Jordan University of Science and Technology
Faculty of Engineering
Biomedical Engineering Department

BME 562 Control and Communication in the Nervous System

Course Catalog
3 Credit hours (3 h lectures). An introduction to the structural and functional elements common to nervous systems with emphasis on cellular dynamics, interneuronal communication, sensory and effector system.

Text Book(s)	
Title	Principles of Neural Science
Author(s)	Kandel, E.R., Schwartz, J.H., Jessell, T.M.
Publisher	McGraw-Hill
Year	2000
Edition	4th Edition

References	
Books	Webster, D.B. (1998) "Neuroscience of Communication." 2nd Edition. Singular. Katz, P.S. (1999) "Beyond Neurotransmission: Neuromodulation and Its Importance for Information Processing." Oxford University Press. Bear, M.F., Connors, B., Paradiso, M. (2006). "Neuroscience: Exploring the Brain." 3rd Edition. Lippincott Williams & Wilkins. Squire, L.R., Roberts, J.L., Spitzer, N.C., Zigmond, M.J. (2002) "Fundamental Neuroscience." 2nd Edition, Academic Press.
Journals	- The Journal of Neuroscience - European Journal of Neuroscience - Annual Reviews of Neuroscience - Journal of Neurophysiology
Internet links	- http://www.bmecentral.com/publications/ - http://www.sciencedirect.com - http://www.elsevier.com - http://www.springer.com

Prerequisites	
Prerequisites by topic	Statistics for Biomedical Engineers, Physiology
Prerequisites by course	BME 302, MED 236A
Co-requisites by course	N/A
Prerequisite for	None

Objectives and Outcomes[1]

Objectives	Outcomes
1. Appreciate the role of control and communication in the nervous system in Biomedical Engineering [f,h,j]	1.1. Appreciate the role of control and communication in the nervous system in the field of biomedical engineering. [f,h,i,j].
2. Study the relationship between brain and behavior [a,e,g]	2.1. Learn the relationship between brain and behavior [g] 2.2. Differentiate between distinct functional regions of the brain [a] 2.3. Identify the loci of cognitive functions, and their mental representation. [a,e]
3. Study the classes, structure, and organization of nerve cells [a,c,e,i,g,j,k]	3.1. Differentiate between classes of cells within the nervous system [a,e] 3.2. Explain the mechanism of signaling networks, their organization, and their ability for conveying unique information [a]
4. Analyze the origin of signals and signaling capability in the nervous system [a,e,g,j,k]	4.1. Identify the types ion channels and signaling, the characteristics and structure of ion channels, the origin of membrane potential. [a,e,g,j,k] 4.2. Calculate the balance of ion fluxes, the contribution of different ions to this balance, and construct an electrical equivalent circuit. [a,e,g,j,k]
5. Study local signaling in the nervous system [a,c,e,g,j,k]	5.1. Define Local signaling and its relation to passive electrical properties of neurons. [a,e,g,j,k] 5.2. Calculate membrane input resistance and membrane capacitance [a,e,g,j,k] 5.3. Calculate the efficiency of signal conduction, and velocity of propagation [a,e,g,j,k]
6. Study propagated signaling and interneuronal / neuro-muscular synaptic transmission [a,c,e,g,j,k]	6.1. Explain propagated signaling [a,j,k] 6.2. Analyze synaptic transmission, chemical vs. electrical synapses, signaling time and signal amplification [a,c,e,g,j,k] 6.3. Determine the quantal units involved in transmitter release [a,c,e,g,j,k] 6.4. Address signaling at the neuron – muscle synapse, neuromuscular junction and end plate potentials, Patch clamp and single channel currents, ACh gated channels, and synaptic integration. [a,c,e,g,j,k] 6.5. Analyze Glutamate, GABA, and Glycine mediated channels, as well as the integration of excitatory and inhibitory signals by these channnels. [a,c,e,g,j,k] 6.6. Groupe synapses according to function [a,c,e,g,j,k]
7. Correlate the coding of sensory information to stimulus energy, modality, and	7.1. Explain the coding of sensory information [a] 7.2. Correlate stimulus with sensation in the nervous system. [a] 7.3. Differentiate between the stimulus energy and sensory modality [a]

[1] Lower-case letters in brackets refer to the Program outcomes

spatial & temporal distribution. [a,c,e]	7.4. Analyze the spatial distribution of sensory neurons, stimulus amplitude and intensity of sensation, as well as the adaptation rate and duration of stimulation [a,e,g,k]
8. Apply neuro-communication principles to the construction and perception of visual images[a,e]	8.1 Explain the mechanism of visual image construction, visual perception, processing of motion, depth, form, and color, as well as visual attention, conscious awareness, and visual processing. [a,e,g,j,k] 8.2 Discuss the operation of the eye's receptor sheet, phototransduction, receptor adaptation to changes in light intensity, and retinal output and signal relay [a,e]
9. Encourage life long learning, foster teamwork and enhance students' communication skills [d,g,h,i,k]	9.1 Write technical report and give oral presentation on team work projects [g,h,i,k]

Topics Covered		
Week	**Topics**	**References**
1-2	– Relationship between brain and behavior. – Distinct functional regions of the brain. – Localization of cognitive functions. – Representation of mental processes.	Chapter 1
3	– Classes of cells within the nervous system. – Signaling networks and their organization. – Conveying unique information.	Chapter 2
4-5	– Ion channels and signaling – Characteristics and structure of ion channels. – Origin and determination of membrane potential. – Balance of ion fluxes. – Contribution of different ions. – Electrical equivalent circuit.	Chapter 6-7
6	– Local signaling: Passive electrical properties of neurons. – Membrane input resistance. – Membrane capacitance. – Efficiency of signal conduction, and velocity of propagation.	Chapter 8
First Exam 11th Nov. 2006		
7	– Propagated signaling – The action potential. – Properties of voltage-gated channels and signaling capabilities. – Signaling function and molecular structure.	Chapter 9
8-9	– Synaptic Transmission. – Chemical vs. electrical synapses. – Signaling time and signal amplification. – Transmitter release. – Quantal units. – Synaptic vesicles and mechanisms regulating their production and release.	Chapter 10, 14
10-11	– Signaling at the neuron – muscle synapse – Neuromuscular junction and end plate potentials. – Patch clamp and single channel currents. – ACh gated channels. – Synaptic integration. – Glutamate, GABA, and Glycine mediated channels. – Integration of excitatory and inhibitory signals. – Grouping of synapses according to function.	Chapter 11, 12
Second Exam 7th Dec. 2006		
12-13	– Coding of sensory information. – Correlating stimulus with sensation. – Stimulus energy and sensory modality. – Spatial distribution of sensory neurons. – Stimulus amplitude and intensity of sensation. – Adaptation rate and duration of stimulation.	Chapter 21
14-16	– Construction of visual images. – Visual perception. – Processing of motion, depth, form, and color. – Visual attention and conscious awareness. – Visual Processing. – Eye's receptor sheet. – Phototransduction. – Receptor adaptation to changes in light intensity. – Retinal output and signal relay.	Chapter 25, 26
Final Exam		

Evaluation		
Assessment Tool	**Expected Due Date**	**Weight**
Participation and project	End of the Semester	10%
First Exam	According to the Department schedule	25 %
Second Exam	According to the Department schedule	25 %
Final Exam	According to the University final examination schedule	40 %

Teaching & Learning Methods

- Active learning, where students should be active and involved in the learning process inside the classroom, will be emphasized in the delivery of this course.
- Different active learning methods/approaches such as: Engaged Learning, Project-Based Learning, Cooperative Learning, Problem-based Learning, Structured Problem-solving, will be used.
- The teaching method that will be used in this course will be composed of a series of mini lectures interrupted with frequent discussions and brainstorming exercises. PowerPoint presentations will be prepared for the course materials.
- A typical lecture would start with a short review (~ 5 minutes) using both PowerPoint presentations and the blackboard. This review will also depend on discussions which will gauge the students' digestion of the previous material. Then, the students would have a lecture on new materials using PowerPoint presentations and blackboard. The lecture presentation will be paused every 15 – 20 minutes with brainstorming questions and discussions that will allow the students to reflect and think in more depth about what they learned in that presentation. Then, some example problems will be presented and discussed with the students to illustrate the appropriate problem solving skills that the students should learn. The lecture will be continued for another 15 – 20 minutes, followed by examples and/or a quiz covering the materials taught in the previous two weeks.

Policy	
Attendance	Attendance will be checked at the beginning of each class. University regulations will be strictly followed for students exceeding the maximum number of absences. In addition, 0.5 point will be deducted from the grade of homework for each unexcused absence.
Term Project	Term projects will be conducted by a group of 2-3 students. The team should share and distribute responsibility. The group will submit a professional report and make an oral presentation. Making use of all resources, e.g., patents, journal publications, internet, labs, etc., is encouraged. The report must be typed. Hand-written reports are not accepted. The report should not exceed 10 pages. Late Reports will be penalized.
Student Conduct	It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in this course. University regulations will be pursued and enforced on any cheating student.

Contribution of Course to Meeting the Professional Component

The course aims at introducing the concepts and physiology of inter-neuronal signaling and communication as it pertains to control and communication in the nervous system.

ABET Category Content	
Engineering Science	3.0 Credits
Engineering Design	

Ultimately, Principles of Neural Science affirms that all behavior is an expression of neural activity, and that the future of clinical neurology and psychiatry hinges on the progress of neural science. Far exceeding the scope and scholarship of similar texts, this unmatched guide offers a commanding, scientifically rigorous perspective on the molecular mechanisms of neural function and diseaseâ€•one that youâ€™ll continually rely on to advance your comprehension of brain, mind, and behavior. FEATURES. The cornerstone reference in the field of neuroscience that explains how the nerves, brain, and Principles of Neural Science, 5e. The field's definitive work from a team of world-renowned authors.Â Sign up for monthly updates and previews of forthcoming products, and learn about new books, special offers, discounts and promotions within your field. First published in 1981 by Elsevier, Principles of Neural Science is an influential neuroscience textbook edited by Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. The original edition was 468 pages; now on the fifth edition, the book has grown to 1747 pages. The second edition was published in 1985, third in 1991, fourth in 2000. The fifth and latest edition was published on October 26th, 2012 and includes Steven A. Siegelbaum and A.J. Hudspeth as editors. It has been hailed as the "Bible