BE556/EC556

Optical Spectroscopic Imaging

Credit hours: 4
When offered: Spring semester annually, starting in 2018
Instructor: Professor Ji-Xin Cheng
Prerequisites: Basic knowledge in cells and tissues, biomolecules, light and waves, and optical microscopy
Topics: Theory, instrumentation, Image analysis, and applications of molecular spectroscopic imaging.
Textbook: Lecture notes

Syllabus:

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

Lecture 1 Basics of light and contrast for optical imaging
Lecture 2 Light matter interactions and molecular spectroscopy
Lecture 3 Principle of lasers and current laser technology
Lecture 4 Wide-field optical microscopy and phase contrast microscopy
Lecture 5 Confocal fluorescence and confocal reflectance microscopy
Lecture 6 Cells, tissues, and introduction of spectroscopic imaging modalities
Lecture 7 In class exam 1; Final project; How to write a convincing proposal

Part 2: Fluorescence-based spectroscopic imaging

Lecture 8 Fluorescence energy transfer and fluorescence lifetime imaging
Lecture 9 Two-photon and three-photon fluorescence microscopy
Lecture 10 Second harmonic, third harmonic, sum-frequency generation microscopy
Lecture 11 Breaking the diffraction limit in fluorescence imaging

Part 3: Absorption-based label-free spectroscopic imaging

Lecture 12 Infrared absorption spectroscopic imaging
Lecture 13 Transient absorption spectroscopy and microscopy
Lecture 14 Photoacoustic tomography
Lecture 15 Photothermal microscopy, in class exam 2

Part 4: Raman scattering based label-free spectroscopic imaging

Lecture 16 Spontaneous Raman imaging
Lecture 17 Coherent anti-Stokes Raman scattering microscopy
Lecture 18 Stimulated Raman scattering microscopy
Lecture 19 Hyperspectral CARS and SRS microscopy
Lecture 20 Applications of CARS and SRS microscopy
Lecture 21 Clinical translation of spectroscopic imaging

Part 5: Hyperspectral image analysis and reconstruction

Lecture 22 Noise reduction schemes
Lecture 23 Multivariate curve resolution
Lecture 24 Spectral phasor analysis, in class exam 3

Part 6: Presentation of original proposal

Lecture 25 Student presentation of original proposal (final project)
Lecture 26 Student presentation of original proposal (final project)

Grading:	Exams	45%
	Homework	20%
	Final project	35%

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