APPENDIX A
WORK PROCESS SCHEDULE

ON-THE-JOB TRAINING OUTLINE
RELATED INSTRUCTION OUTLINE

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Appendix A

WORK PROCESS SCHEDULE
Photonics Technician
O*NET-SOC CODE: 17-3029.08 RAPIDS CODE: 2045CB

This schedule is attached to and a part of these Standards for the above identified occupation.

APPRENTICESHIP APPROACH

☐ Time-based ☒ Competency-based ☐ Hybrid

TERM OF APPRENTICESHIP

The term of the apprenticeship is 3 years with an OJL attainment of approximately 6,000 hours, supplemented by the minimum required 486 hours of related instruction.

RATIO OF APPRENTICES TO JOURNEYWORKERS

The apprentice to journey worker ratio is: 1 Apprentice(s) to 1 journey worker(s).

APPRENTICE WAGE SCHEDULE

Apprentices shall be paid a progressively increasing schedule of wages based on either a percentage or a dollar amount of the current hourly journeyworker wage rate, which is: $21.00

2,000 hours: $17.00

2,000 hours: $18.00

2,000 hours: $19.00

PROBATIONARY PERIOD

Every applicant selected for apprenticeship will serve a probationary period of 90 days.

SELECTION PROCEDURES

The sponsor has adopted the following selection procedures, consistent with the requirements set forth in 29 CFR § 30.10(b):

A. Employer posts available jobs on the ApprenticeshipNH website, New Hampshire Works Job Match System, other web-based job search engines such as Indeed.com and notifies recognized pre-apprenticeship organizations of current openings.

B. The Community College System of New Hampshire, under the Apprenticeship State Expansion grant, provides an information session(s) to discuss the registered apprenticeship program, the expectations, and the training provided for the selected occupation.

C. Names of candidates who attend the information session are forwarded to (Business) and the attendees are all encouraged to apply by completing an application with (Business).

D. Prior to the interview, each applicant will be given the option to review the Apprenticeship Standards and will be provided information about the program. If the applicant has any additional questions on the qualifications or needs additional information, it will be provided by the sponsor.

E. The Sponsor will schedule interviews based upon hiring needs. The most qualified applicants who meet or exceed the minimum requirements will be contacted to participate in an interview with the HR Manager where the HR Manager will ask a standard set of questions.

F. Applicants who do not meet the minimum qualifications and are not selected, will receive an email notifying them they were not selected for an interview.

G. Applications of candidates who do not meet the minimum requirements are stored in a secure location for five years.

H. Applicants who successfully complete a pre-apprenticeship program recognized by (Business) will be invited to an interview with the hiring manager.

I. During the interview, the interviewer will ask standardized questions to be answered by candidates. Non standard questions will also be asked if the conversation progresses in a specific interest.

J. Candidate responses are kept by written record along with notes by the interviewer.

K. Interview notes are kept on file along with the application for five years.

L. After the interview is conducted, the interviewer will meet with the COO and/or Management Team to review applicant's answers, application and notes. Based on these results, the Interviewer and COO will decide who to hire.

M. Candidates who meet these criteria will be notified of a formal offer of employment contingent upon passing a pre-employment drug screen and physical. Candidates will have up to five days after an offer is made to accept the position.

N. Candidates who are not being hired for the apprenticeship will be notified within two weeks from their last interview.

O. Hired apprentices will be required to pass a pre-employment physical during their first work week and complete onboarding orientation which includes but is not limited to, a review of the company handbook, review of employee benefits and safety training and will be filed electronically through the company's payroll and admin system.

Appendix A

ON-THE-JOB TRAINING OUTLINE
PHOTONICS TECHNICIAN
O*NET-SOC CODE: 17-3029.08 RAPIDS CODE: 2045CB

Occupational Description: Optics manufacturing technicians produce and inspect precision optical components, apply optical coatings, and assemble optical systems that are used in a broad range of applications, including but not limited to: defense, homeland security, aerospace, biomedical equipment, microlithography, digital displays, alternate energy production, and nanotechnology.

Critical Work Function 1: Identify, inspect, and qualify materials for manufacturing optical components.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Determine material requirements as defined by blueprint specifications. b. Inspect and accurately evaluate material certification sheets to match print specifications. c. Ensure physical safety in handling hazardous materials by marking material containers with appropriate material safety data sheet (MSDS) identifications. d. Follow material handling procedures to ensure physical safety, avoid contamination, and maintain material inventory and identification. **e.** Maintain prescribed documentation of bulk materials using a job jacket or its equivalent.			
Critical Work Function 2: Participate in the planning and verification of optical fabrication processes.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Use design specifications, technical drawings, and/or government documentation to meet specifications and tolerances. b. Use basic processing techniques for producing plano, cylindrical, spherical, and aspheric optics.			

c. Assist and advises in the selection of fabrication processes and their sequencing. d. Recommend process changes to increase quality, improve efficiency, and reduce production costs. e. Identify standard operating and safety procedures of the optics shop and equipment required in the process. f. Document process changes and non-conformances and may identify preventative and corrective actions to improve process control.			
Critical Work Function 3: Shape and finish bulk materials to generate optical components.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Determine and perform procedures for measuring, tooling, blocking, generating, shaping, beveling, grinding, polishing, and centering. b. Practice accepted procedure for handling optical materials. c. Apply appropriate procedures for processing a variety of optical materials such as glass, crystals, optical ceramics, and plastics. d. Measure and accurately records dimensionality to ensure adherence to specifications and tolerances. **e.** Properly clean, store, secure, document, package, and transports the finished optical components to ensure their integrity and proper identification.			

Critical Work Function 4: Operate, maintain, and calibrate optics manufacturing and testing equipment.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Apply accepted standards to maintain work area cleanliness. b. Inspect and maintain equipment, per prescribed schedules, to ensure optimal use and productivity and document these efforts. c. Use the work instruction template to verify set points in the control screens. d. Detect malfunctioning equipment and adjust or repair as necessary and/or notify appropriate work personnel. e. Identify health hazards associated with specific material and process and use accepted practices to ensure health of self, others, and the environment.			
Critical Work Function 5: Conduct optical metrology measurements and inspections for in process work and final distribution.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Coordinate with quality assurance to ensure compliance to design specifications and documentation requirements. b. Inspect surface quality of finished product to comply with appropriate scratch-and-dig standards as specified on the component drawing or specification sheet. c. Measure the processed surfaces or components using appropriate equipment (e.g., profilometer, optical comparator, coordinate measuring device, micrometer, or drop gage). d. Determine and select, using written instructions and specifications,			

appropriate packaging for protecting, storing and shipping optics.			
Critical Work Function 6: Assemble optical components and systems (e.g., cemented and air-spaced doublets and triplets).	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
Critical Work Function 7: Apply anti-reflectance coatings to optical components.	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Interpret drawing for coating specifications. b. Clean and inspect optics for coating using accepted procedures. c. Load and properly operate coating equipment to apply thin film coatings using prescribed procedures. d. Operate spectrometer to test coating performance on witness samples and verify results with drawing specifications.			
TECHNICAL SKILLS **General Proficiencies (Demonstrated Abilities)**	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Understand and use basic mathematical concepts to include fractions, decimals, ratio, proportion, powers and algebra principles. b. Use and convert metric and English units, and use of scientific notation. c. Use of angle measurements in degrees, radians, minutes, and seconds. d. Apply procedures of geometry and trigonometry to optics. e. Use hand calculators and computers proficiently. f. Operate common machine shop equipment for metals such as lathes, band saws, drill presses, and milling machines.			

Planning (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Accurately identify the shapes of various optical components and their use in an optical assembly/system. b. Read and interpret technical drawings and specifications. c. Use quality assurance criteria to determine deficiencies in materials and optics using established design specifications. d. Incorporate basic project management strategies in developing production plans. e. Use basic cost estimation techniques to determine cost vs benefit factors.			
Material Selection (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Determine optical, chemical, thermal and mechanical properties of selected materials from handbooks, supplier specification sheets, and Internet sources, and assess their relevance to specified manufacturing processes. b. Apply chemical safety procedures to chosen optical materials and solvents. c. Evaluate physical property of materials for hardness, cleavage, fracturing and chemical stability and assess their relevance to specified manufacturing process. d. Identify physical and environmental hazards associated with various optical materials and the solvents used to process them. e. Measure and analyze homogeneity of materials using interferometry techniques.			

Optical Fabrication (Demonstrated Abilities)	Date: Rating:	Date: Rating:	Date: Rating:
a. Use a loupe to identify bulk material defects such as inclusions, bubbles, striae, and fractures. b. Use polarization measurement techniques to identify internal stress. c. Use appropriate hand tools (e.g., calipers, micrometers, depth gauges, spherometers) during fabrication and inspection of optical components. d. Optimize fabrication tools and parameters to increase efficiency and quality. e. Prepare fixtures for mounting starting material as part of the fabrication process. f. Determine the interaction between various material used in high tolerance optics fabrication such as hot pitch and acetone. g. Inspect finished optical components to ensure compliance with established specifications.			
Optics Inspection (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Measure deviations from specifications in dimensionality and surface quality and roughness. b. Measure surface quality using appropriate equipment (e.g., scratch-and-dig inspection box, microscope, loupe, and magnifiers). c. Measure surface roughness with appropriate equipment (e.g., white light interferometer, laser surface profiler).			

d. Use quality assurance criteria to determine deficiencies in materials and optics using established design specifications.			
Clean Room and Assembly (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Use established procedures for personnel gowning for clean room operations, including booties and beards. b. Use proper procedures for entering and exiting air locks and door locks in a clean room facility. c. Interpret clean room Class Ratings required in optics fabrication (e.g., Class 100, 1000, and 10,000). d. Monitor air flow filtration, room pressure, air velocities, temperature and relative humidity of clean rooms. e. Clean optics to specifications using proper techniques. f. Store optics in appropriate container with environmental controls. g. Align physical and optical centers following specifications. h. Inspect finished products following accepted procedures to ensure compliance with established specifications.			
Thin Film Coatings (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Identify the function of anti/reflection and protective thin film coatings on optical surfaces. b. Prepare optics for thin film coatings by cleaning optical surfaces requiring a coating. c. Interpret drawings for coating specifications to determine proper coating materials.			

d. Operate vacuum systems used for coating optics. e. Use fixtures for mounting optics in coating chambers. f. Select appropriate coating procedures and operate coating equipment. g. Use proper sensors to monitor film properties during coating processes. h. Operate spectrometer to test coatings on witness sample.			
Maintenance and Tooling (Demonstrated Abilities)	**Date:** **Rating:**	**Date:** **Rating:**	**Date:** **Rating:**
a. Apply appropriate maintenance instructions from manufacturer's equipment manuals. b. Maintain and prepare pumps and conduits to properly deliver slurry and coolant to work surfaces.			

EVALUATING PERFORMANCE SCALE

This rubric is an example that may be used to rate apprentices:

Rating	Definition
0	**Learning:** Apprentice has not learned this through RTI or OJL.
1	**Understands:** Apprentice can explain and discuss issues and concepts; has studied applications; and is familiar with this function, competency, and performance indicators of this occupation.
2	**Developing:** Apprentice integrates relevant knowledge and skill, and demonstrates this performance indicator with a limited degree of consistency in routine tasks.
3	**Competent:** Apprentice applies relevant knowledge and skill, and demonstrates this performance indicator with consistency in routine interactions and responsibilities.
4	**Skilled:** Apprentice demonstrates, applies, and integrates relevant knowledge and skills, and demonstrates this performance indicator with a high degree of consistency and effectiveness in most situations.
5	**Master:** Apprentice is especially skillful in demonstrating, applying, and integrating relevant knowledge and skills, and demonstrates this performance indicator with a high degree of consistency and effectiveness in routine and complex situations.

Level 3 ratings are expected for each performance indicator within each competency for successful completion of an apprenticeship program.

Levels 4 and 5 ratings should only be used occasionally to describe exceptional performance.

Appendix A

RELATED INSTRUCTION OUTLINE
PHOTONICS TECHNICIAN
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Manchester Community College

Class Number	Class Name	Credits	Hrs/Wk Class	Hrs/Wk Lab	Total Hours
ADMT110M	Manufacturing Processes	3	2	3	75
MATH155M	College Algebra with Trigonometry	4	4	0	60
PHYS135M	College Physics 1	4	3	3	90
ADMT115M	Engineering Print Reading	3	2	3	75
ADMT135M	Basic Machining Practices	3	1	5	90
ADMT118M	Electrical Fundamentals of Manufacturing	4	3	3	90
				TOTAL MINIMUM HOURS	**480**

Course Curriculum Outline or Course Descriptions:

ADMT110M	**Manufacturing Processes**

Students will explore the manufacturing process not only as a sequence of material manipulation but also as a product of management. Current managerial philosophies and their effects on every phase of manufacturing will be examined. This information will be synthesized and applied to a manufacturing model, which will give students an opportunity to test their theories on managing a manufacturing facility with limited resources. Throughout the course, emphasis will be placed on effective workplace skills including teamwork, integrity, and dependability.

Upon completion of this course, the successful student will:

1. Apply safety procedures in the shop/lab area according to the Standard Safety Procedures and Material Safety Data Sheets (MSDS) and Safety Data Sheets (SDS).
2. Describe the full range of the manufacturing process including machining, forging, cast, fabrication of cloth and the roll-forming process.
3. Demonstrate how automation affects manufacturing with material moving apparatus

Robots, conveyors, and other equipment.

4. Create a CNC Program and apply it to the Manufacturing Process
5. Discuss the factors affecting productivity and explain strategies to address those factors and control/enhance productivity with Lean Manufacturing.
6. Define quality and discuss factors affecting quality control.
7. Discuss the strategies to control quality.
8. Discuss and describe the application of the current theories in material control.
9. Discuss the impact of facility and layout on manufacturing process.
10. Discuss Value vs. Cost including value analysis.
11. Use management tools to present and gather data.
12. Apply theories in manufacturing processes to develop a manufacturing model and present it to others as a case study.

MATH155M	College Algebra with Trigonometry

This course covers the essentials of numerical algebra, geometry, and trigonometry and is designed for science, engineering, technology, computer science, and mathematics students. It provides a solid preparation for student toward Precalculus and Calculus track. A short review of elementary algebra is followed by an introduction to geometric and trigonometric functions. Applied problems are solved by integrating the above mathematical strategies. The trigonometric functions include ratios in solving right triangles and vector applications, and Law of Sines and Cosines in solving oblique triangles.

Upon successful completion of this course, the student will be able to:

1. Determine whether the relationship between a set of variables represents a function identify the graph of a function, and obtain and list elements from the graph of a function.
2. Solve problems involving complex number and quadratic equations.
3. Solve linear inequalities, compound inequalities, and absolute value inequalities.
4. Solve problems involving trigonometric functions when applied to right and oblique triangles.
5. Solve problems involving vectors in two dimensions.
6. Use the graphing calculator to evaluate exponential and logarithmic form.
7. Solve applied problems related to the topics study at this course.
8. Apply appropriate precision, accuracy, and tolerance measures in customary measurement units (US) and metric units (SI) to all numerical solutions.
9. Solve mathematical or scientific problems by incorporating critical thinking skills.
10. Use the graphing calculator to obtain and interpret numerical and/or graphical information in the discipline under study.

PHYS135M	College Physics I

This course is an introduction to the basic principles of Newtonian mechanics with emphasis on the application of these principles. Topics to be covered include kinematics of motion, vectors, Newton's laws, friction, work-energy, impulse-momentum for both translational and rotational motion, and the mechanical properties of matter. Dimensional (unit) analysis and critical thinking are stressed.

Upon completion of this course, each student will be able to:

1. Convert units (dimensions) from one system of measure to any other system of measure.
2. Demonstrate enhanced problem-solving skills using critical thinking.
3. Complete open-ended lab investigations in a rich content-based environment using the scientific method.
4. Perform laboratory activities, as outlined in instructions, with appropriate attention to safety
5. Take, organize, and interpret data obtained both by direct measure and by using the computer, and draw conclusions from the data in accordance with the scientific method.
6. Apply algebraic and trigonometric skills to analyze realistic physical situations.
7. Communicate, qualitatively and quantitatively, an understanding of, and the relationships among or between, interacting variables.
8. Apply appropriate precision, accuracy, and tolerance measures in customary measurement units (US) and metric units (SI) to all numerical solutions.
9. Use dimensional analysis and common sense to check results of each activity with reality.

ADMT115M	Engineering Print Reading

This course provides the basic concepts and practices of blueprint reading and technical drawing. Other topics of discussion will include sketching, dimensioning, tolerances, as well as Geometric Dimensioning & Tolerancing (GDT) and other information needed to read and interpret engineering drawings. Emphasis will be placed on using reading and interpreting drawings to understand the conventions for interpreting engineering drawings for Design and Manufacturing and other Engineer disciplines.

At the successful completion of this course, each student will be able to:

1. Interpret engineering drawings to be able to extract information for problem solving.
2. Sketch lines, circles, arcs, and other geometric shapes as well as orthographic projection views.
3. Learn how to use scales and precision measuring instruments for Metric and Imperial.

4. Summarize dimensioning systems and evaluate part tolerances.
5. Understand the ASME standard for line conventions and lettering applications.
6. Identify the ASME standard for auxiliary view drawings
7. Define and describe given manufacturing materials, material terminology, numbering systems, and material treatment.
8. Read and calculate dimension tolerances on a print.
9. Determine the maximum material condition of given features.
10. Read and identify the parts of metric and Unified and American National threads.
11. Identify the ASME standard for multi-view and sectional view drawings.
12. Read prints containing geometric dimensioning applications.
13. Read and interpret Cam, Gear, and Bearing Prints.
14. Describe the methods used to display precision sheet metal fabrication drawings on prints.
15. Read detail and assembly drawings and parts lists.
16. Discuss a variety of welding processes. Identify the elements of welding symbols, define types of welds on prints and interpret prints with welding symbols.
17. Identify types of pictorial drawings and how to read pictorial drawing prints.
18. Identify the standards for electrical drawings and the different types of electrical diagrams.

ADMT135M	**Basic Machining Practices**

An introductory course in machine shop practices introducing students to the basic machines used in industry relating to Advanced Manufacturing. It is intended to provide the basic concepts of machine tool operation on lathes, millers, power saws, drill presses, hand grinders, and part finishing processes. The course will include part layout, bench work, some simple CNC programming, and processes for producing products using measuring instruments for quality control. Emphasis is placed on shop safety, housekeeping and preventive maintenance.

Upon successful completion of the course, students will be able to:

1. Demonstrate personal and laboratory safety.
2. Demonstrate approved safe use of all basic hand tools using standard procedures.
3. Apply basic shop math for calculation of standard practices used in machining parts.
4. Read precision measuring inspection tools and record the measurements
5. Identify other common precision measuring tools.
6. Relate basic metallurgical properties to machining and ASM Standards.

7. Identify various types of machine tools and their purpose for the process of manufacturing.
8. Calculate feeds, speeds, proper tooling and lubricants for safe machine operation.
9. Assemble material for cutting operations on all manual machines in the Lab.
10. Practice safe performance of cutting operations on all manual machines in the lab.
11. Write a basic CNC program.
12. Demonstrate application of Cartesian coordinates for milling machines and/or lathes.
13. Demonstrate concepts of tool offsets (i.e., tool fixture, length, and radius).
14. Describe other basic traditional machine shop methods in welding and cutting.
15. Describe nontraditional machining processes like Electrical Discharge (EDM), laser, water jet, and other processes.
16. Identify the processes to manufacture a production part.
17. Demonstrate critical thinking skills by formulating solutions to given problems.

ADMT118M	Electrical Fundamentals for Manufacturing

This course provides an introduction to basic electrical concepts, practices, and procedures. The material presented includes electrical safety, basic AC/DC electrical theory, magnetic theory, electrical formulas and calculations, test equipment, testing procedures, and electrical diagrams. Laboratory work will provide reinforcement and application of theoretical concepts.

Upon completion of this course, the successful student will be able to:

1. Demonstrate a general knowledge of the importance of electrical and electronics in the advanced manufacturing field.
2. Explain and utilize proper safety practices and procedures when working with and around electrical systems and equipment.
3. Demonstrate knowledge of the basic electrical concepts of voltage, resistance, current flow, power, and energy.
4. Describe the operations of AC and DC circuits.
5. Demonstrate a basic knowledge of transistor and solid state theory.
6. Apply basic electrical concepts to AC and DC electrical circuits.
7. Read and interpret line, block, and circuit diagrams.
8. Understand and apply Boolean logic and arithmetic.
9. Select and use electrical and electronic test equipment properly.
10. Understand grounding and bonding and the way they are integrated into an electrical system.

11. Explain overcurrent protection methods and equipment integrated into an electrical system.