COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of Orthopaedic Biomechanics

Course

Field of study
Biomedical Engineering
Area of study (specialization)

Level of study
First-cycle studies
Form of study
full-time

Year/Semester
3/5
Profile of study
general academic
Course offered in
Polish
Requirements
compulsory

Number of hours

Lecture
15
Laboratory classes

Other (e.g. online)

Tutorials
15
Projects/seminars

Number of credit points

2

Lecturers

Responsible for the course/lecturer:
dr n. med. Adam M. Pogorzała

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Responsible for the course/lecturer:

Prerequisites

Basic knowledge of human body anatomy and physiology with kinesiology. Basic knowledge of mechanics.

Course objective

The student-bioengineer should acquire the knowledge and skills in the field of clinical orthopedic

biomechanics of the normal musculo-skeletal system and selected pathologies /presented to the extent enabling the orthopedic surgeon to plan surgical treatment /.

Course-related learning outcomes

Knowledge

1. Student has basic knowledge on the fundamentals of clinical orthopedic biomechanics of the normal skeletal-muscular system and selected pathologies.

2. Student has basic knowledge about the possibilities of endoprosthesoplastics of selected joints.

Skills

1. The student is able to characterize and determine the basic biomechanical properties of organs and parts of the bone-joint system and the human muscular system in health conditions and for selected pathologies.

2. Student is able to prepare and present oral and written presentation on basic clinical orthopedic biomechanics issues

Social competences

1. The student is able to work in a group.

2. The student is aware of the basic importance of clinical orthopedic biomechanics and the anatomy and physiology of the skeletal system for biomedical engineering, in particular for engineering biomechanics.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Test covering the entire knowledge of the subject, conducted at the end of the semester. Completion of the course - in the case of a correct answer to min. 60% of the final test questions; proportional scale of positive ratings (dst, dst +, db, db +, bdb).

Exercises / seminars: Credits based on oral or written answers regarding the content of each exercise, report on each exercise as instructed by the instructor. In order to pass the exercises, all exercises must be passed (positive grade from the answer and report).

Programme content

Lectures:

1. Introduction to the biomechanics of the musculoskeletal system, biocybernetic scheme of the human movement system, the action of internal (mainly muscles) and external forces on the human body and the mechanical effects of these forces.

2. Muscle functions: basic muscle functions; biostructure of muscle and striated muscle fiber; sliding theory of muscle contraction, electromechanical coupling; motor unit; muscle bioelectric activity, muscle fiber action potential, electromyography (EMG); stretch-contraction cycle.

3. Muscle as a servomotor (= source of mechanical strength): muscle strength and mass, absolute, relative and specific strength, physiological cross-section of the muscle and mucosal angle of muscle; structural biomechanical model of muscle, active and passive components of muscle strength, muscle strength as a function of its length; muscle strength as a function of excitation; muscle strength as a function of shortening speed, Hill equation, muscle power; the energy of muscle elasticity and its use in human movements.

4. Structure and biomechanics of bone and articular cartilage.

5. Structure and biomechanics of ligaments and tendons.

6. Structure and fundamentals of the biomechanics of the spine (development and structure of the spine: structure of the intervertebral disc, structure of the vertebrae, vertebral connections, structure and biomechanics of the movement segment of the spine, physiological curvatures of the spine - their role in damping (together with the intervertebral discs) mechanical dynamic loads, responsible muscles for static balance and spine movements, mobility of individual sections of the spine and the entire spine, basic spine load models (Schultz, Sotte).

7. Structure and biomechanics of the hip joint (structure of bone elements of the joint, articular surfaces, joint capsule and synovial membrane, synovial fluid and biotribological properties, muscles affecting the hip joint, normal hip joint mobility, basic models of joint load.

8. Pathomechanics of selected diseases of the hip (hip dysplasia, osteoarthritis), joint arthroplasty.

9. Construction and biomechanics of the knee joint (construction of bone elements of the joint, joint surfaces, menisci, joint ligament apparatus).

10. Pathomechanics of selected diseases of the knee joint (arthrosis, traumatic injuries), arthroplasty.

11. Structure and biomechanics of the ankle and shoulder joints, possibilities of arthroplasty of these joints.

12. Bone fractures, radiological and clinical diagnostics of the human musculoskeletal system.

Exercises / seminars:

1. Action of muscle forces on bone levers: types of lever, muscle moment, lever balance conditions, calculating the value of moments of strength and muscle forces acting on bone levers and reaction forces in bone joints.

2. Characteristics of human body inertia: translational and rotational movement of body parts; moment of inertia, Steiner's theorem about the moment of inertia; moment of inertia of a system composed of several parts (solids) applied to upper and lower limbs of a human being; methods of determining the moments of inertia of body parts.

3. Centers of mass and centers of gravity of body parts - determination methods.

4. Normal and pathological gait (gait phases, gait cycle, muscular activity during gait, gait parameters), kinematics of the joints of the lower limbs, pelvis and torso during gait.

5. Basics of biomechanics of the spine and pathomechanics of selected diseases of the spine (degeneration of the intervertebral disc, scoliosis, spondylolisthesis),

6. Pathomechanics of selected diseases of the ankle and shoulder joints.

Teaching methods

1. Lecture: presentation illustrated with examples given on the blackboard, solving problems.

2. Exercises: solving practical problems, discussion..

Bibliography

Basic

1. Bochenek A.: Anatomia człowieka, T.1. PZWL, Warszawa (wielokrotne wydania).

2. Sokołowska-Pituchowa J.: Anatomia człowieka. PZWL, Wyd. VIII, Warszawa 2008.

3. Nordin M., Frankel V. H.: Basic Biomechanics of the Musculoskeletal System (3-rd Ed.). Lippincott Williams & Wilkins 2001.

4. White A. A., Panjabi M. M.: Clinical Biomechanics of the Spine (2-nd Ed.). Lippincot Williams & Wilkins 1990.

5. Bober T., Zawadzki J.: Biomechanika układu ruchu człowieka. Wyd. BK, Wrocław 2006.

6. Błaszczyk J.W.: Biomechanika kliniczna. PZWL, Warszawa 2004, 2019.

7. Zeevi Dvir: Clinical Biomechanics. Churchill Livingstone 2000.

Additional

1. Mrozowski J., Awrejcewicz J.: Podstawy biomechaniki. Wyd. Politechniki Łódzkiej, Łódź 2004.

2. Maquet P. G. J.: Biomechanics of the Knee. Springer 1983.

3. Maquet P. G. J , Harris W. H.: Biomechanics of the Hip. Springer 1984.

4. Ramachandran M.: Basic Orthopaedic Sciences. Hodder Arnold Publication 2006.

5. Tencer A. F., Johnson K. D.: Biomechanics in Orthopedic Trauma. Lippincot Co. 1994.

6. Będziński R.: Biomechanika inżynierska, Wyd. Politechniki Wrocławskiej, 1997.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for tests, project preparation) [1]	20	1,0

[1] delete or add other activities as appropriate