services:

Your experience in this class is important to me. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please activate your accommodations via myDRS so we can discuss how they will be implemented in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), contact DRS directly to set up an Access Plan. DRS facilitates the interactive process that establishes reasonable accommodations. Contact DRS at disability.uw.edu.

Academic Integrity:

The University takes academic integrity very seriously. Behaving with integrity is part of our responsibility to our shared learning community. If you are uncertain about if something is academic misconduct, ask me. I am willing to discuss questions you might have.

Acts of academic misconduct may include but are not limited to:

- Cheating (working collaboratively on quizzes/exams and discussion submissions, sharing answers and previewing quizzes/exams)
- Plagiarism (representing the work of others as your own without giving appropriate credit to the original author(s))
- Unauthorized collaboration (working with each other on assignments)

Concerns about these or other behaviors prohibited by the Student Conduct Code will be referred for investigation and adjudication by (include information for specific campus office).

Students found to have engaged in academic misconduct may receive a zero on the assignment (or other possible outcome).