



Learning Optics and Photonics with the Asian Photonics Association

Welcome to learning Laser Engineering and Applications with Dr. Muhammad Hassan Sayyad, Former Professor of Photonics and Dean, Faculty of Engineering Sciences (FES), GIK Institute, Topi, Pakistan.

This course is designed for senior undergraduate and graduate students doing or have done BS, MS and PhD in Electronics Engineering, Mechanical Engineering, Optomechatronics Engineering, Materials Science & Engineering, Optical Engineering, Photonics Engineering and Physics.

The course will comprise both the theory lectures, design, simulation & modeling of fiber lasers.

Please fill out the following registration form to secure your spot in the course:

[Registration Form](#)

APA472 Laser Engineering and Applications (3 Credit Hours) – Spring 2024	
Duration:	15 Weeks
Cost:	Free
Instructor:	Prof. Dr. Muhammad Hassan Sayyad, Former Professor of Photonics and Dean, Faculty of Engineering Sciences (FES), GIK Institute, Topi, Pakistan
Email:	asianphotonicsassociation@gmail.com

Course Introduction

This course covers the laser fundamentals and applications in industry, medicine, military, communication and scientific investigations.

Course Contents

- Atomic and molecular spectroscopy

- Introduction to the Laser
- Laser Theory
- Laser Beam Properties
- Types of Lasers
- Beam Delivery
- Metrological Applications, Introduction to Interferometry
- Interaction of High-Power Laser Beams with Materials, Material Processing Applications of Lasers
- Scientific Applications of Lasers
- Environmental Monitoring using Lasers
- Medical Applications of Lasers
- Optical Information Systems

The above outlines serve only as a rough guideline of the course contents and may be changed as and when deemed necessary by the instructor. The Instructor is at a liberty to best distribute number of lectures to cover the entire course.

Mapping of CLOs & PLOs			
CLOs	Course Learning Outcomes	PLOs	Blooms Taxonomy
CLO1	Solve the problems related to lasing mechanism.	PLO1 Engineering Knowledge	C3 Applying
CLO2	Analyze various types of lasers and related mechanisms.	PLO1 Engineering Knowledge	C4 Analyzing
CLO3	Design lasers-based solutions for different types of applications.	PLO3 Design/Development of Solutions	C5 Evaluating
CLO4	Describe a relevant engineering application of lasers which can be useful for the society.	PLO6 The Engineer and Society	C3 Applying
CLO5	Active participation on the part of the student. Formally present the results of an investigation/project	PLO10 Communication	C5 Evaluating

	related to Laser Applications		
--	-------------------------------	--	--

Assessment methods

The course grading is based on a final oral exam which counts for 80% of the grade and two quizzes during the semester which count for 20% of the grade.

Text and Reference Books

Text books:

1. Silfvast, William T. Laser Fundamentals. Cambridge University press (2004).
2. James T. Luxon and David E. Parker, Industrial Lasers and Their Applications, Prentice Hall (1992)
3. Taylor, Travis S. Introduction to Laser Science and Engineering. CRC Press (2019).

Reference books:

1. Orazio Svelto and David C. Hanna, Principles of Lasers, 4th edition, Springer, (1998)
2. John F. Ready, Industrial Applications of Lasers, Academic Press (1978)
3. Elijah Kannatey-Asibu, Jr., Principles of Laser Materials Processing, John Wiley & Sons, Inc. (2009)
4. Robert Langdon, Understanding Cosmetic Laser Surgery, University Press of Mississippi (2004)
5. David J. Goldberg, Laser Dermatology, Blackwell Publishing (2008)
6. Paras N. Prasad, Introduction to Biophotonics, John Wiley & Sons, Inc. (2003)
Rami Arieli, Laser Adventure, (<http://perg.phys.ksu.edu/vqm/laserweb/>)

Computer Usage

Students are taught the use of Software's for the simulation, modeling, design and analysis of fiber lasers.

Lectures Breakdown

Week	Topic
1	Atomic and molecular spectroscopy (Text Book #1, Chapters 3, 4, 5): <ul style="list-style-type: none"> • Energy levels of free atoms and molecules, term symbols, energy level diagrams and transition selection rules
2	Introduction to the Laser (Text Book #2, Chapters 5): <ul style="list-style-type: none"> • Unique properties of laser light • Requirements for laser action • How the laser works

3	<p>Laser Theory (Text Book #2, Chapter 6):</p> <ul style="list-style-type: none"> • Population inversion • Stimulated emission, Einstein coefficients, Amplification • Power output for CW lasers, Pulsed operation • Two-, three and four-level systems • Rate equations • Line broadening • Q-switching, cavity dumping • Mode locking
4	<p>Laser Beam Properties (Text Book #2, Chapter 7):</p> <ul style="list-style-type: none"> • Optical cavity and laser modes • Laser modes • Beam propagation for stable laser resonators • Unstable resonators
5	<p>Types of Lasers (Text Book #2, Chapter 8):</p> <ul style="list-style-type: none"> • Classification of lasers, classification gas lasers • He-Ne laser • Molecular gas Lasers, Carbon-dioxide (CO₂) laser • Solid-state lasers, Ruby laser, Nd:YAG laser • Dye lasers, semiconductor (diode) lasers • Fiber lasers • Femtosecond lasers
6	<p>Beam Delivery (Lecture slides):</p> <ul style="list-style-type: none"> • The Electromagnetic spectrum, reflection and refraction • Birefringence, Brewster angle, polarization • Mirrors and lenses, Beam expanders, Beam splitters • Beam delivery
7	<p>Metrological Applications, Introduction to Interferometry (Text Book #2, Chapters 9 and 10):</p> <ul style="list-style-type: none"> • Alignment • Gauging, Surface inspection • Optical radar

	<ul style="list-style-type: none"> • Mathematical description of laser light • Michelson interferometer
8	<p>Interaction of High-Power Laser Beams with Materials, Material Processing Applications of Lasers (Text Book #2, Chapters 12 and 13):</p> <ul style="list-style-type: none"> • Materials and laser parameters, laser beam parameters • Basic heat-transfer equation, uniform, constant irradiance model • Energy balance approximation, heating with melting • Material removal, heating with vaporization • Keyhole welding • Surface hardening, Welding, Cutting, Drilling
9	<p>Scientific Applications of Lasers (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Isotope separation, • Nuclear fusion • Laser ablated plasma • Laser-induced break-down spectroscopy
10	<p>Scientific Applications of Lasers (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Isotope separation, • Nuclear fusion • Laser ablated plasma • Laser-induced break-down spectroscopy
11	<p>Environmental Monitoring using Lasers (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Remote sensing and pollution monitoring
12	<p>Medical Applications of Lasers (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Lasers in Medicine and Surgery • Therapeutic Applications of Lasers • Diagnostic Applications of Lasers
13	<p>Medical Applications of Lasers (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Lasers in Medicine and Surgery • Therapeutic Applications of Lasers • Diagnostic Applications of Lasers
14	<p>Optical Information Systems (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Laser beam communications

	<ul style="list-style-type: none"> • Laser scanners, • Optical computing • Laser printing • Optical disk systems
15	<p>Optical Information Systems (Lecture slides and Handouts):</p> <ul style="list-style-type: none"> • Laser beam communications • Laser scanners, • Optical computing • Laser printing • Optical disk systems

Instructor Biography:

Prof. Dr. Muhammad Hassan Sayyad possesses wide multidisciplinary experience of (1) teaching physics, electronics, lasers, optics and Photonics at O-Level, A-Level, Intermediate, Bachelor, Master and PhD students, (2) research supervision to BS, MS/M.Phil and PhD students at the Dublin City University, Government College University Lahore and the GIK Institute of Engineering Science and Technology, He has written several books, published 100 plus research articles, supervised 100 plus BS, MS and PhD students in research.

He has been honored with the Pak-US and Pak-China research projects, focusing on advancing next-generation solar cell technologies, and has served as a visiting scientist in prestigious universities in the United States, China, and Malaysia.

To see the Instructor CV, please click the following link:

<https://sites.google.com/view/cvdrmuhammadhassansayyad/home>