PHO 241 Introduction to Lasers 3 credits
PHO 242 Introduction to Lasers Lab 1 credit
Fall 2010

Course Description

This course is designed to introduce you to the basic principles of laser physics and to provide you with a working knowledge of the various types of laser systems and their applications. Topics will include: properties of laser light, basic laser principles including stimulated and spontaneous emission, modification of the laser output, laser safety, and an exposition of the various laser types and their application to industry. Non-laser light sources will also be covered, and their operation and characteristics will be compared and contrasted to laser sources. Course lectures will be supplemented with instructor handouts and video demonstrations of laser principles. There is a required laboratory course for students earning the LFOT degree or certificate.

Pre requisites: TCN 105; MAT 186; PHO 101; or permission of the instructor

Texts

- Instructors Notes and Handouts (There is no required text)
- Recommended, but not required: Hitz et al, Introduction to Laser Technology, ed 3 This book was written for company training and has a lot of nice analogies. It's somewhat dated, but easy to read and understand.
- Internet research- the best way to get up-to-date knowledge.
- LIGHT: Introduction to Optics and Photonics (Donnelly and Massa) as needed.
- An online textbook: http://web.phys.ksu.edu/vqm/laserweb/

Attendance Policy

Students are expected to attend all classes, be on time and be prepared. Obviously, if you miss classes you will be at a disadvantage. It is up to you to find out what you missed and make up assignments. Note that most materials are online in the Vista course shell.

Exams, Homework, Paper

There will be two hourly tests and a cumulative final exam. A sheet of equations will be allowed for each exam. *Makeup exams will only be given in the case of serious illness or other bona-fide excuse. Students will be expected to have appropriate documentation to schedule a make-up exam*. Note that the lab is a separate grade from the lecture grade.

A paper is required, describing in detail one type of laser and its applications. You will also give a brief PowerPoint presentation on this laser during the two weeks of the semester. Additional details were be available by midterm.

Homework will be assigned on a regular basis but will not be collected. Tests are based on homework problems.

COMMUNICATIONS

Class communications are by email. Please check your email frequently. No I will not send you a text message. And speaking of communications, **turn off cell phones and pagers during class.**

Students with Disabilities

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact the Disabilities Counseling Services at 383-5240. To avoid any delay in the receipt of accommodations, you should contact the counselor as soon as possible. Please note that I cannot provide accommodations based upon disability until I have received an accommodation letter from the Disabilities Counselor.

TOPICS

Introduction and Physics of Light Sources and Lasers
- energy states
- non-laser sources
- absorption and gain

Basic Principles of Operation
- Parts of a laser
- Laser operation/loop gain
    - Cavity configurations

Test #1

Laser Characteristics
- wavelength: cavity modes, linewidth, longitudinal modes
- TEM modes/modes effects
- Gaussian beam characteristics
- divergence/focused spot size
- coherence (wave optics review)
- polarization (wave optics review)
- CW/pulse (pulse calculations)

Laser Accessories
- creating short pulses: Q switch, cavity dump, modelock
- passive components (windows, filters, splitters, retarders, tuning and wavelength selection, etc)
- active components (e/o and a/o switches, optical amplifiers, modulators, etc)
- non-linear optics (harmonic generators, opos, raman shifter)

Test #2
- Using PowerPoint, as needed
- Types of lasers and applications (student presentations)

Review and Final Exam (cumulative)

Grade Breakdown

Three Exams	60%
Paper and presentation	20%
Other stuff*	20%

*Other stuff includes concept maps and reports from any PBL Challenges, occasionally collected homework, or quizzes if I detect that homework is not being done.

PHO 242 Introduction to Laser Lab
Experiments will be chosen from the following and may include longer term projects.

Basic physics		**Outcomes/students will explain, perform**
absorption coefficient	Beer's law, dependence of absorption on thickness and material	Power measurement, graph and interpret exponential curve, explain importance of medium absorption (and gain) to laser operation
photoelectric effect	Use PE to determine Planck's constant	experimental methods (source/meter issues, zeroing meter), interpret graph and use slope to find unknown (h)
emission and absorption	Gas atomic emission and absorption by solid	Explain emission lines (gas) and absorption band (solid laser rod)
Laser output characteristics		
Brewster's angle	Measure %R for two polarizations	Dependence of reflectance on polarization and implications for material processing
Spiricon Laser Beam Analyzer	Measure beam divergence	Use SLBA to measure beam spatial parameters
OSA	Measure diode laser central wavelength and mode spacing	Use OSA to measure wavelength and power
Fabry-Perot Interferometer	Set up the FP interferometer and measure HeNe mode spacing.	How the FP interferometer is used to measure modes of a laser
Gaussian Beams (fiber probe)	Use an optical fiber to map a Gaussian beam profile	Gaussian beam profile, opto-mech: mounting fiber on translation stage
pulsed lasers	Measure pulse width and height and calculate energy and duty cycle	Use detector with oscilloscope, calibration of detector with power meter
Coherence length	Use Michelson Interferometer to measure coherence length	Importance of coherence length to interference phenomena
Fiber Laser	Measure the effect of changing pump power and output coupler ratio on laser output	Dependence of output power on energy input and feedback
Alignment practice		
Spatial filter	alignment of pinhole	Remove optical noise from HeNe beam
Expander/collimator	Autocollimation/collimation tester	Telescopes to expand or shrink

Zygo lab II	Alignment with beam splitter	beams Hand skills
Mach Zehnder Interferometer		Hand skills
Twyman Green Interferometer		Hand skills
Applications		
Bar code scanner	Read simulated bar code on rotating can	Alignment of source, object, detector; use of oscilloscope
Optical Image Processing	Build and experiment with a 4F optical image processing set up; Study optical Fourier transforms and filters	Alignment
Laser Material Processing	Effects of focal length, speed, power, frequency on engraving quality	

JOB SHADOW: With industry participation, each student will complete a one-day job shadow at a laser-related company. The job shadow will take the place of two lab sessions. More details will be provided later.