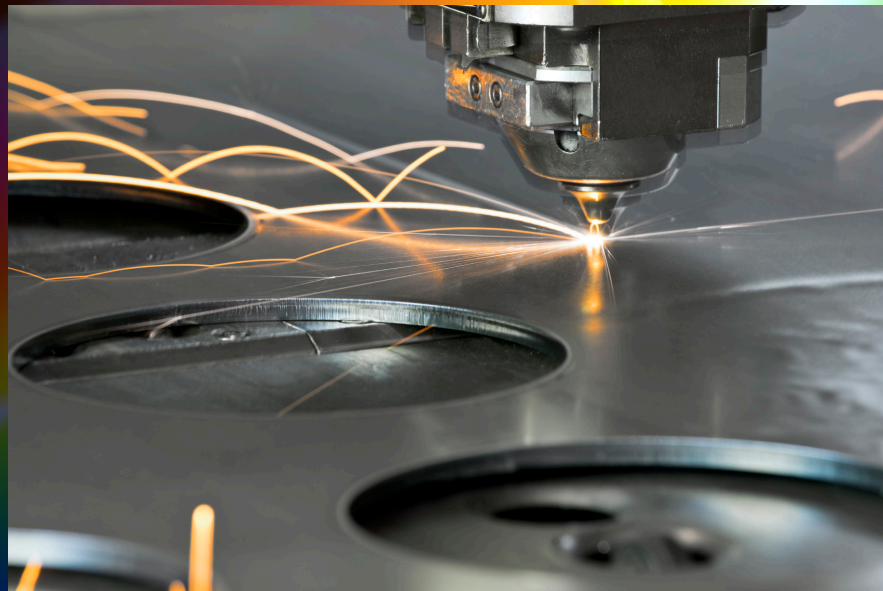


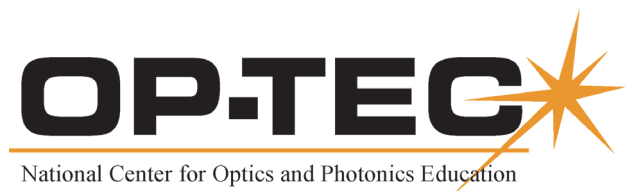
The National Skill Standards for Photonics Systems Technicians



OP-TEC 

THE NATIONAL SKILL STANDARDS FOR PHOTONICS SYSTEMS TECHNICIANS

January 2018



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PREFACE

In the last two decades photonics (optics, lasers and electro-optics) has grown from a specialized technology to an “enabling technology, which means that lasers, LEDs, electro-optical systems and optics are used in a wide variety of equipment, devices and processes: either as the critical (enabling) element, or to improve the performance of the equipment or process. As the nature of the technology has changed, so have the education and skill requirements for photonics technicians. Today there are three types of photonics-related technicians:

- **Laser/Electro-Optical (LEO) Specialist Technicians: for Research and Development Labs, and for Laser Original Equipment Manufacturers (OEMs)**

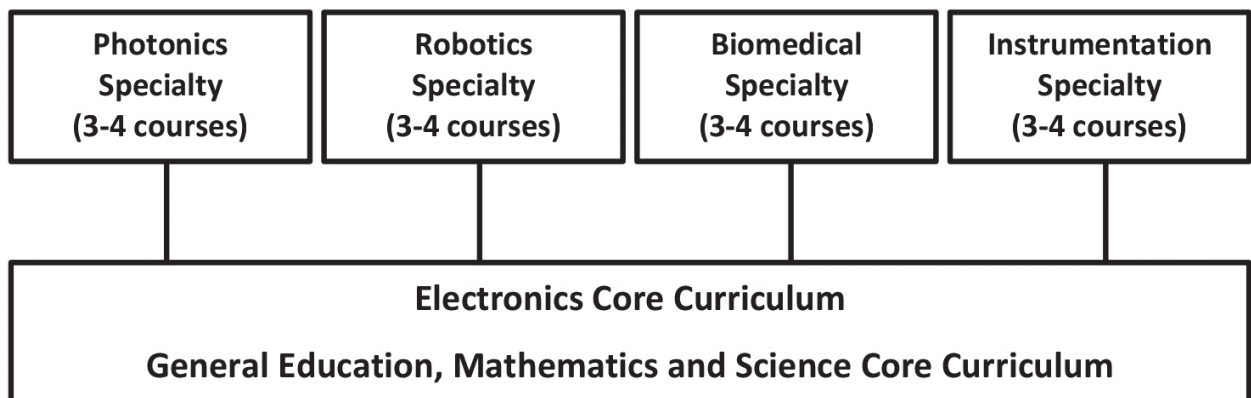
Three decades ago nearly all employers required photonics specialist technicians, and all the AAS degree programs in the country (as many as twenty-five) used LEO curricula that included 8-10 photonics courses in full AAS degree programs. Most of the colleges with LEO programs employed 2-3 LEO faculty and over \$2 million in lab equipment. In the 21st century less than 20% of the photonics technician jobs require LEO specialists. And only three or four colleges continue to offer those AAS degree programs.

- **Application Technicians: Technicians Educated and Trained in Other Fields Where Photonics is an Enabling Technology**

These fields include manufacturing, materials processing, medical instrumentation and fiber optic/communications. Technicians in these fields typically operate lasers or other electro-optics devices, and benefit from completing an elective course in the “Fundamentals of Lasers and Optics.” Colleges that prepare technicians in manufacturing, materials processing, medical instrumentation, etc., frequently include one or two elective courses in lasers, optics and specific applications of lasers/optics to the major field of study.

- **Photonics Systems Technicians (PSTs): Integrating and Using Photonics in Larger Systems**

PSTs are in the greatest demand; they are qualified for over 80% of the photonics technician jobs in the U.S. Similarly, over 80% of the two-year colleges that offer education for photonics technicians are adopting the PST curriculum model. Most of these colleges are attempting to offer three or four photonics courses as one specialty field in electronics programs.



Skill standards are the “employer specifications” that can be used to design curricula and develop teaching materials for educating and training technicians. The original Photonics Skill Standards was developed in 2001 and updated in 2008.¹ It was based on the knowledge and skills needed for LEO Specialist Technicians.

In 2010, OP-TEC recognized the growing employer demand for Photonics Systems Technicians, as well as the need for colleges to offer a simplified curriculum that could be delivered in a more cost-effective manner, using fewer dedicated photonics faculty and lower-cost laboratories. OP-TEC initiated the transition to PSTs by meetings with employers of photonics technicians and experienced photonics faculty. Focus groups of employers and faculty were organized and convened at the 2013 Photonics West national conference. OP-TEC staff and several senior photonics faculty presented proposed drafts of PST job descriptions and critical work functions. These drafts were reviewed and revised by the focus groups. Subsequently, OP-TEC submitted the draft PST standards to a wide range of employers for further review and validation. The Standards in this document are the result of the validation process.

Subsequently, OP-TEC created curriculum models for PSTs, revised/developed/tested teaching materials to support the specialty courses and prepared a PST Curriculum Planning guide.²

Daniel Hull, PI

2018

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¹OP-TEC/CORD. *The National Photonics Skill Standards for Technicians, 3rd Edition*, 2008.

² University of Central Florida /OP-TEC. *Photonics Systems Technician Curriculum Guide*, 2018.

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HOW TO USE THE PHOTONICS SYSTEMS TECHNICIANS SKILL STANDARDS

The National Skill Standards for Photonics Systems Technicians are intended to define the basic knowledge and skills of technicians who may work in any specific photonics application, such as fiber-optic communications, manufacturing/materials processing, defense/aerospace, medical equipment, university research labs, energy/environmental, integrated photonics, etc.

The Skill Standards are composed of three elements:

- A broad job description of a Photonics Systems Technician
- Seven Critical Work Functions with Specific Work Assignments under each Critical Work Function
- Soft Skills, or “Employability Skills”

The Critical Work Functions and specific work assignments provide the information that is needed to identify the technical content and competencies for designing and developing the photonics specialty courses. The required math, science, communications and related technologies are determined from the photonics technical specialty courses.

Specific, in-depth knowledge and skills for technicians working in one or more photonics applications may require additional coursework or on-the-job training. Colleges serving employers with a concentration in one of the application areas are encouraged to provide the National Skill Standards for Photonics Systems Technicians to their employer advisory committee and solicit recommendations for additions or modifications to their curriculum plan.

The National Skill Standards for Photonics Systems Technicians

Job Description

- Photonics systems technicians (PSTs) work in industries whose processes and operations require the extensive use of optics and photonics components, equipment and devices to meet production or mission goals. Where photonics is an enabling technology, PSTs frequently integrate optical and photonics devices or subsystems into larger systems. PSTs have the responsibility of ensuring these devices operate within prescribed specifications with proper safety considerations, and are compatible and/or complementary with the entire integrated system.
- These technicians must know how optical and photonic devices operate and interface with the equipment or systems in which they are embedded. They must also understand how optics, photonics devices and subsystems enable equipment and systems to accomplish specific tasks.
- PSTs must have broad, working knowledge and skills of optics as well as electronics, controls, optomechanical and electromechanical devices/systems and basic laser/electro-optical safety, combined with their specialty knowledge and skills in photonics to efficiently and effectively repair systems, and operate, maintain, and calibrate photonics subsystems, and integrate these subsystems into full systems.

Critical Work Functions

1. Measure characteristics of passive optical components, as well as their support and manipulating equipment.
 - A. Identify, maintain, measure, and use prisms, mirrors, wedges, polarizers, filters, gratings, attenuators, waveguides, etc.
 - B. Identify, maintain, and use plates, optical benches, rails, vibration-isolated tables, and other optomechanical components and equipment.
 - C. Identify, maintain, and use holders of optical components, mounts, translation stages.
 - D. Measure focal lengths, grating size, spot size, beam profiles, and beam divergence.
 - E. Clean and store optics and optical support equipment.

2. Perform optical alignments, testing, installation, maintenance and operations for optical and photonics systems
 - A. Establish optical axis, and position/align components to function along the axis according to specifications
 - B. Measure and control beam alignment and output power stability
 - C. Use and troubleshoot photometers, burn paper, and other methods for measuring beam characteristics
 - D. Maintain and use spectrometers and interferometers, beam-shaping devices, laser beam delivery systems, and other passive optical systems
 - E. Determine and control efficiency of beam delivery optics and light coupling (input/output) between devices
3. Measure output characteristics of lasers and other light sources.
 - A. Measure and analyze temporal characteristics: pulse shape, pulse duration, stability and pulse repetition frequency
 - B. Measure and analyze spatial characteristics: beam diameter, beam profile, divergence
 - C. Measure and analyze spectral characteristics: wavelength, bandwidth, operational (TEM) modes
 - D. Use and maintain the following equipment: detectors, power meters, beam scanners, modulators, spectrometers and associated electronic equipment
4. Operate and maintain lasers and other photonics devices
 - A. Operate and maintain the following laser types: HeNe, CO₂, YAG, diode, fiber, excimer, argon
 - B. Operate and maintain modulators for CW, pulsed, Q-Switched, mode-locked, and frequency doubled operation
 - C. Operate and maintain beam scanners and pointers
 - D. Calibrate, trouble shoot and repair electronic equipment such as power supplies, meters, and controllers
 - E. Measure input/output characteristics of electronic and photonics devices and compare them to performance specifications
 - F. Calibrate or adjust parameters to control laser output
 - G. Communicate with manufacturer to service, calibrate and/or repair laser systems, or arrange for replacements
5. Operate and maintain other optical and light-emitting devices
 - A. Operate and maintain spectrometers, interferometers, microscopes, trackers, scanners, sensors, etc.
 - B. Operate and maintain LEDs, diodes, lamps, etc.

- C. Calibrate, adjust, modify, and repair aforementioned devices as required
 - D. Communicate with manufacturer to repair or replace devices when necessary
6. Integrate optics and lasers into systems to serve in photonics applications
 - A. Determine or assure electrical compatibility
 - B. Determine and/or assure optical compatibility and proper alignment
 - C. Determine and assure environmental compatibility
 - D. Design, build, and/or install appropriate input/output interfaces between electrical systems, and between optical/electro-optical systems
 - E. Assure mechanical/structural compatibility
 - F. Measure and control optical input/output devices
 - G. Measure integrated system to assure proper operation
 - H. Understand, control, and assure safety of basic laser beam and non-beam hazards
 7. Maintain a clean and orderly lab environment
 - A. Organize and clean work area and equipment
 - B. Record procedures and notes in a logbook
 - C. Minimize trip hazards and other impediments in a lab environment
 - D. Follow clean room procedures as instructed

Soft Skills

Employers highly value employees who are knowledgeable and experienced in project management, because they have acquired the following “soft skills”:

- Leadership
- Planning
- Goal setting
- Teamwork
- Scheduling and time management
- Resource management (making maximum use of available time, budgets and effective tools)
- Setting and adhering to standards of quality in their work

Group projects and other tasks that facilitate these types of skills are encouraged as part of any curriculum.