External Resources - Instructor Manual

This manual is designed to help instructors effectively use the open-educational book “ECE 5143: Intro to Optics and Photonics” in active learning environments. The goal of the course is to engage senior undergraduate and 1st-year graduate students in higher-order thinking activities during class, leveraging pre-class video content to maximize in-class learning outcomes.

Below is a list of guidelines to facilitate the adoption of this OER book:

Instructor Preparation

1. Review Pre-Class Material:
    - Ensure students have access to pre-class videos and any accompanying materials.
    - Identify key points and potential areas of confusion.
2. Prepare In-Class Activities:
    - Design 2-4 problems/activities that build on the video content.
        - Include a mix of individual, pair, and group activities.
        - Include problem-based learning, concept application activities, think-pair-share, peer teaching, and role play/simulation
3. Plan for Assessment:
    - Develop quick formative assessments (e.g., quizzes, polls) to check students’ understanding.
        - **Quizzes**: Use short quizzes at the start of each class to reinforce key concepts.
        - **Polls**: Conduct live polls using tools like Kahoot! or Mentimeter to gauge student understanding.
    - Develop summative assessments to dissect students' understanding
        - **Projects**: Assign 2-4 individual/group projects where students apply concepts to a comprehensive problem or application-based problem
        - **Exams**: Include both conceptual and application-based questions.
4. Providing Feedback
    - Offer immediate feedback during class activities.
    - Use peer feedback during group discussions and projects.
    - When it is possible, provide feedback within a week window.

Student Preparation

1. Students are required to watch instructional videos before coming to class. These videos introduce key concepts, allowing class time to be used for:
    - Problem-solving exercises
    - Group discussions
    - Hands-on activities

2. Complete any required pre-class quizzes or reading assignments.

3. Submit a 1-page hand-written summary of the class notes taken while watching the class video.

4. Come prepared with questions.

Suggested Course Schedule

Class no.	Module	Lecture Topic
1	Geometrical/Ray Optics	Postulates and Rules in Ray Optics
2		Mirrors
3		Planar Boundaries, External and internal refraction, Total internal reflection
4		Spherical Boundaries and Lenses
5		Matrix Optics and 4f imaging system
6	Wave Optics	Postulates of Wave Optics, Monochromatic Waves, Helmholtz equation

7		Elementary Waves: plane, spherical and paraboloidal waves
8		Relation ray-wave optics, interference of two waves, interferometers
9		Young experiment
10	Beam Optics	Gaussian beam: features and mathematical description
11		Properties of Gaussian beams
12		Propagation of Gaussian beams through optical systems
13	Fourier Optics	Space vs Fourier Domains, Principle of Fourier Optics, Linear Systems and Shift-invariant Systems
14		Impulse response and Transfer function in free propagation
15		Fresnel and Fraunhofer diffraction patterns
16		Lenses, Optical Fourier Transforms, 4f imaging system and spatial filtering
17	Electromagnetics (EM) Optics	Maxwell equations, Boundaries Conditions, Poynting theorem, EM waves in a dielectric medium
18		Monochromatic EM waves, absorption and dispersion
19	Polarization Optics	Poincare sphere – linear, circular and elliptical polarization; Natural light; Polarizers and Malus' law
20		Birefringent Crystals, Retarders, Stokes formalism
21		Jones formalism, Polarization by reflection, Brewster angle

Note that other sequences are also possible. For example, some instructors may prefer the following sequence:

1. Module 1: Geometrical/Ray Optics
2. Module 2: Wave Optics
3. Module 3: Electromagnetics (EM) Optics
4. Module 4: Polarization Optics
5. Module 5: Gaussian Optics
6. Module 6: Fourier Optics