COURSE DESCRIPTION CARD - SYLLABUS

Course name
Heat transfer in bioengineering [S2IBio1-IIiP>WCwB]

Course

Field of study
Biomedical Engineering

Year/Semester
2/3

Area of study (specialization)
Engineering of Implants and Prosthesis

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Knowledge of mathematics, mechanics, fluid mechanics, strength of materials, heat transfer and differential equations, finite element method. Skills of logical thinking, the use of information obtained from the library and the Internet. Social competencies of understanding the need for learning and acquiring new knowledge.

Course objective

Getting to know theoretical knowledge and acquisition of computational practice to solve problems of heat transfer and biotherm in biomedical engineering. Acquiring the ability to take into account the effects of heat and temperature on the body. Acquiring the ability to analyze the influence of thermal- mechanical properties on materials and biomedical devices.

Course-related learning outcomes

Knowledge:
He has an ordered, theoretically founded knowledge of technical mechanics and computational fluid mechanics, which allows to calculate: elements of the theory of stress and strain, laminar and turbulent flow, flows through closed and open channels, Navier-Stokes equations, heat transfer and thermoelasticity issues.

Skills:
He can use a mathematical apparatus to describe mechanical issues, structures and technological processes, can use the known methods and mathematical models, as well as computer simulations to analyze and evaluate the operation of elements and systems in devices.

Social competences:
Is aware of the importance and understanding of non-technical aspects and effects of engineering activities, including its impact on the environment, and the related responsibility for decisions made.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lecture: Credit in writing on the basis of general questions or scores (credit in the case of obtaining 51% of points:> 50% - 3.0,> 60% - 3.5,> 70% - 4.0,> 80% - 4.5,> 90 % of points - 5.0) carried out at the end of the semester. In the case of remote work, it may be implemented in the form of a technical problem developed and solved described in the selected scientific publication.
Laboratory / project: Assessment on the basis of the project of the developed problem / issues in the field of content of issues performed in the laboratory exercises. The form and quality of prepared materials is assessed (description of issues, theory, method, results, analysis and literature). The prepared data will allow calculations and graphical representation of the calculations.

Programme content

Heat transfer by conduction, convection and radiation. It exchanges heat in the liquid. It exchanges heat in organisms (biothermal equation). The flow of body fluid through a tissue or organ (perfusion). Basic laws of heat conduction and thermal stresses. Mathematical models of heat transfer
and thermal stresses. Boundary and initial conditions. Finite element method in the problems of heat transfer.

Course topics

Lecture: Heat transfer by conduction, convection and radiation. It exchanges heat in the liquid. It exchanges heat in organisms (biothermal equation). The flow of body fluid through a tissue or organ (perfusion). Basic laws of heat conduction and thermal stresses. Mathematical models of heat transfer and thermal stresses. Boundary and initial conditions. Finite element method in the problems of heat transfer.
Laboratory: Solving engineering problems related to the content of the lecture in a computer program (eg Comsol Multiphysics). Computer and mathematical models (equations with initial-boundary conditions) for the analysis of the impact of temperature on human skin, modeling the cryotherapy and ablation treatment, and the influence of solar radiation on the body will be prepared for the laboratory content presented in the lecture. The prepared data will allow for calculations and graphical representation of the calculations.

Teaching methods

Lecture: lecture / problem lecture / lecture with multimedia presentation.
The content of the lecture is presented in the form of a multimedia presentation in combination with a classic blackboard lecture enriched with shows related to the issues presented.
Computer laboratory: project method (research, implementation, practical project) / group work / task solving.

Bibliography

Basic
Stefan Wiśniewski, Tomasz S. Wiśniewski, Wymiana ciepła (wyd 6), PWN, Warszawa, 2017.
Adrian Bejan, Allan D. Kraus, Heat Transfer Handbook, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.
Ryszard Tadeusiewicz, Inżynieria biomedyczna - księga współczesnej wiedzy tajemnej w wersji przystępnej i przyjemnej, Wydawnictwo AGH, 2008.

Henryk Leda, Materiały inżynierskie w zastosowaniach biomedycznych, Wydawnictwo Politechniki Poznańskiej, Poznań, 2011.
Andriy Milenin, Podstawy metody elementów skończonych. Zagadnienia termomechaniczne, Wydawnictwo AGH, 2010.
Irving P. Herman, Physics of Human Body, Springer, Berlin, 2007.
O.C. Zienkiewicz , R.L. Taylor , The Finite Element Method, Volume 1-3, 5th edition, Butterworth-Heinemann, Oxford, 2000. (7th edition - 2013: https://www.elsevier.com/books/the-finite-element-method-its-basis-and-fundamentals/zienkiewicz/978-1-85617-633-0)
William B. J. Zimmerman, Multiphysics Modeling With Finite Element Methods, Series on Stability Vibration and Control of Systems, Series A - Vol. 18, 2006.
Additional
Taler J., Duda P.: Rozwiązywanie prostych i odwrotnych zagadnień przewodzenia ciepła, WNT, Warszawa 2003.
A.J.H. Frijns, G.M.J. van Leeuwen, A.A. van Steenhoven, Modelling Heat Transfer in Humans, Ercoftac Bulletin, nr 68(2006), str. 43 – 47.
Yu.I. Luchakov, A.D. Nozdrachev, Mechanism of Heat Transfer in Different Regions of Human Body, Biology Bulletin, nr 36(2009), str. 53 – 57.
V. Mitvalsky, Heat Transfer in the Laminar Flow of Human Blood through Tube and Annulus, Nature 206(1965).
Marek Paruch, Zastosowanie metod identyfikacji w wybranych zagadnieniach przepływu biociepła, Gliwice, 2005.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00