Biomekanik (SE2121), 9 ECTS (6 credits), 2013

1 Structure

The course provides the foundation for one, two- and three dimensional mechanical problems in soft tissue biomechanics with applications to arteries in health and disease, and muscles. In particular, related experimental studies, physical and numerical formulations are pointed out.

2 Teachers

The teaching consists of lectures, tutorials and laboratory works. Details are shown on page 3. The laboratory will be carried out at the Department of Solid Mechanics.

Lectures

Prof. Gerhard Holzapfel (coordinator), email: gh@hallf.kth.se, phone: 790 8205

Tutorials and laboratory works

M.Sc. Andrii Grytsan, email: grytsan@kth.se, phone: 790 7544

3 Schedule

Time and place for the lectures, tutorials, laboratory works and the content of the course can be found on page 3.

4 Course Material, Books

The course is not based on a book. It is a compilation of several papers and books driven by the experience and the own research work by the instructor. Students may, however, wish to consult the following English literature (listed from more to less important):

D. Boal, “Mechanics of the Cell”, Cambridge University Press, 2012, Cambridge, 2nd edition, 523 kr

C.R. Ethier and C.A. Simmons, “Introductory Biomechanics. From Cells to Organisms”, Cambridge University Press, 2007, Cambridge, 448 kr

Y.C. Fung, “Biomechanics. Mechanical Properties of Living Tissues”, Springer-Verlag, 1993, New York, 2nd edition, 693 kr

G.A. Holzapfel, “Nonlinear Solid Mechanics. A Continuum Approach for Engineering”, John Wiley & Sons, 2000, Chichester, 389 kr

G.A. Holzapfel, R.W. Ogden (eds). “Biomechanics of Soft Tissue in Cardiovascular Systems”, Springer-Verlag, 2003, 1283 kr

G.A. Holzapfel, R.W. Ogden (eds.): “Mechanics of Biological Tissue”, Springer-Verlag, 2006, Heidelberg, 1283 kr

G.A. Holzapfel, R.W. Ogden (eds.): “Biomechanical Modelling at the Molecular, Cellular and Tissue Levels”, CISM Courses and Lectures No. 508, Springer, Wien, New York, 2009, 1470 kr

G.A. Holzapfel, E. Kuhl (eds.): “Computer Models in Biomechanics: From Nano to Macro”, Springer, 2013, 1872 kr

J.D. Humphrey, S.L. Delange, “An Introduction to Biomechanics, Solids and Fluids, Analysis and Design”, Springer-Verlag, 2004, New York, 802 kr

J.D. Humphrey, “Cardiovascular Solid Mechanics. Cells, Tissues, and Organs”, Springer-Verlag, 2002, New York, 1097 kr

5 Course Requirements

5.1 Assignments (4.5p)

A set of assignments will be distributed during the course. For the student it is a requirement to hand in the processed assignments to the tutor Andrii Grytsan by **May 8, 2012, 6pm** at the latest. All assignments must be handed in. They are graded as positive or negative. A positive grade is a requirement to register for the written exam.

5.2 Written exam (4.5p)

A written examination will take place May 22, 8.00-13.00, in Lecture hall L51. The student must register his/her participation in advance on the department home page www.hallf.kth.se.
The written examination is composed of 10 problems that each has a maximum of five points. Hence, completely correct solutions to all problems will give 50 points. At the grading of a problem, reduction is made with:
1 point for a careless mistake, 2 points for a smaller principal error, and 3 points for a serious principal (logical) error. If the point reductions are larger than 3, the grading will be 0 points for that particular problem.

The grading will be made according to:

0-17 points: Not passed; F
18-20 points: Grade Fx
21-26 points: Grade E
27-32 points: Grade D
33-38 points: Grade C
39-44 points: Grade B
45-50 points: Grade A

The grade achieved by a student on the written examination is also his/her final grade on the course. Those with Grade Fx who are qualified and interested in a complementary examination should notify Gerhard A. Holzapfel at the latest on Friday, June 14. The complementary examination will consist of three new problems that cover three specified subject areas and that each has a maximum of six points. To achieve the Grade E at least 11 points are required. The principles for corrections will be the same as in the ordinary examination.

6 Course Evaluation

All students are asked to participate in the computer based course evaluation. The evaluation form will be available on the department home page www.hallf.kth.se

7 Detailed Program

Below, lectures are denoted **F**, and laboratory works are denoted **L**.

Week	Form of teaching	Date	Subject
12	F1	Mån: Mar-18	Introduction to Biomechanics and Mechanobiology – Motivation
	F2	Tis: Mar-19	General mechanical characteristics of soft biological tissues
	F3	Tor: Mar-21	1D, 3D modeling of (isotropic) materials undergoing large deformations
	F4	Fre: Mar-22	2D modeling of (isotropic) materials
13	F5	Tis: Mar 26	Modeling of anisotropic materials
	F6	Ons: Mar-27	Structure and function of normal and diseased arterial walls
	F7	Tor: Mar-28	Experimental identification of mechanical properties; specific constitutive equations
15	F8	Tis: Apr-9	Stress analysis
	F9	Ons: Apr-10	Residual stress
	F10	Tor: Apr-11	Growth and remodeling
	F11	Fre: Apr-12	Material testing of biological tissue
16	F12	Mån: Apr-15	Clinical applications – aneurysms
	F13	Tis: Apr-16	Balloon angioplasty
	L1	Ons: Apr-17	Structure and function of muscles
	F14	Tor: Apr-18	Material testing of biological tissue – I
	F15	Fre: Apr-19	Passive and active mechanical properties
17	F16	Mån: Apr-22	Constitutive equations
	F17	Tis: Apr-23	Skeletal muscle
	F18	For: Apr-25	Heart muscle
	F19	Fre: Apr-26	Smooth muscle
18	F20	Mån: Apr-29	Basic composition of cells
	F21	Tis: Apr-30	Typical loading on cells
	F22	Tor: May-2	Mechanical properties of blood cells
	F23	Fre: May-3	Endothelial cells and fibroblasts
19	L2	Mån: May-6	Cell adhesion
	F24	Tis: May-7	Material testing of biological tissue – II

May 22, 8.00-13.00: Written examination in Lecture hall L51