BIOMECHANICS OF JOINTS AND ORTHOPAEDIC IMPLANTS

PROF. SANJAY GUPTA
Department of Mechanical Engineering
IIT KGP

PRE-REQUISITES : Engineering Mechanics, Solid Mechanics

INTENDED AUDIENCE : B.Tech / M.Tech / PhD students of Mechanical, Civil, Engineering Design, Biomedical Engineering and Medical students (with special interest)

INDUSTRIES APPLICABLE TO : Global Implant manufacturing companies like DePuy Johnson & Johnson, Zimmer, Stryker, Biomet, Smith & Nephew. Sports Authority of India and organizations requiring knowledge on Human Movement Science.

COURSE OUTLINE :

Biomechanics is a subject that seeks to understand the mechanics of living system. This subject helps to understand the relationship between structure and function of human joints, predict changes due to alterations, and propose methods of artificial interventions. This course is designed for B.Tech / M.Tech / PhD students who are likely to be benefited by learning the fundamental concepts of Biomechanics, joint kinetics and kinematics, tissue mechanics, implants design and analysis, as well as state-of-the-art techniques of modelling and simulation of biomechanical systems.

ABOUT INSTRUCTOR :

Prof. Sanjay Gupta earned his Ph.D. degree from the Delft University of Technology, The Netherlands, in the year 2002 for his research on shoulder biomechanics. Subsequently, he worked as Senior Research Fellow in University of Southampton, UK and as Research Associate in Imperial College London, UK, where he was involved in a variety of research projects in Orthopaedic Biomechanics and Implant Design. His primary research areas are bone and joint mechanics, pre clinical analysis of implant design and tissue engineering. He completed his Bachelor's degree in Mechanical Engineering from Bengal Engineering College, University of Calcutta in 1989 and Masters degree in Mechanical Engineering from Jadavpur University, Calcutta in 1992. He has developed Biomechanics Laboratory in the department and has successfully completed sponsored research projects, funded by national and international agencies.

COURSE PLAN :

Week 1: Introduction Musculoskeletal system Bone, Muscle, Ligament, Tendon, Cartilage and Meniscus – structure and function Anatomy of Synovial Joints – Hip, Knee, Shoulder, Elbow

Week 2: Biomechanics of Human Joints: (a) Hip Joint; (b) Knee Joint; (c) Shoulder Joint; (d) Elbow Joint

Week 3: Biomechanics of Gait cycle Gait Analysis Measurement techniques 3-D Motion analysis system – markers, cameras and force platform Lower extremity – hip musculoskeletal forces

Week 4: Joint Kinematics Principle of Forward and Inverse Dynamics Calculations on joint forces and moments Calculations on muscle forces Model-based estimation of musculoskeletal forces during movements

Week 5: Concepts of Stresses and Strain Bone structure - Cancellous and Cortical Bone Mechanical Behaviour of Bone Adaptation and Viscoelasticity Bone Anisotropy.

Week 6: Biomechanics of Joint Replacement – Hip, Knee, Shoulder, Spine Cemented and Cementless fixation Failure mechanisms of implants Implant Design Considerations

Week 7: Biomechanical modelling techniques and analysis Finite Element Analysis of bone and implant Bone Remodelling – formulation, algorithm, simulation Experimental validation of numerical models

Week 8: Bone Fracture Healing Tissue Differentiation Mechanoregulatory principle Mechanobiology based simulation of bone ingrowth around implants – acetabular and femoral components