CERTIFICATE IN PHOTONICS & LASERS TECHNICAL SPECIALIST

OPSC 102 LASER SYSTEMS AND APPLICATIONS I

Contact hours: Thirty (30) lecture hours & forty-five (45) laboratory hours – 4 Credit

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Course Description: This is the first of two courses covering more advanced concepts in photonics and the operating principles, output characteristics, diagnostics, and applications for the most widely used laser types. These are described and classified according to their active medium, output wavelength, and applications. The lecture and lab will cover specific types of lasers such as diode-pumped Nd:YAG lasers, carbon dioxide (CO2) lasers, and fiber lasers. Requirements OPSC 100, OPSC 101.

Competences / Objectives:

At the end of the course, the student will develop and apply the skills to:

1. Understand why some lasers are appropriate for certain applications.
2. Identify which laser systems are used in various technology areas.
3. Select one or two types of lasers that are suitable for a particular application.
4. Manage, read, and understand specifications and other information available for commercial laser systems.
5. Describe what are the facility requirements, utility services and safety requirements for installing a commercially available laser system in a commercial, laboratory, or industrial setting
6. Measure the output characteristics of a laser.
7. Engage in basic troubleshooting of laser equipment.
8. Recognize the applications of the specific types of lasers studied to different industries and the used of these systems to address the needs of society at large.
9. Access information sources related to photonics and lasers effectively and use this information ethically and legally.

Course Content:

a. Laser Q-Switching, Mode Locking, and Frequency Doubling
Q-Switching: Basic Principles and Techniques
Mode Locking: Generation of Ultra-Short Pulses
Frequency Doubling in Nonlinear Materials

b. Laser Output Characteristics
Laser Beam Characteristics
Optical Detectors
Measurements

c. Laser Types and Applications

Laser Materials, Excitation, Structure, and Output
Laser Types

d. CO2 Lasers and Their Applications
Molecular Energy Levels
CO2 Laser Composition and Energy Processes
Continuous Wave CO2 Lasers
Intracavity Devices for CO2 Lasers
Applications of CO2 Lasers

e. Fiber Lasers and Their Applications
Basic Structure of Fiber Lasers
From Pump to Output
Master Oscillator Power Amplifier
Pulsing Methods
Output Characteristics of Fiber Lasers
Advanced Structures
Fiber Laser Applications

LABORATORY - LASER SYSTEMS AND APPLICATIONS I

This first Laser Systems and Applications course will introduce the student to the theory and practice of CW and pulsed lasers. At the end of the course, the student will understand the principles of laser operation, safety guidelines, measurement of output beam characteristics, basic troubleshooting, and applications. This will allow the student to understand and operate lasers in research, commercial, and industrial settings, and will give him or her the skills to choose appropriate laser systems and the knowledge to setup and operate them.

Laboratory Content

a. Laser Q-Switching, Mode Locking, and Frequency Doubling
Operation of a Diode-Pumped Nd:YAG Laser
Operation of a Diode-Pumped Q-Switched Nd:YAG Laser

b. Laser Alignment
Safety Procedures
Alignment of an Open-Cavity HeNe Laser

c. Measurement of Laser Output Characteristics
Measuring of Beam Power
Measurement of Focused Beam Power
Measurement of Beam Profile
Measurement of Divergence of a laser beam
Measurement of Divergence at a focal point

d. Measurement of Laser Output of a CO2 Laser
e. Measurement of CW and Pulsed Output from a Fiber Laser

f. Measurement of Beam Diameter and Beam Divergence

Grading Policy:

30%	Two (2) partial exams
20%	Homework and class presentations
30%	Laboratory logbook
20%	One (1) comprehensive final exam

Textbook: National Center for Optics and Photonics Education OP-TEC. (2014). *Laser Systems and Applications*. Waco, TX: OP-TEC.

References:

a. Printed Resources

Antsiferov, V. V., & Smirnov, G. I. (2005). *Physics of Solid-state Lasers*. Cambridge: Cambridge International Science Publishing.

Desmet, E., & Thys, M. (2011). Laser Beams : *Theory, Properties, and Applications.* Hauppauge, N.Y.: Nova Science Publishers.

Ghafouri-Shiraz, H. (2004). *The Principles of Semiconductor Laser Diodes and Amplifiers : Analysis and Transmission Line Laser Modeling*. London: Imperial College Press.

Khanin, I. I. (2006). *Fundamentals of Laser Dynamics*. Cambridge: Cambridge International Science Pub

b. Audiovisual Resources

Arieli, R. (1999, January 10). The Laser Adventure. [Video file]. Retrieved from https://perg.phys.ksu.edu/vqm/laserweb/

OP-TEC. (Producer). (2014). Laser Systems and Applications: Course 2: Laser Systems and Applications. [Video file]. Retrieved from http://optecvideo.opteccrm.org/laser-systems-and-applications/lab-videos/index.html

Students with Special Needs (ADA):

Students receiving Vocational Rehabilitation services, who present evidence, should communicate with his/her professor at the beginning of the semester to arrange for reasonable accommodations and the necessary assistance equipment. Any student needing any special accommodations should communicate these needs to the professor during the first week of class.

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