Credit hours: 4
When offered: Spring semester annually
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, skills in presentation and proposal writing
Textbook: Lecture notes

Syllabus:
Part 1: Basic concepts of electromagnetic wave, spectroscopy and microscopy
Jan 19 Lecture 1 Basics of light and contrast for optical imaging
Jan 24 Lecture 2 Light matter interactions and molecular spectroscopy
Jan 26 Lecture 3 Principle of lasers and current laser technology
Jan 31 Lecture 4 Wide-field optical microscopy and confocal microscopy
Feb 02 Lecture 5 Fluorescence energy transfer and fluorescence lifetime imaging
Feb 07 Lecture 6 Two-photon and three-photon fluorescence microscopy
Feb 09 Lecture 7 In class exam 1, How to write a convincing proposal

Part 2: Absorption-based spectroscopic imaging
Feb 14 Lecture 08 Infrared absorption spectroscopic imaging
Feb 16 Lecture 09 Mid-infrared photothermal microscopy
Feb 21 substitute Monday class
Feb 23 Lecture 10 Photoacoustic tomography
Feb 28 Lecture 11 Transient absorption spectroscopy and microscopy
Mar 02 Lecture 12 How to formulate a project; In class exam 2
Mar 04 to Mar 12 Spring break

Part 3: Raman scattering based spectroscopic imaging
Mar 14 Lecture 13 Spontaneous Raman imaging spectroscopy and imaging
Mar 16 Lecture 14 Coherent anti-Stokes Raman scattering microscopy
Mar 21 Lecture 15 Stimulated Raman scattering microscopy
Mar 23 Lecture 16 Hyperspectral CARS and SRS microscopy
Mar 28 Lecture 17 Second harmonic, third harmonic, sum-frequency microscopy

Part 3: Image analysis
Mar 30 Lecture 18 Noise and noise reduction
Apr 04, Lecture 19 Multivariate curve resolution, Spectral phasor analysis
Apr 06, Lecture 20 How to give a scholar presentation; In class exam 3

Part 6: Presentation of original proposal
Apr 11, Lecture 21  Student presentation of an original proposal (final project)
Apr 13, Lecture 22  Student presentation of an original proposal (final project)
Apr 18, Lecture 23  Student presentation of an original proposal (final project)
Apr 20, Lecture 24  Student presentation of an original proposal (final project)
Apr 25, Lecture 25  Student presentation of an original proposal (final project)
Apr 27, Lecture 26  Student presentation of an original proposal (final project)
May 02, Lecture 27  Student presentation of an original proposal (final project)

Grading:
- Three exams: 45%
- Weekly Homework: 20%
- Final presentation: 20%
- Final paper: 15%

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