Birla Institute of Technology & Science, Pilani
Hyderabad Campus

INSTRUCTION DIVISION
FIRST SEMESTER 2019-2020
COURSE HANDOUT- Lasers and Applications

Date: 22.07.2019

Course No.	**:**	**PHY F418**
Course Title	**:**	**Lasers and Applications**
Instructor-in-charge	**:**	**ARANYA B BHATTACHERJEE**
Instructor	**:**	**Aranya B Bhattacherjee**

1. Course Description: Main topics to be covered in the course include: Properties of laser light, theories of some simple optical processes, basic principles of lasers, solid-state lasers, gas lasers, semiconductor lasers, free electron lasers, liquid, dye and chemical lasers, dynamics of laser processes, advances in laser physics, Q-switching, mode-locking (active and passive), saturable absorbers, Kerr lens mode locking, non-linear optics, laser spectroscopy, time resolved spectroscopy, multiphoton spectroscopy.

2. Scope and objective: A laser is a device that emits a beam of coherent light through an optical amplification process. There are many types of lasers including gas lasers, fiber lasers, solid state lasers, dye lasers, diode lasers and excimer lasers. All of these laser types share a basic set of components. Ever since the advent of the first LASER (acronym for Light Amplification by Stimulation Emission of Radiation) in 1960, there has been a steady increase in the application of lasers. Applications have kept on becoming more and more diverse as the capability of the lasers have increased. In this chapter we will enumerate and classify many of the applications of lasers and then go on to discuss in more detail some of the more modern applications. Quantum optics is one of the important fields in physics at present and it heavily relies on the use of lasers. The course will start with the concept of what are lasers, decay of excited states, Doppler broadening in gases, cavity radiation, absorption and stimulated emission, laser amplifiers, requirements for obtaining population inversion, Three level systems, Development and growth of laser beams, concepts of Q-switching, mode-locking, pulsed lasers, Nonlinear optics, semi-classical theory of laser,

3.Text Book: Laser Fundamentals, by William T. Silfvast, Cambridge University Press, (2004).

5. Course Plan:

Lecture Number	Learning Objectives	Topics to be Covered	Chapter in the Text Book
1-2	Introduction to Lasers	Definition of laser, basic properties, wavelength regions	1
3-8	Radiative transitions and emission linewidth	Radiative and non-radiative decay of excited states of atoms. Linewidth broadening.	4.1-4.3
9-12	Energy levels	Dielectric laser materials. Semiconductor laser materials	5.3, 5.4
13-20	Absorption and Stimulated Emission	Equilibrium, Radiating bodies, cavity radiation, absorption and stimulated emission	6.1-6.4
21-28	Laser Amplifiers	Absorption and gain, population inversion, saturation intensity, development and growth of laser beam, Exponential growth factors, Threshold requirements	7.1-7.8
29-32	Requirements for obtaining population inversion	Inversion and two level system, three and four level, Transient population inversion, process that destroy inversions.	8.1-8.4
33-34	Laser resonators	Laser cavity modes, Properties of laser modes	10.1-10.3
35-38	Special laser cavity effects	Unstable resonators, Q-switching, mode locking	12.1-12.3
39	Specific laser systems	Helium Neon, Argon-Ion, Dye lasers, Ruby lasers	13.1,13.2, 14.1, 14.2
40-42	Nonlinear optical effects	Second and third order nonlinear process, Nonlinear materials	15.1-15.5

6. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Date, Time	Nature of Component
1.	Mid-Semester Test	60 mins.	30%	NA	Closed Book
3.	Quiz (1)	30 mins	15%	NA	Open Book
4.	Assignment		10%		
5.	Comprehensive Examination	180 mins.	45%	NA	Closed Book

7. Notices: Notices and solutions for examination's question papers will be displayed on the physics department notice board and/or on CMS website.

8. Make-up Policy: Make up may be considered provided a make-up application (for a genuine health issue) forwarded by the Chief Warden is produced. There will be no makeup for Quiz.

Aranya B Bhattacherjee

Instructor-in-charge