PHY 303 : Principles of lasers and their applications

Department of Physics, I.I.T. Kanpur. 2024-25-I

Harshawardhan Wanare, Office: FB 474, Ph: 7885, email: hwanare@iitk.ac.in

Lectures: ~~Wednesday, Friday : 0900-1015 hrs in XXXX~~

Objectives: Lasers are ubiquitous in our daily lives. What makes them from "a solution waiting for a problem" to literally solving a plethora of problems in ever widening range of human endeavour? There is probably no other human invention that has dominated such vast range of domains. In this course we will understand the intricacies of its functioning and focus on a few *student chosen* applications.

Pre-requisites: None; however, familiarity with the Maxwell's equations will be a plus.

Course contents:

1. Introduction to properties of laser radiation: spectrum, coherence etc.
2. Classical theory of dispersion
3. Atomic levels: absorption, spontaneous and stimulated emission
4. Interaction of a 2-level atoms and radiation
5. Einstein A and B coefficients
6. Population inversion and gain media, rate equations
7. Level broadening mechanisms
8. Cavity modes, threshold conditions for lasing, 3-level and 4-level systems
9. Transverse mode structure, optical resonators
10. Pulsed lasers: Q-switching and mode-locking
11. Laser systems: Gas lasers (He-Ne, Ar^+,CO_2); Dye lasers, Solid state lasers (Ruby, Nd-YAG, Ti-Sapphire lasers); Excimer Lasers, Semiconductor lasers
12. Laser applications: Laser cooling, holography, optical communications (Fiber lasers and amplifiers), medical applications, materials processing, and a host of other applications.

References:

1. P.W. Milonni and J.H. Eberly, *Lasers* (Wiley, 1988)
2. O. Svelto, *Principles of Lasers* (Plenum Press, 1977)
3. A. Yariv, *Quantum Electronics*, $3^r d$ edition, (Wiley, 1989)
4. B.B. Laud, *Lasers Lasers and Nonlinear Optics* (A very useful introductory book)
5. B.E.A. Saleh and M.C. Teich, *Fundamentals of Photonics* , (Wiley, 1991)

Course Policies:

1. Attendance: Compulsory
2. Evaluation: Assignment and/or Quiz: 15+15%, Mid-Sem Exam: 30% and End-Sem Exam 40%.
3. We can collectively decide the above breakup and the manner of evaluation in the first class.
4. Send me an email to book an appointment to meet me beyond the class hours.
5. The specific *applications* that will be discussed will be based on your interests and input.