

BE556/EC556
Optical Spectroscopic Imaging
Spring 2025

Credit hours: 4

Instructor: Professor Ji-Xin Cheng

Prerequisites: CAS PY 212; EK 125 or equivalent Matlab; PY 212 or equivalent knowledge of light and waves.

Topics: Theory, instrumentation, Image analysis, and applications of molecular spectroscopic imaging, skills in presentation and proposal writing

Textbook: Lecture notes

Syllabus:

Module 1: Basic concepts of electromagnetic wave, spectroscopy and microscopy

Jan 21 Lecture 1	Basics of light and contrast for optical imaging
Jan 23 Lecture 2	Light matter interactions and molecular spectroscopy
Jan 28 Lecture 3	Principle of lasers and current laser technology
Jan 30 Lecture 4	Wide-field optical microscopy and confocal microscopy
Feb 04 Lecture 5	Fluorescence energy transfer and fluorescence lifetime imaging
Feb 06 Lecture 6	Two-photon and three-photon fluorescence, SHG, THG
Feb 11 Lecture 7	How to write a convincing proposal; In class exam 1

Module 2: Absorption-based spectroscopic imaging

Feb 13 Lecture 08	Infrared absorption spectroscopic imaging
Feb 18	substitution of Monday class
Feb 20 Lecture 09	Mid-infrared photothermal microscopy
Feb 25 Lecture 10	Photoacoustic tomography
Feb 27 Lecture 11	Transient absorption spectroscopy and microscopy
Mar 04 Lecture 12	How to formulate a project; In class exam 2

Module 3: Spontaneous and coherent Raman spectroscopic imaging

Mar 06 Lecture 13	Spontaneous Raman imaging spectroscopy and imaging
Mar 08 to Mar 16	Spring break
Mar 18 Lecture 14	Coherent anti-Stokes Raman scattering microscopy
Mar 20 Lecture 15	Stimulated Raman scattering microscopy
Mar 25 Lecture 16	Stimulated Raman photothermal microscopy
Mar 27 Lecture 17	SHG, THG, SFG microscopy

Module 4: Image analysis

Apr 01 Lecture 18	Noise and noise reduction
Apr 03, Lecture 19	Multivariate curve resolution, Spectral phasor analysis
Apr 08, Lecture 20	How to give a scholar presentation; In class exam 3

Module 5: Presentation of an original proposal

Apr 10, Lecture 21	Student presentation of an original proposal (final project)
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Apr 15, Lecture 22 Student presentation of an original proposal (final project)
Apr 17, Lecture 23 Student presentation of an original proposal (final project)
Apr 22, Lecture 24 Student presentation of an original proposal (final project)
Apr 24, Lecture 25 Student presentation of an original proposal (final project)
Apr 29, Lecture 26 Student presentation of an original proposal (final project)
May 01, Lecture 27 Student presentation of an original proposal (final project)

Grading:	Three exams	45%
	Weekly Homework	20%
	Presentation	20%
	Proposal	15%

Final presentation and proposal content:

Significance, Innovation, Approach (Research Plan), Expected outcome