UR East Overview of Year

10th/11th Grade Precision Optical Fabrication II Curriculum

SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE
Unit 1 Lens Function & Design		**Unit 2** Fabricating a Part to Spec & Cementing			**Unit 3** Lens Alignment and Image Quality			**Unit 4** Advanced Lens Design	

Precision Optical Fabrication II/III at East High:

Students explore the nature of light, glass, and the interplay between the two in order to understand how optical elements are designed and assembled together to create quality images. Science and engineering content is embedded throughout the year as students build on the fundamentals of advanced manufacturing processes learned in Precision Optics I. Students develop habits of mind and skills necessary to manufacture, test, and evaluate a finished good, based on customer specifications.

Specific to Precision Optics II, students learn basic theoretical underpinnings of optical engineering so that they understand the variables that are considered and the choices that are made when an optical system is designed. Students translate this understanding in a way that allows them to machine, polish, and verify the physical dimensions of precision lenses, flats, and prisms. Additionally, students will learn techniques to create, capture, and assess images created by different optics.

The culminating project for this course revolves around a multi-element optic that has been fabricated by a student or group of students. The students will create a poster that describes the process to manufacture & assemble the optic. The poster will also include information about the optic's image quality and performance relative to first order aberrations. Each project will be based on a professionally-designed blue print that includes specific dimensions and tolerances.

Students use equipment, machines, and tools identical to those found in Rochester's thriving optical fabrication and engineering industry. Skills developed and practiced in this class can give students direct entry into the workforce after graduation or entrance to Monroe Community College's and the University of Rochester's optics programs.

Key skills include maintaining a safe and clean work area, precision metrology, blueprint interpretation, and precision assembly. Students get experience operating a Blanchard Grinder, a Rogers & Clarke Curve Generator, a Centering (edging) machine, bench top grinders, spindle polishers, and a planetary polisher. Students will use test plates for rough verification. Students will use a zygo interferometer for final verification of part dimensions. CMOS cameras are used to take digital images from student-made optics. The digital images are analyzed with industry standard software to characterize aberrations in each system.

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Unit I - Overview Lens Function and Design: Students explore the nature of light, glass, and the interplay between the two in order to understand how optical elements are designed and assembled together to create quality images. Science and engineering content is embedded throughout the year as students build on the fundamentals of advanced manufacturing processes learned in Precision Optics I. Students develop habits of mind and skills necessary to manufacture, test, and evaluate a finished good, based on customer specifications.

Unit 1

Mission & Vision Infused CDOS Standards!	Understanding	Essential Question
Standard 1 **(TP)**: Students will be knowledgeable about the world of work and relate personal skills, aptitude and abilities to ***set short term goals*** and to ***work collaboratively.*** . Standard 2: Students will demonstrate how academic knowledge and skills are applied in workplace and other settings ***to solve problems and make decisions***. Standard 3a: Students will ***take risks and learn from mistakes*** in order to demonstrate mastery of the foundation skills and competencies essential for success in the workplace. Standard 3b: Students ***will access resources necessary to*** acquire the career specific technical knowledge/skills to progress toward gainful employment, career advancement and success in postsecondary programs.	Enduring Understandings *Scholars will understand that…* • *Optics is the science of controlling light.* • *The performance of a lens (system) depends on each lens' shape, orientation, glass type, and alignment within the system.* • *Real lens systems are designed to minimize deviations from ideal, but every system creates images with some degree of aberration.*	Essential Questions *Scholars will consider such questions as…* 1. Why happens when light hits an air-glass boundary? 2. Why does curve and composition of the glass matter? 3. What can we "get away with" when designing optics? 4. How do optical designers maximize the performance of an optical system?
Performance Task: *At the end of this unit, students will use what they have learned to independently… examine ray diagrams for several optics systems and evaluate and compare the predicted image quality created by each optic with special attention paid to the type and severity of first order aberrations. Students will construct an illustrated essay. This essay will indicate the student's level of understanding about how lenses are designed to control light.*		
Formative Assessments: Career Pathways programs will monitor universal employability skills for each student. These will be formally assessed with our school Employability Profile.		

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Unit II Overview – Fabricating a Part to Spec & Cementing: Students enter the manufacturing space in this unit. The first order of business is reestablishing safe practices and productive habits. Students will follow a blueprint, with industry tolerances, to create a set of lenses. The manufacture of the lenses require students to better master production skills that were learned in Precision Optics I. After lenses are fabricated, students will be tasked with cementing lens pairs into achromatic doublets.

Science and engineering content is infused in the unit but students are expected to become more comfortable and proficient with the stages of production in optical fabrication.

Unit 2

Mission & Vision Infused CDOS Standards!	Understanding	Essential Question
CDOS Standards (Career Development and Occupational Studies): 1, 2, 3a, and 3b **CCTE (Common Career Technical Core)** 1, 2, 8, 10	Enduring Understandings *Scholars will understand that…* 1. productive and profitable workplaces pay close attention to employee safety and logical workflow. 2. it is important to measure and verify a part throughout a manufacturing process. 3. mathematics is an essential tool that is used to efficiently machine precision parts.	Essential Questions *Scholars will consider such questions as…* 1. What makes a safe workplace? 2. How do I know when to move to the next step in the process? 3. How is mathematics used to make accurate and reliable predictions?
Performance Task: Students will machine, grind, polish, and verify spherical optical components according to blueprint specifications. Each part is made through a multi-step production process. The spherical process gives students experience operating a curve generator, using a loose abrasive benchtop grinder, and working with a spindle polisher. Throughout the process, students use precision tools to verify part dimensions. Students will learn how to align and cement lenses to create doublets.		
Formative Assessments: Career Pathways programs will monitor universal employability skills for each student. These will be formally assessed with our school's Employability Profile.		

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Unit III Overview – Lens Alignment and Image Quality: A great image requires precision lenses **AND** precision assembly. As much attention needs to be paid to axial alignment and position for each lens as is paid to surface quality of the polished surface. After optical elements are produced, precision mechanical supports are used to configure lenses according to blueprint specifications.

Once assembled, the image created by the optical system must be measured and evaluated with high tech CMOS cameras and analysis software. Special attention will be paid to the type and extent of aberrations.

Unit 3

Mission & Vision Infused CDOS Standards!	Understanding	Essential Question
CDOS Standards (Career Development and Occupational Studies): 1, 2, 3a, and 3b **CCTE (Common Career Technical Core):** 1, 2, 8, 10	Enduring Understandings *Scholars will understand that…* 1. You can only manufacture a product to the precision that you can measure. 2. An optical system depends on precision in both element manufacturing and assembly. 3. An optical system is evaluated by the images captured with CMOS cameras.	Essential Questions *Scholars will consider such questions as…* 1. How can I prove the precision of my part? 2. How important is each element's position when two or more optics are assembled into a system? 3. How can software allow real analysis of final images?
Performance Task: Students will cement/assemble and test an achromatic doublet. This is constructed from two lenses that are aligned and precisely assembled in a custom housing. Students will continue to refine the lens manufacturing process and gain experience verifying lenses.		
Formative Assessments: Career Pathways programs will monitor universal employability skills for each student. These will be formally assessed with our school's Employability Profile.		

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Unit IV Overview – Advanced Lens Design: Students will

Unit 4

Mission & Vision Infused CDOS Standards!	Understanding	Essential Question
CDOS Standards (Career Development and Occupational Studies): 1, 2, 3a, and 3b **CCTE (Common Career Technical Core):** 1, 2, 8, 10	Enduring Understandings *Scholars will understand that…* 1. small adjustments at different stages of production can have large rippling effects on the final product. 2. technical communication is learned and must be practiced to be effective.	Essential Questions *Scholars will consider such questions as…* 1. What happens when a production variable is changed? 2. Why is it important to analytically analyze a production process?
Performance Task: Students will choose one area of the optical fabrication process and carryout an engineering/efficiency study of their choosing. Students will submit a summary proposal of their study. After receiving feedback, and eventually approval, students will write and carry out a plan of investigation. A summary of the study will be presented to the class.		
Formative Assessments: Career Pathways programs will monitor universal employability skills for each student. These will be formally assessed with our school's Employability Profile.		

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Unit 5

	Understanding	Essential Question
	Enduring Understandings *Scholars will understand that…*	Essential Questions *Scholars will consider such questions as…*
Performance Task:		
Formative Assessments:		

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Unit 5-	Understanding	Essential Question
	Enduring Understandings *Scholars will understand that…*	Essential Questions *Scholars will consider such questions as…*
Performance Task:		
Formative Assessments:		

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Unit 6-	Understanding	Essential Question
	Enduring Understandings *Scholars will understand that…*	Essential Questions *Scholars will consider such questions as…*
Performance Task:		
Formative Assessments:		