



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Biomedical Engineering

Subject Code: DI04003091

Subject Name: Biomechanics

<b>w. e. f. Academic Year:</b>	2025-26
<b>Semester:</b>	4 <sup>th</sup>
<b>Category of the Course:</b>	MOPEC

<b>Prerequisite:</b>	Basic knowledge of human anatomy and physiology, applied physics, and elementary engineering mechanics.
<b>Rationale:</b>	Biomechanics deals with the application of mechanical principles to biological systems, particularly the human body. This course introduces diploma students to fundamental concepts of forces, motion, and material properties as applied to bones, joints, muscles, and physiological systems. The subject provides a foundation for understanding human movement, rehabilitation devices, and basic biomedical applications.

## Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
1	Explain basic concepts of biomechanics and their relevance to human body systems.	R, U
2	Describe forces and movements acting on bones and joints.	R, U, A
3	Explain mechanical behavior of muscles and soft tissues.	R, U
4	Understand basic principles of biofluid flow in cardiovascular and respiratory systems.	R, U
5	Apply biomechanics concepts to posture, gait, and basic biomedical applications.	R, U, A

*\*Revised Bloom's Taxonomy (RBT)*



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### Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE(E)		PA(M)	PA(I)	ESE (V)	
3	0	0	3	70	30	0	0	100

### Course Content:

Unit No.	Content	No. of Hours	% of Weightage
<b>1</b>	<b>Introduction to Biomechanics and Basic Mechanics</b>	<b>09</b>	<b>20 %</b>
	1.1. Definition and scope of biomechanics 1.2. Importance of biomechanics in biomedical engineering 1.3. Review of basic mechanics: a. Force, mass, weight b. Types of forces c. Work, energy, and power (basic concepts only) 1.4. Newton's laws of motion with biological examples 1.5. Moment and lever system in the human body		
<b>2</b>	<b>Biomechanics of Bones and Joints</b>	<b>10</b>	<b>25</b>
	2.1 Overview of human skeletal system 2.2 Types of bones and joints 2.3 Mechanical properties of bones (strength, stiffness – qualitative) 2.4 Forces acting on joints 2.5 Basic joint movements: • Elbow joint • Knee joint • Hip joint		
<b>3</b>	<b>Biomechanics of Muscles and Soft Tissues</b>	<b>10</b>	<b>25%</b>
	3.1 Introduction to soft tissues 3.2 Structure and function of: • Muscle • Tendon • Ligament		



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	<ul style="list-style-type: none"> <li>• Cartilage</li> </ul> <p>3.4 Types of muscle contraction:</p> <ul style="list-style-type: none"> <li>• Isometric</li> <li>• Isotonic</li> </ul> <p>3.5 Basic muscle mechanics (force-length and force-velocity concept – descriptive)</p>		
<b>4</b>	<b>Biofluid Mechanics and Cardiovascular System</b>	<b>08</b>	<b>15 %</b>
	<p>4.1 Introduction to biofluids</p> <p>4.2 Properties of blood (viscosity – qualitative idea)</p> <p>4.3 Laminar and turbulent flow (basic concept)</p> <p>4.4 Blood flow in arteries and veins</p> <p>4.5 Introduction to cardiovascular system:</p> <ul style="list-style-type: none"> <li>• Heart as a pump</li> <li>• Blood vessels</li> </ul> <p>4.6 Introduction to artificial heart valves</p>		
<b>5</b>	<b>Applied Biomechanics and Biomedical Applications</b>	<b>08</b>	<b>15 %</b>
	<p>5.1 Biomechanics of posture:</p> <ul style="list-style-type: none"> <li>• Standing</li> <li>• Sitting</li> <li>• Lifting</li> </ul> <p>5.2 Introduction to gait:</p> <ul style="list-style-type: none"> <li>• Phases of walking</li> <li>• Normal human gait</li> </ul> <p>5.3 Basics of orthopedic implants:</p> <ul style="list-style-type: none"> <li>• Need for implants</li> <li>• Examples: hip joint, knee joint</li> </ul> <p>5.4 Role of biomechanics in rehabilitation and assistive devices</p>		
	<b>Total</b>	<b>45 Hrs.</b>	<b>100 %</b>

**Suggested Specification Table with Marks (Theory):**

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
30 %	40 %	30 %	--	--	--

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*



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## References/Suggested Learning Resources:

### (a) Books:

1. Duane Knudson – Fundamentals of Biomechanics
2. N. Ozkaya & M. Nordin – Fundamentals of Biomechanics
3. D. J. Schneck & J. D. Bronzino – Biomechanics: Principles and Applications
4. Roger Bartlett – Introduction to Sports Biomechanics
5. Khandpur – *Handbook of Biomedical Instrumentation*

### (b) Open-source software and website:

1. <https://nptel.ac.in/courses/102106098>
2. [https://onlinecourses.nptel.ac.in/noc26\\_hs51/preview](https://onlinecourses.nptel.ac.in/noc26_hs51/preview)

## Suggested Activities for Students (Biomaterials & Implants):

In addition to classroom and laboratory learning, students are encouraged to engage in co-curricular and activity-based learning that enhances their understanding of biomechanics concepts and their biomedical applications. These activities may be conducted individually or in groups and should be documented in the form of brief reports (approximately 5 pages). Collection of photographs, charts, models, or other physical evidence of work will support student portfolios and may be useful during placement interviews.

### Hands-on Model Development Activity

- Activity: Students design and prepare physical or 3D models of human joints (elbow, knee, hip) or lever systems in the human body using low-cost materials.
- Objective: To strengthen understanding of joint mechanics and movement.

### Gait and Posture Observation Activity

- Activity: Students record or observe normal human gait and posture using videos or live observation and identify different phases of gait and posture deviations.
- Objective: To understand applied biomechanics in daily human activities.

### Biomechanics Chart and Poster Preparation

- Activity: Students prepare charts or posters on topics such as muscle contraction types, joint movements, soft tissue functions, or biomechanics of daily activities.
- Objective: To improve conceptual clarity and visual learning.



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## **Case Study on Orthopedic Implants**

- Activity: Students study and present a case study on commonly used orthopedic implants (hip or knee) focusing on design, material, and biomechanical function.
- Objective: To relate biomechanics concepts to clinical applications.

## **Simulation and Video-Based Learning Activity**

- Activity: Students use open-source videos, animations, or simulations to study muscle movement, blood flow, gait cycle, or posture correction techniques.
- Objective: To visualize complex biomechanical processes.

## **Mini-Project Group Activity**

- Activity: In small teams, students develop a conceptual or prototype model related to biomechanics, such as a low-cost rehabilitation aid, posture correction device, or joint movement model.
- Objective: To encourage teamwork, problem-solving, and application of biomechanics principles.

## **Expert Talk / Hospital or Rehabilitation Centre Visit**

- Activity: Students attend an expert lecture or visit a hospital, physiotherapy, or rehabilitation centre to observe real-world biomechanics applications.
- Objective: To connect classroom learning with industry and healthcare practices.

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