

FACULTY of SCIENCE
Department of Physics and Astronomy

Course: SC/BPHS 2090 3.0 (cross-listed to SC/BIOL 2090 3.0) – **Current Topics in Biophysics**

Course Webpage: <https://moodle.yorku.ca>

Prerequisite / Co-requisite: SC/PHYS 1010 6.00 or SC/PHYS 1410 6.00 or SC/PHYS 1420 6.00; SC/BIOL 1000 3.00 and SC/BIOL 1001 3.00 or SC/BIOL 1410 6.00.

Course Instructor: Stan Jerzak, Office: 233 PSE, e-mail: jerzak@yorku.ca,
phone: 416-736-2100, ext. 44102.

Time and Location: Lectures, Tuesdays and Thursdays, 11:30 a.m. – 1:00 p.m., CB 129.

Course Description: An introduction to biophysics highlighting major themes in pure and applied biophysical research. The current topics format gives the course director latitude to choose topics that illuminate both biology and physics. Sample topics: fluid mechanics, diffusion, neuro-biophysics, biophotonics, nuclear biophysics and magnetic resonance imaging technique. Concepts surveyed in this course will be further expanded in the third and fourth year biophysics courses.

Organization of the Course: The lectures are central to the course. Lectures serve to enrich, clarify, and illustrate crucial current issues in biophysics, with a primary focus on the application of physical approaches to biological problems. The material is reinforced by take-home assignments, student presentations and term tests.

Course Text / Readings

Stan Jerzak: Course Notes for Current Topics in Biophysics (2016)

(Detailed handouts and pdf files will be available on the Moodle website to provide the students with basic knowledge that is then expanded on in lectures.)

Evaluation

- Two term tests (40% total) and a final exam (35%)
 The term tests will be held on Tuesdays, October 11 and November 22
- Assignments (10%)
- Class participation (7.5%)
- Student presentations (7.5%)

Missed Tests: Students with a documented reason for missing a course test, such as illness, compassionate grounds, etc., which is confirmed by supporting documentation (e.g., doctor's letter) will have the weight of the missed term test transferred to the final exam.

“Final course grades may be adjusted to conform to Program or Faculty grades distribution profiles.”

Grading: The grading scheme for the course conforms to the 9-point grading system used in undergraduate programs at York (e.g., A+ = 9, A = 8, B+ = 7, C+ = 5, etc.). Assignments and tests* will bear either a letter grade designation or a corresponding number grade (e.g. A+ = 90 to 100, A = 80 to 90, B+ = 75 to 79, etc.). For a full description of York grading system see the York University

Undergraduate Calendar - <http://calendars.registrar.yorku.ca/2013-2014/index.php>. Students may take a limited number of courses for degree credit on an ungraded (pass/fail) basis. For full information on this option see Alternative Grading Option in the (*Faculty of Science and Engineering*) section of the Undergraduate Calendar.

Assignment Submission: Proper academic performance depends on students doing their work not only well, but on time. Accordingly, assignments for this course must be received on the due date specified for the assignment.

Lateness Penalty: Assignments received later than the due date will be penalized (usually 10% for the first day, 20% for the second, 40% for the third, ad infinitum).

IMPORTANT COURSE INFORMATION FOR STUDENTS

All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage (see Reports, Initiatives, Documents) - <http://www.yorku.ca/secretariat/senate/committees/ascp/index-ascp.html>

- Senate Policy on Academic Honesty and the Academic Integrity Website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation

Detailed course content:

Fluid Dynamics

Streamline and turbulent flow
Viscosity of fluid and Poiseuille equation
Reynolds number
Flow of blood and anaphylactic shock
Fluid flow in trees
Motion of organisms in viscous fluids

Diffusion

The Stokes-Einstein equation
Fick's laws of diffusion
Osmosis
Transport through membranes

Biophotonics

Absorption of radiation, Lambert-Beer Law, absorption cross-section and linear absorption coefficient
Absorption spectra of chlorophyll and aminoacids
Fluorescence, Phosphorescence, Quenching and Energy Transfer
Ultraviolet and skin cancers
Porphyria
Cancer therapies using light: Photothermal Therapy, Photodynamic Therapy and Plasmonic

Photothermal Therapy

Fluorescence microscopy and Stimulated Emission Depletion (STED) microscopy

The eye (cones and rods, rhodopsin and retinal, colour blindness, night blindness and visual acuity)

Nuclear Biophysics

Interaction of gamma radiation and charged particles with matter

Rate of radioactive decay (Activity)

Attenuation of nuclear radiation, absorbed dose, Relative biological effectiveness and biological dose equivalent

High and low linear energy transfer radiation

Somatic and genetic radiation effects

Direct and indirect radiation damage of DNA

Deterministic and stochastic effects of radiation

Applications of radioisotopes in biology and medicine

Biological half-lives

Cancer radiation therapy, Bragg Peak and Endoradiotherapy

Positron Emission Tomography (PET)

The Brain (Neurobiophysics)

Membrane potential and Nernst equation

Action potential formation and the role of gated ion channels

Electrical properties of neurons

Electroencephalography, Magnetoencephalography and Transcranial Magnetic Stimulation

Functional Magnetic Resonance Imaging (F-MRI)

- Precession of spin angular momentum in a magnetic field

- Longitudinal (spin-lattice) relaxation time and Transverse (spin-spin) relaxation time

- Blood-oxygen level dependent (BOLD) F-MRI

- Magnetism of hemoglobin (high and low spin hemoglobin)

17 November 2016