CERTIFICATE IN PHOTONICS & LASERS TECHNICAL SPECIALIST

OPSC 101 FUNDAMENTALS OF LIGHT AND LASERS

Contact hours: Forty-five (45) lecture hours & sixty (60) laboratory hours – 5 Credit

Prepared by: **Dr. Andrés Díaz – 2014**
Revised by: Dr. Jonathan Friedman, Dr. Andrés Díaz
María C. Ortiz, Dean School of Environmental Affairs - 2015

Course Description: Fundamentals of Light and Lasers is the introductory course in the Certificate in Photonics and Lasers, and consists of a comprehensive study of photonics that provides the foundation required to prepare technicians in the areas of optics, electro-optics, lasers, and photonics. In this course, students will learn the basic physical principles of optics (geometric and physical optics) and in the lab they will develop the skills required to properly handle optical devices and components and to safely and efficiently manipulate laser beams.

Competences / Objectives:

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

1. Set-up optical systems involving light sources, optical components, and sensors, on vibration-fee tables, and correctly handle all optical components.
2. Understand the hazards of nonlaser and laser optical sources, and the ways to avoid and minimize any danger to the eye and the skin.
3. Develop physical and mathematical connections useful in explaining everyday optical phenomena.
4. Understand how laser light is generated, and how it differs from other types of light sources.
5. Maintain an individual logbook to record in an organized a systematic way all the procedures, data, and conclusions of each experiment.
6. Recognize the importance of optics, photonics, and lasers in present-day technology and their contribution to society.
7. Access information sources related to photonics and lasers effectively and use this information ethically and legally.

Course Content:

a. Nature and properties of Light
- Properties of Light
- Light Interactions

b. Optical Handling and Positioning
- Laboratory Mountings
- Positioning Equipment
- Surface Quality of Optical Components
- Inspection Methods and Procedures
- Care and Cleaning of Optics

c. Optical Materials and their Properties
- Bulk Optical Materials and Their Properties
- Optical Coatings and Methods of Coating Deposition

d. Light Sources and Laser Safety
- Properties of Non-laser and Laser Light Sources
- Non-laser light sources
- Concepts of Laser Safety
- Laser Safety Standards and Safety Classifications

e. Basic Geometrical Optics
- Laws of Reflection and Refraction
- Image Formation with Mirrors
- Image Formation with Lenses

f. Basic Physical Optics
- Light Waves and Physical Optics
- Interaction of Light Waves: principle of superposition and wavelets
- Interference
- Diffraction
- Polarization: Law of Malus, Brewster angle and Brewster windows

g. Principles of Lasers
- Generation of Laser Light
- Optical Cavities and Modes
- Laser Beam Characteristics
- Brief Description of Different Types of Lasers

LABORATORY - FUNDAMENTALS OF LIGHT AND LASERS

This Optical Science course will introduce the student to the basic physical concepts and lab techniques that will be required for the technical courses of the certificate program in Photonics, Lasers, and Fiber Optics. This is done by a lecture component and a hands-on laboratory component that will provide the students learning opportunities to build the technical skills in working with lasers and optical components. These skills will have direct practical application in the areas of optics, lasers, photonics, and in fields such as biomedical equipment, manufacturing, defense, nanotechnology, and communications where photonics is an enabling technology.

Laboratory Content

a. Fundamentals of laboratory safety

b. Nature and Properties of Light
- Finding the speed of red light in optical-grade plastic
- Finding the wavelength of red light
- Spectrum of colored light
- Polarization of light

c. Optical Handling and Positioning
Familiarization with optical equipment and components
Care and cleaning of high-grade optical components
Building a simple spectrometer

d. Light Sources and Laser Safety
Measuring power and irradiance
Laser eye protection equipment
Fresnel reflection and measurement of reflection and transmission coefficients
Optical filters
Using an optical photometer

e. Basic Geometrical Optics
Prisms and Lenses: determine index of refraction and focal length
Optical Alignment Techniques
Law of Reflection
Lenses: measure real images formed by converging lenses

f. Basic Physical Optics
Working with Diffraction Patterns, Wavelengths, and Polarization
Measurement of Interference and Diffraction
Experiments with Polarization

g. Principles of Lasers
Measurement of Beam Diameter and Beam Divergence
Laser Basics
Measurement of Operating Efficiency of Helium Neon Lasers

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

The learning assessment policy and related tools may be accessed at: http://www.suagm.edu/umet/vicerrectoria_opai_papara.asp

Textbook: National Center for Optics and Photonics Education OP-TEC. (2013). *Fundamentals of Light and Lasers* (2nd ed.). Waco, TX: OP-TEC.

References:

a. Printed Resources

Hecht, E. (1998). *Optics. Reading, Mass.*: Addison-Wesley Publishing, 1998.

Papoyan, A. V., Gurzadian, G. G., Kryuchkyan, G. Y., & Erevani Petakan, H. (2010). *Modern Optics and Photonics: Atoms and Structured Media*. Singapore: World Scientific.

Sharma, K. K. (2006). Optics: *Principles and Applications*. Amsterdam: Academic Press.

b. Audiovisual Resources

CORD. (Producer). (2010). *Mathematics for Photonics Education: Scientific Notation*. [Video file]. Retrieved from http://optecvideo.opteccrm.org/mini-tutorial-videos

CORD. (Producer). (2010h). *Lab Activities* Videos. [Video file]. Retrieved from http://optecvideo.opteccrm.org/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.

Equal Opportunity: Universidad Metropolitana (UMET)provides equal education and employment opportunities and does not discriminate on the basis of race, color, religion, sex, gender, gender identity, real or perceived sexual orientation, national origin, military status, status as protected veteran, physical or mental disability, social condition, age, marital status, political ideologies, domestic violence or sexual attack victim status, or any other characteristic protected by federal, state, or local law. Disabilities: Services are available to students who may need accommodations, interpreters, and/or specialized equipment. All student requests are dealt in confidential manner.

The Certificate in Photonics & Lasers Technical Specialist is part of New Horizons: Puerto Rico Lasers and Photonics Career Pathways, a project funded by the United States Department of Labor – Employment and Training Administration – Trade Adjustment Assistance Community College and Career Training Grant (TAACCCT) Round 4. TC-26472-14-60-A-72. The program materials were created by Puerto Rico Photonics Institute (PRPI)/UMET and do not necessarily reflect the official position of the U.S. Department of Labor.