University of Victoria | Engineering

Course [1]	Quantitative human physiology (BME-201), Summer 2014	
Class time	Tuesdays and Wednesdays – 7:30 – 8:50	
Class Location	CLE A203	
Lecturers		E-Mail Addresses
Prof. Abdul Roudsari		abdul@uvic.ca
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Description

Physiology is the science of the function of living systems. This course specifically deals with the functions in human bodies and approaches it from a mathematical point of view. Each of these functions is performed by various systems, such as cardiovascular or endocrine system.

We will follow the same classification to better understand the measureable processes which result in body functions. Understanding these measurements is especially important as they can show us whether the studying function is performed normally or some abnormal behaviour is present. From the engineering point of view, this can be applied to systems for measuring and interpreting the functions; the feedback systems which aim to return the function to the normal level or the prosthetic systems which will totally replace the defective organs. Although the science of physiology is mainly focused on the function of the human systems in normal conditions, we will use some examples of pathological situations to understand better the impact of changes in our quantitative measures on body functions.

Course goals

- Discuss human organ systems and their functions
- Learn the quantitatively measureable variable related to the functions of each of those organ systems
- Discuss the normal range of those variables and provide some examples for the effect of abnormal values of those variables

[1] *This course has no lab component and it does not require Human Subject Research approval.*

- Learn about controlling mechanisms in human body which keeps those variables in normal range and the threshold effect which affects the performance of organ systems
- Learn the interactions between organ systems and the effect of impairment in each system on others

Learning outcomes

Upon successfully completing this course, students will be able to:

- Explain the measures for normal functioning of each of organ systems
- Discuss the impact of change in those measures on the related organ system functions
- Discuss the interactions between organ systems and calculate the impact of changes in one system on other systems
- Utilize the mathematical models presented in this course to develop artificial systems that can improve or even replace organ systems

Required reference

Joseph Feher. Quantitative human physiology: An introduction. Academic Press, Elsevier; 2012, ISBN: 978-0-12-382163-8

You can purchase the textbook from the University of Victoria bookstore[2] or online at http://www.uvicbookstore.ca/text/text.php. The second option is reading it at http://site.ebrary.com/lib/uvic/docDetail.action?docID=10533732 either through UVic LAN or via VPN connection to the university network.

Course teaching techniques

The main method of education in this course will be class-based lectures and discussions. We will follow an interactive scenario-based model to discuss the methods for applying the theories. We highly recommend active contribution to class discussions. The assignments and lecture handouts will be posted on CourseSpaces.[3]

Four hands on experience sessions will be provided. These sessions will cover Cardiac System, Pulmonary System, Neuro-Muscular Conduction and Metabolic measurement.

[2] *Please allow sufficient time for textbook delivery.*

[3] The PowerPoint presentations for this course are provided solely for the use by the student for research, private study, review, criticism or reporting. Any other use may be an infringement of copyright if done without securing the permission of the copyright owner.

The contents of the hand on experience sessions and assessment method are presented in CourseSpaces.

Students are expected to have read the material prior to the session; required reading for each session will be in Coursespaces.

Course sessions

(Please refer to Coursespaces for the detailed reading for each session)

Date	Title
May 6	Introduction of the Course, course outline and meeting with Instructors (45 min) Plasma and Blood (45 min) - Microcirculation and Solute Exchange
May 7	Plasma and Blood (45 min) - Microcirculation and Solute Exchange
May 13	Cardiac – Overview of the Cardiovascular system and Heart as a Pump
May 14	Cardiac – Action Potential and Electrocardiogram
May 20	Cardiac –Cardiac Function
May 21	Cardiac – Hemodynamics and Regulation of Perfusion
May 27	Cardiac – Cardiac Output and Venous return and Regulation of Arterial Pressure
May 28	Repiratory - Mechanics of Breathing review and Lung volumes and airway resistance
June 3	Respiratory - Gas exchange and Oxygen and Carbon Dioxide Transport
June 4	Nervous – Organization of Nervous System and Cells, synapses, and neurotransmitters
June 10	Mid-Term – Blood, Cardiac and Respiratory Systems
June 11	Nervous – Cutaneous Sensory Systems, Spinal Reflexes, Balance and Control of movement
June 17	Nervous – Hearing and Vision
June 18	Endocrine – General principles
June 24	Endocrine – Endocrine pancreas
June 25	Endocrine – Calcium and phosphorus homeostasis
July 2	Endocrine - Reproductive physiology
July 8	Renal – Body fluid compartments, functional anatomy of kidneys
July 9	Renal - Glomerular filtration and fluid volumes
July 17	Renal – Tubular reabsorption and secretion
July 18	Renal – Mechanism of concentration and dilution of urine, regulation of fluid and electrolyte balance
July 24	Renal - Components of acid-base balance
July 25	Gastrointestinal System Overview
July 30	Energy balance and regulation of food intake
July 31	Review session

Course Requirements and Grading Standards

Grading system:

Please refer to the following Uvic website for more information (http://web.uvic.ca/calendar2014/FACS/unin/UARe/Grad.html

Policies

All of the individual and group assignments must be completed to pass the course. For late submitted assignments, there should be evidence of why submissions are late such as a doctor's note. Otherwise, the penalty will be 5% for each of first three days and each day thereafter would be 20%.

Attendance is expected at least 20 out of 24 sessions. Instructor must be notified if student will not be coming to a session.

Uvic's policy on Academic Integrity is enforced.
http://web.uvic.ca/calendar2014/FACS/UnIn/UARe/PoAcI.html

Graded requirements:

The grades will be posted on Moodle.

Activity	Weight (%)
Mid-term test	20
Assignment	20
Hands-on experience	20
Final test	40

Mid-Term:

Mid-term will be given in June 10, 2014 and will include the material from May 6th to June 3rd Mid-term will be 20% of the course mark and will include 30 multiple choice questions (12 points) and five short answer questions (8 points).

Assignment:

Assignment will make up 20% of the course mark. The objective of the assignment is to encourage Bio-medical engineering students to identify the functions of a selected organ, review existing technologies, and identify the strengths and weaknesses of existing technologies to achieve the

required functions of the selected organ. Forming groups for assignment is allowed and up to 3 students can be a group.

The following questions are provided as guideline for assignment.

1. What is the overall function of the organ selected?
2. What are the specifications for the organ (e.g. output capacity, force it needs to generate, force it needs to endure, frequency of output, sensitivity, connectivity, ability to respond to changing needs, energy required, weight, size, etc.). These specifications would change depending on the organ, for example output capacity and ability to respond to changing needs might be relevant specifications for the heart but not for the eye. The specifications of the eye might be the image size, image clarity, and connection to the nervous system.
3. What kind of technology do we currently have and what kind of technology that is promising a future to repair the damaged organ?
4. What are the problems with the existing technologies? What is the most important challenge that technology needs to overcome in order to develop a viable solution?

Evaluation of the Assignment: Maximum total length of the paper is 6 paged single spaced and 12 pages double spaced. A minimum of 12pt characters must be used with one inch or 2.54 cm borders. Appendices are not counted within the page limit.

Characteristic	Percentage of the Mark
Description (calculation) of the organ's function and specifications	30%
Environmental scan for existing solutions	30%
Gap between the identified specifications and existing technologies	30%
Quality of writing and referencing (logical flow, clarity, brevity, factual, without duplications)	10%

Plagiarism detection software (Turnitin) might be used to screen anonymized version of assignments in this course for educational purpose. This is being done to verify that use of all materials and sources in assignments is documented. You can read more about the UVic policy on academic integrity at: http://ltc.uvic.ca/initiatives/integrity/student.php. Information about Turnitin is available at http://elearning.uvic.ca/turnitin and www.turnitin.com

You will retain copyright of the work submitted to Turnitin. Its use of student work complies with the Canadian copyright and privacy laws. Assignments submitted to Turnitin will be included as source documents in their restricted access database solely for the purpose of detecting plagiarism in such documents for five academic years.

You should check your assignments against Turnitin database before submission. We will provide you with a username and password for accessing this system. More information and training videos about using Turnitin are available at: http://elearning.uvic.ca/turnitin/student-guidelines. If you do not want to have your assignment screened, you should email us at least two weeks prior to the assignment due date.

Hands on Experience:

There will be four hands on experience sessions (each session is 5% and in total 20% of the course mark). Instructions and grading scheme for the hand on experience sessions are published in Coursespaces. The common structure is of the each hands of experience session includes a pre-session questions (1 point) and post-session questions (5 points). You need to bring the pre-session questions completed to the session and post-session questions to be handed in within two weeks after the session.

In the hands on experience sessions students will set-up experiments and collect data to be used for assignments. The topics covered will include four fundamental areas of human physiology:

Cardiovascular System

- Explain the following events in the cardiac cycle: changes in ventricular, aortic and atrial pressure; changes in ventricular volume; and heart sounds.
- Trace the path of action potentials through the conduction system of the heart and relate the heart's electrical activity to its pumping action.
- Describe the physics of blood flow through blood vessels. Explain the concepts of pressure gradients and resistance.
- Explain the role of arterioles in varying resistance. Describe how intrinsic control of vascular resistance regulated blood flow to organs. Explain the role of extrinsic control of arteriole radius in determining mean arterial pressure.
- Describe what the arterial baroreceptor is and explain how it regulates mean arterial pressure.

Respiratory System

- Describe the mechanics of breathing. Name the muscles of respiration.
- List the normal and partial pressures of oxygen and carbon dioxide in arterial and mixed venous blood and explain how they contribute to the exchange of gases.
- Identify the neural mechanisms that establish the respiratory rhythm.
- Distinguish between the respiratory centers that establish the rhythm and those that regulate the rhythm.
- Explain the role of peripheral and central chemoreceptors in the control of ventilation.

Metabolism

- Describe the path of oxygen from inspired air to muscle.

- Measure real-time human metabolism using indirect-calorimetry during rest and exercise.
- Describe the cardiovascular, pulmonary, and muscle factors are influence metabolism.
- Measure and describe the phenomenon of oxygen deficit and post-exercise oxygen consumption during varying exercise intensities.
- Describe how anaerobic energy systems supplement adenosine triphosphate (ATP) production throughout the spectrum of rest to maximal exercise.

Nervous System

- Identify the various properties of graded potentials, including direction of change in potential, magnitude of change and temporal and spatial summation.
- Measure electrical activity in human muscle.
- Describe the function of sensory receptors and explain how they perform that function.
- Measurement of nerve conduction velocity and reflex pathways.

Hand on Session Number	Session Date	Post-Session Questions due
1	TBA	
2	TBA	
3	TBA	
4	TBA	

Final Exam:

Final exam is 40% of the course mark. It will include the topics taught after June 3rd, 2014. These will include the nervous system, endocrine and renal systems. The final exam will consist of two sections. In the first section, 22 multiple-choice or matching questions are provided. Each correct answer to these questions will receive half point. Twenty multiple-choice questions with best answers will be marked. In the second part of the exam, 21 short-answer questions are presented. The best answers will be marked for 30 points.

Grading scheme:

Numerical Letter	Marks Grade	GPA
90 - 100	A+	9
85-89	A	8
80-84	A-	7
77-79	B+	6
73-76	B	5
70-72	B-	4
65-69	C+	3
60-64	C	2

50-59	D	1
0-49	F	0
0-49	N	0