Baylor College of Medicine
GRADUATE SCHOOL OF BIOMEDICAL SCIENCES

Fundamentals of Human Neuroimaging

Course:	**GS-NE-400**
Credits:	4
Didactic:	Y
Academic Year:	2016
Term:	1-2
Room:	S104
Class:	TTH, 10:45 AM – 12:00 PM

COURSE DIRECTOR CONTACT INFORMATION

Name: David Ress, Ph.D.
Office: BCMS-S104N
Email: ress@bcm.edu
Office Hours: Wednesdays, 1-2 PM, and after class, 12-12:30 PM

COURSE DESCRIPTION AND OBJECTIVES:

Neuroimaging has rapidly become one of the most popular and powerful tools for neuroscience. This course surveys a variety of brain imaging modalities, describing what each measures and how the results are used for research. Neuroscience has classically relied on invasive electrode measurements, mostly in animals, to directly map electrical activity in the brain, and modem microelectrode arrays have expanded this method. Two other brain activity measurement schemes, electroencephalography (EEG) and magnetoencephalography (MEG), provide non-invasive measurements with excellent temporal resolution but limited spatial accuracy. Recently, magnetic resonance imaging (MRI) has become tremendously popular because it is non-invasive, involves no ionizing radiation, and offers substantial flexibility. In particular, MRI is used to measure brain structure in a variety of fashions, to measure white-matter connectivity using diffusion-weighted imaging (e.g., DTI), and to measure brain function (e.g., fMRI). Extensive techniques have been developed to localize and probe cortical activity in a variety of specialized areas. Optical imaging techniques have also contributed substantially to our understanding of brain function, mostly as an invasive technique in animal models. Positron-emission tomography (PET) provides additional specialized information about brain function. Students should have introductory physics and calculus capability at the freshman level.

REQUIRED TEXTS AND MATERIALS:

Huettel, S. A., Song, A. W., McCarthy, G. (3rd ed, 20014). Functional Magnetic Resonance Imaging. Sunderland, MA, Sinauer Associates, Inc.

PREREQUISITE(S) or EXCLUSIONS:

None

ATTENDANCE REQUIREMENTS: none

GRADING:

A, B, C, F grading based on exams and projects, weighted as follow:
Midterm 1: Introductory neurobiology, electrical brain activity, structural MRI (30%)
Midterm 2: Neurovascular coupling, optical imaging, fMRI, PET, vision science (30%)
Imaging project proposal or term paper (40%)
Grades will be assigned statistically ("on the curve")

PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in a professional manner and abide by all policies of Baylor College of Medicine, the Graduate School of Biomedical Sciences and their Programs. Any conduct not in keeping with the ethical or professional standards of BCM is defined as professional misconduct. Academic misconduct is defined as dishonesty (e.g. cheating, plagiarism, etc.) that occurs in conjunction with academic requirements such as coursework including homework and examinations.

STUDENT DISABILITY SERVICES:

Students with documented disabilities can seek accommodations from Student Disability Services at 713-798-8137 or email to the Student Disability Coordinator, Ms. Mikiba Morehead at mikiba.morehead@bcm.edu. Information about a student's disability will be kept private. The student is responsible for informing the course director of approved accommodations prior to the first examination.

COURSE SCHEDULE:

Lecture	Date	Topic	Content
0	8/23	Overview, syllabus	Course structure & introductions
1	8/25	Introduction to brain imaging	Overview of brain structure and an introduction to neuroimaging
2	8/30	Electrical activity in the brain	Measuring brain function using electrodes and arrays
3	9/1	EEG & MEG: introduction	How does brain activity give rise to EEG and MEG signals?
4	9/6	EEG & MEG: spatial localization	Examples of the use of EEG & MEG source localization
5	9/8	Electrocorticography	Invasive measurement of electrical activity in the human brain (Lecturer: Beauchamp)
6	9/13	The nuclear magnetic resonance	What is the nuclear magnetic resonance and how does it behave?
7	9/15	NMR signal characteristics	Description of MR relaxation processes and their manipulation.
8	9/20	Introduction to signal & image processing	How does one sample data to make an image? What issues are involved with "sampled data systems"?
9	9/22	Spatial encoding & image acquisition	How is an MR image acquired? What artifacts can occur?
10	9/27	Pulse sequences & contrast mechanisms	How MR relaxation processes are measured and used to create various image contrasts
11	9/29	The MRI scanner	Description of the major systems of an MRI scanner and how they work
12	10/4	Diffusion weighted imaging	What is diffusion weighting and how is it obtained? What tissue properties does it reveal? (Lecturer: Kim)
13	10/6	Brain structural imaging & analysis	How is brain structure segmented and quantified using MRI?
D1	10/11	Demonstration 1: structural imaging	Anatomical image acquisitions of the brain: T1, T2, SPGR, etc.
MT1	10/13	Midterm 1, lectures 1—12	Electrical brain activity, structural MRI
14	10/18	Neurovascular coupling & the BOLD response	How does neural activity couple to a vascular response? (Lecturer: Kim)
15	10/20	Optical brain imaging	How is brain function measured using light?
16	10/25	Midterm 1, results & review BOLD response: signal & noise	Definition and characteristics of BOLD signal & noise
17	10/27	BOLD response: resolution &	What are spatial & temporal resolution limits of

		linearity	BOLD imaging? How does the response vary with the neural response?
18	11/1	BOLD pulse sequences	Standard and novel pulse sequences for fMRI research
19	11/3	fMRI experiment design	How do we design an fMRI experiment?
20	11/8	fMRI experiment analysis	How does one analyze a simple fMRI experiment?
21	11/10	Positron-emission tomography	Measurements of brain function using PET
--	11/15	SFN (no class)	
22	11/17	fMRI of human vision: retinotopy & binocular rivalry	What has fMRI revealed about visual field representations and attention?
23	11/22	fMRI of multi-sensory integration	fMRI results on the integration of vision and audition (Lecturer: Beauchamp)
--	11/24	Thanksgiving (no class)	
D2	11/29	fMRI demonstration experiment	A simple experiment that measures activation in early visual cortex
MT2	12/1	Midterm 2, lectures 13—23	Diffusion, neurovascular coupling, optical imaging, BOLD contrast, fMRI, PET
D3	12/6	Review of MT2 fMRI data analysis demo	Test results; analysis of data obtained in demonstration 2
P1	12/8	Student presentations	15 minute presentations on research projects or proposals
P2	12/13	Student presentations	15 minute presentations on research projects or proposals