

Course Title	Course Code	Number of Study Hours			Year	Level	Prerequisites
		Theoretical	Laboratory	Credit			
Laser and its applications	412PHYS	3	-	3	4 th	7 th	312PHYS

(1) Brief Course Description

This course is designed to provide students with the fundamentals of laser oscillation, its properties and applications. It describes the interaction of photon with matter and covers the essential laser requirements, laser gain media, laser oscillations inside various resonators, and their stability conditions. It also discusses the laser beam characteristics, transformation, and mode structure. It enables students to explore some of the laser types and the related aspects of various technological applications that employ lasers and beam optics.

(2) Course Objectives

This course is designed to provide students with:

- The fundamental concepts and principles of light matter interactions.
- The essential concepts of laser oscillations, its operational requirements and laser beam properties.
- The formulations of laser rate equations in various systems, laser threshold conditions and some of the laser types and their characteristics.
- The adequate analysis of the continuous-wave and pulsed laser operation using appropriate formalisms.
- The criteria of assessment of optical resonator stability and mode structure.
- The basics of some laser applications.

(3) Course Contents

- **Laser Fundamentals:** The nature of light, Blackbody Radiation, The Einstein relations (Emission + Absorption), Rate equations (gain and population inversion), Pumping methods, Three and Four level systems, and Threshold condition of laser oscillation .
- **Laser beam propagation and transformation:** Resonators and stability condition, Laser Modes (transverse and longitudinal modes).
- **Properties of Laser Radiation:** Coherence, Monochromaticity, Directionality, Focusing, and Brightness.
- **Some types of lasers:** Gas lasers {Atomic (He-Ne)- Ionic (Argon)- Molecular (CO₂, Excimer), Solid State Lasers (Ruby, Nd:YAG, Ti:Sapphire), Semiconductor Lasers (GaAlAs), Free electron laser .
- **Laser output:** Q-Switching, Methods of Q-Switch, Mode locking, and Methods of Mode Locking.
- **Laser's Applications:** Optical communication, Metrological and Scientific Application, Medical, Industrial and Military Applications, Commercial and Information Applications, Holography and its Applications.

(4) Assessment Criteria

- Periodic Exams: 40%
- Oral, Student Activity and Essay: 10%
- Final Exam: 50%

(5) Course Teaching Strategies

- Lectures, Reports and Essay Assignments, Homeworks, and Web-based assignments.

(6) Text Book

- Lasers and Electro-optics: Fundamentals and Engineering, Christopher C. Davis, Cambridge University Press, 2nd Ed., 2014

(7) Reference Books

- Principles of Laser, Orazio Sevelto- Translated by *David C. Hanna*, Springer, 5th Ed.2013
- Laser Fundamentals, William T. Silfvast, Cambridge University Press; 2nd Ed. 2008

Approved by:

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