6.161-6.637 COURSE CALENDAR **Fall 2021** **(Revised 08 Sept 2021)**

Date	Topics	PSets	Class Demos
TR 09 Sep	**Course Overview –** Description of content, expectations and requirements, grading policy, exams, etc; **1. Geometric optics** – Lenses and mirrors. Ray tracing. Linear image magnification. Real and virtual images.		
TU 14 Sep	Ray-matrix (ABCD) methods. Single-lens and multiple-lens imaging systems. Angular magnification. Applications to telescopes and microscopes and zoom systems. Lens waveguide.	**1 Geom out**	
	Lab 0 – Lab orientation (38-633); Lab safety training, etc. Lab 1A - Single-lens imaging system with positive and negative lenses		
TR 16 Sep	**2. Review of properties of E&M waves**; amplitude, intensity, phase, polarization and coherence, E and H fields, Maxwell's equations, dielectric and conducting media, wave equation, plane and spherical wave solutions.		
TU 21 Sep	Linear, circular and elliptical polarization. Quarter & half-wave plates. Propagation in anisotropic materials. Jones vectors and matrices. Dipole model of interaction of light with matter.	**1 Geom In** **2 EMW out**	Polarizers, magic sheet. Calcite xtal, stressed plexiglass
	Lab 1B – Design, build and evaluate your own zoom lens system for: (a) classroom projector, or (b) terrestrial projector, or (c) binoculars		
TR 23 Sep	Reflection, refraction, Snell's law, critical angle, Brewster's angle, reflection and transmission coeffs.		
TU 28 Sep	**3. Coherence and Interferometry** - Temporal and spatial coherence, conditions for interference, two-beam interferometers (Michelson and Mach-Zehnder).	**2 EMW in** **3 Intf out**	
	Lab 2 – Experiments with LPs, QWPs and HWPs. Dielectric reflection.		
TR 30 Sep	Multiple-beam interference, finesse. Fabry-Perot and Lummer-Gehrcke interferometers. Antireflection coatings, dielectric mirrors, interference filters.		Soap films, dielectric filters/mirrors
TU 05 Oct	**4. Diffraction** - Spatial frequency, wavefront analysis, scalar diffraction theory	**3 Intf in** **4 Diff out**	Laser pointer-phone screen
	Lab 3 – Haidinger Interference fringes (thin glass sides), two-beam and multiple-beam interferometers.		
TR 07 Oct	Free-space propagation, Fresnel diffraction formula. Fourier Optics interpretation.		MEMS Mirror phase modulator
TU 12 Oct	Review of the properties of Fourier transforms. Fraunhofer approximation. Examples, diffraction-based light modulators.		
	Lab 4 - Fresnel and Fraunhofer diffraction from various apertures and objects.		
TR 14 Oct	Fresnel zones and diffractive optical elements		

Office Hours: Time to be scheduled at convenience of students

TU 19 Oct	**5. Holographic Imaging** - Top level view of basic principles of holography. Transmission and reflection holography. Readout with reference and phase-conjugate waves. Central dogma of holography	**4 Diff in** **5 Hol out**	
	Lab 5A – View, analyze and fabricate transmission & reflection holograms		
TR 21 Oct	**QUIZ 1**		
TU 26 Oct	Thick holograms. Bragg readout condition. Choice of recording media, image separation conditions, effects of recording medium resolution. holography in photorefractive media. Computer-generated holography. Volumetric imaging systems. Real-time. Optical storage.	**5 Hol in**	Transmission, white light & Comp. Gen. Holograms
	Lab 5B - Design and make your own static Hologram. (perhaps do FT of a rotating 3-D object in photorefractive media as possible project on volumetric imaging)		
TR 28 Oct	**6. Light modulators and displays -** Electro-optic light modulation, index ellipsoid, Pockels and Kerr effect, electro-optic tensor. Longitudinal and transverse modulators.	**6 Mod out**	
TU 02 Nov	Acousto-optic light modulation and its applications, Liquid crystal light modulation		
TU 02 Nov	**Proposal for final project due (Begin Projects)**		
	Lab 6 – Electro-optic and acoustic light modulation		
TR 04 Nov	**7. Introduction to optical signal processing.** Fourier Optics – 2-D Transforming properties of lenses.	**6 Mod in** **7 Fou out**	
TU 09 Nov	Two-lens coherent image processors. Vander Lugt & matched filters, polychromatic image processors.		View Fourier transforms
TR 11 Nov	N**o Classes**		
TU 16 Nov	**8. Principles of Lasers** - Spontaneous and stimulated emission, gain, rate eqns, resonators, oscillation frequencies, longitudinal modes	**7 Fou in** **8 lasers out**	
TR 18 Nov	Scanning Fabry-Perot spectrometer. Specific laser systems (e.g., He-Ne, GaAs, CO_2, YAG:Nd). Laser frequency doubling (Second Harmonic generation)		Scanning Fabry-Perot spectrometer
TU 23 Nov	**QUIZ 2**		
TR 25 Nov	**No Class** (Thanksgiving Day)		
TU 30 Nov	**9. Optics of the eye** - 3D-Vision. Perception of depth and color.	**8 Lasers in**	
TR 02 Dec	**Near-eye systems** - Stereoscopic systems. Digital light field. Virtual reality systems. Augmented reality. Survey of commercial systems (e.g., Occulus, Hololens, Magic Leap System, Google glass, etc)		
	Lab 7 (optional) – Design and build your own near-eye 3-D stereoscopic system – 3D print the package (optional – expand to possible project)		
TU 07 Dec	**Image detection** - Thermal and quantum detectors. Detector Responsivity, NEP, D*. Detector noise. Visible and infrared photodetector arrays. Specific detector devices and systems in the visible and infrared. Infrared imaging techniques and systems (e.g., thermal imagers)		Bolometer Photodiode, CCD, PMT.
TU 09 Dec	**Final Project Presentations (2 hours - class begins at 2 pm)**		

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