SDSU Systems Neuroscience

Professor:
Marty Sereno -- email: msereno@sdsu.edu
class time (2019): MWF 9:00-9:50 AM (grad: F 8:00-8:50 AM)
location (lectures and exams): SSW 2667
expect to take copious notes
exam mostly based on lecture content

Readings:
readings, lecture videos (links, top of homepage)
background reading (neuroscience reference texts):
background reading (undergrad neuroscience textbooks):

Exams:
multiple question short-answer, each question with a few subsections, examples given in lecture
undergraduate: 2 midterms, final -- short-answer (midterms: 30% each, final: 40%)
graduate: 2 midterms, final (midterms: 24% each, final: 32%), and short final paper (20%)
old pdf answer keys from my similar UCSD Systems Neuroscience course (2007) here and here

Learning Objectives:
Students will be able to do the following:
(1) describe neuronal electrochemistry, development, and relation to simple dendritic, Hebbian, and attractor models
(2) diagram neuroanatomical structures/connections from low to high levels in visual, somatosensory, auditory sensory systems
(3) diagram structures/connections involving superior colliculus, cerebellum, striatum, motor cortex, and limbic systems
(4) analyze sequential processing stages in visual, somatosensory, and auditory systems from signals and systems perspective
(5) describe neural models of eye movement planning, hierarchical motor control, and body position and orientation
N.B.: consult with me if a disability hinders your performance so we can use University resources to maximize learning

Lecture Topics: (Spring 2019)
Week of Jan 21 (W) -- Introduction
introduction to course
membrane (Nernst) potential

Week of Jan 28 (MWF) -- Cellular Physiology
action potential, voltage-gated channels
post-synaptic potentials, ligand-gated channels
NMDA channels, synaptic-timing-dependent plasticity

Week of Feb 04 (MWF) -- Relation to Neural Models
dendritic propagation, equivalent circuits
relation to simple Hebbian network models
relation to simple attractor network models

Week of Feb 11 (MWF) -- Neural Development
gastrulation, neural plate, neural tube, optic cup
cylindrical coordinate system, temporal lobe formation
the 'rule of Sereno'

Week of Feb 18 (MWF) -- Visual System I
retinal circuitry and streams
dLGN (layers, non-lagged/lagged)
visual map structure (conformal maps)

Week of Feb 25 (MWF) -- Visual System II
general scheme for cortical layers
edges, brightness, and primary motion in V1
1st midterm review
1st Midterm Exam -- Fri, Feb 29

Week of Mar 04 (MWF) -- Visual System III
aperture problems in general (color intro)
aperture problems for vis. pattern translation, optical flow
visual attention
visual object recognition

Week of Mar 11 (MWF) -- Somatosensory System
somatosensory receptor types
arm diagram (length, force, alpha/gamma motoneurons)
pathways (dorsal column, spinothalamic, spinocerebellar)
somatosensory cortical areas
somatosensory cortical plasticity

Week of Mar 18 (MWF) -- Auditory System I
auditory transduction and hair cell receptors
monaural cochlear nuclei responses

Week of Mar 25 (MWF) -- Auditory System II
auditory brainstem sound localization
reception and speech sound processing
auditory cortical areas

Week of Apr 01 -- SPRING BREAK

Week of Apr 08 (MWF) -- Motor System I
gaze stabilization (VOR, OKN, pursuit)
superior colliculus retinal and motor maps
sensorimotor coord transforms (double-step memory saccade)
multisensory map interactions -- sup. collic visual/auditory
multisensory map interactions -- VIP somatosensory/visual

Week of Apr 15 (MWF) -- Motor System II
motor system overview
cortical and spinal pattern generators
motor cortex
2nd midterm review
2nd Midterm Exam -- Fri, Apr 13

Week of Apr 22 (MWF) -- Motor System III
cerebellum anatomy, physiology
cerebellum and learning/conditioning connectional overview
connectional/functional overview striatum striiatum and hierarchical sequencing

Week of Apr 29 (MWF) -- Limbic System
connectional overview limbic system
H.M. and intermediate term memory vs. inertial guidance
place cells
head direction cells
grid cells
models: theta rhythms, attractor networks

Week of May 06 (MW) -- Neuroimaging EEG/MEG
hardware, spin vs. precession, Bloch equation
spin echo and gradient echo
phase-sensitive detection, intro to complex numbers, frequency-encoding -- incorrect and correct intuitions
signal-to-noise
neural source of EEG/MEG signals
current source density, linear forward solution

May 13 -- Final Exam 8-10 AM
Graduate students: final paper due May 16