Course Information

Course Number:	PHYS 673
Course Title:	Laser Physics
Section:	600
Time:	TBD
Location:	TBD
Credit Hours:	3

Instructor Details

Instructor:	Hans A. Schuessler
Office:	MPHY 442
Phone:	979.845.5455
E-Mail:	schuessler@physics.tamu.edu
Office Hours:	TBD, TBD

Course Description

Absorption and emission of light; optical cavities; molecular spectroscopy; photoelectron spectroscopy; mass spectroscopy.

Course Prerequisites

Graduate classification; instructor's consent.

Special Course Designation

None.

Course Learning Outcomes

At the end of the course, students will be able to

- identify the basic laws and concepts of physics in optical cavities, absorption and emission of light, surface plasmon spectroscopy, and molecular spectroscopy.
- apply the basic laws and concepts of physics in optical cavities, absorption and emission of light, surface plasmon spectroscopy, and molecular spectroscopy.
- implement quantum-enhanced detection methods

Textbook and/or Resource Materials

Recommended

Laser Electronics, 1989 by Joseph T. Verdeysen, Prentice-Hall
ISBN: 0-13-523630-4

Atomic Physics by C. J. Foot
ISBN: 978-0-19-850696-6

Laser Spectroscopy by W. Demtroeder
ISBN: 3-540-10343-0

Molekülphysik by W. Demtroeder
ISBN: 3-486-24974-6

Grading Policy

35% written homework sets
10% in-class homework problem presentation
10% short topic presentation (10 min); week 8
30% longer (~30 minute) lecture presentation; weeks 13-14
15% term paper (week 15)

A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = 0-59

See http://student-rules.tamu.edu/rule07 for information on university-excused absences.

Late Work Policy

Late work will be accepted for university-excused absences, as per student rule 7 (Student Rule 7). Late work will not be accepted for absences that are not university-excused absences unless prior arrangement was made with the instructor.

Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy (Student Rule 7).

Course Schedule

Homework: Assigned problems will be collected every other week.

Homework problem presentation: Students will take turns working the homework problems on the board and leading discussion of the processes and solutions.

Short topic presentation (week 8): During the course of the semester, students will make at least one short presentation on a question from a recent lecture or on current lecture material, as agreed with the instructor.

Lecture presentation (weeks 13-14): As part of one of the course lectures, students will make a (nominal) 30-minute presentation on a subject related to that of the lecture. These lecture presentations will be coordinated in order to distribute them evenly throughout the semester. For extra credit, students may volunteer to make 10-minute presentations at the end of the semester; this can be a review of an advanced chapter in a textbook or a selected journal article, or it can be about a problem being addressed in the student's research if that research is related to the course material.

Term paper (week 15): Students will write a term paper on a course-related, as agreed with the instructor.

wks 1-3	I.	Optical cavities, ray approach for periodic focusing systems (3 weeks)
		A. Ray matrices
		B. Stability criterion and diagram
		C. Optical resonator configurations
		D. Ray tracing in a stable cavity
		E. Astigmatism
		F. Vortex beams
wks 4-8	II.	Absorption and emission of light (5 weeks); *includes short presentations in week 8*
		A. Einstein's A and B coefficients
		1. Definitions
		2. Relation between coefficients
		3. Rate equations and lifetime broadening
		B. Line shape
		1. Homogeneous broadening — Natural line width
		2. Inhomogeneous broadening — Doppler width
		C. Transition rates for monochromatic waves
		D. High resolution laser spectroscopy of atoms
		1. Widths and profiles of spectral lines
		2. Fine structure, hyperfine structures, and isotope shift
		3. Collinear fast beam laser spectroscopy
wks 9-10	III.	Surface plasmon spectroscopy (2 weeks)
		A. Time-line of major discoveries
		B. Surface plasmons — surface mode of electromagnetic waves on a metal surface
		C. Spectroscopy of SPs in nanostructures
		1. Nanoparticles
		2. Gratings, nanostructures
		D. Applications: Sensors, nanophotonics, surface enhanced Raman spectroscopy (SERS)
wks 11-15	IV.	Molecular spectroscopy (5 weeks); *includes long presentations in weeks 13-15 and term papers due at beginning of week 15*

A. Electronic states
B. Rotation and vibrational structure of diatomic molecules
   1. The fixed rotor
   2. The harmonic and anharmonic oscillator
C. Spectra of diatomic molecules
   1. Transition probabilities
   2. Thermal population of molecular levels
D. Experimental techniques of molecular physics
   1. Laser-absorption spectroscopy
   2. Intra-cavity laser spectroscopy
   3. Ring-down and leak-through spectroscopies
   4. Photo-acoustic spectroscopy
   5. Spectroscopy in molecular beams and ion traps
   6. Multi-photon spectroscopy
   7. Time resolved femtosecond pump probe spectroscopy
   8. Coherent control and femto-chemistry
   9. Fourier transform spectroscopy
   10. Frequency comb spectroscopy
   11. Above threshold ionization
   12. Raman spectroscopy

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

Texas A&M at College Station
You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus

Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the 988 Suicide & Crisis Lifeline (988) or at 988lifeline.org Links to an external site..

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items may do so by going to howdy.tamu.edu and clicking on the "Directory Hold Information" link in the Student Records channel on the MyRecord tab. The complete FERPA Notice to Students and the student records policy is available on the Office of the Registrar webpage.

Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees honors and awards received,

participation in officially recognized activities and sports, medical residence location and medical residence specialization.