GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3733107
Semester –III
Biotransport Process

Type of course: Program Elective V

Prerequisite: Human anatomy and physiology, Basic Physics, Higher engineering mathematics

Rationale: The transport phenomena occurs in the biological systems is the quantitative description of momentum transport and mass transport. The biotransport phenomena uses the fundamental principles of momentum, heat and mass transfer at microscopic and macroscopic scales and use the fundamentals in conjunction with conservation laws to develop mathematical descriptions of physiological systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**Overview of biotransport processes and phenomena:** Introduction, Fundamental and derived Dimensions, Conservation of Mass, First and Second Law of Thermodynamics	5
2	The physical and flow properties of body fluid, Cellular components and rheology, body fluid composition, capillary plasma protein retention, osmotic pressure, the formation of the interstitial fluid, net capillary filtration rate, cell membrane, ion pumps, capillary rise, and capillary action	8
3	**Solute transport in biological systems:** Introduction, capillary properties and flow rate, solute diffusion, solute diffusion within heterogeneous media, solute permeability, irreversible thermodynamics of membrane transport, transport of solutes across the capillary wall, Krogh tissue cylinder and modeling	10
4	**Oxygen transport in biological systems**: Diffusion of oxygen in multicellular systems, hemoglobin, oxygen-hemoglobin dissociation curve, oxygen levels in the blood, Hill equation, tissue oxygenation, Oxygen transport in bioartificial organs and tissue-engineered constructs, Artificial Blood	10

5	**Pharmacokinetic analysis**: Terminology, entry routes for drugs, modeling approaches, factors affecting drug distribution, drug clearance, a model for intravenous injection of the drug, accumulation of the drug in the urine, constant infusion of the drug Extracorporeal devices, contacting schemes, membrane solute transport, estimating the mass transfer coefficients, estimating the solute diffusivity in blood, hemodialysis, Blood-oxygenators.	**9**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	**25%**	**20%**	**15%**	**15%**	**10%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

Reference Books:

1. Basic Transport Phenomena in Biomedical Engineering Third Edition Ronald L. Fournier, CRC Press

2. Biotransport: Principles and Applications, Robert J. Roselli, Kenneth R. Diller, Springer

3. Transport Phenomena Second Edition R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot

John Wiley and Sons Inc.

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To understand the fundamentals of Biotransport processes.	15
CO-2	To analyze the fluid transport phenomena.	20
CO-3	To study solute transport mechanisms with thermodynamics and mathematical modeling.	25

CO-4	To understand the oxygen transport in natural and artificial systems.	25
CO-5	Application of biotransport principles in pharmaceutical drug transport and relevant medical devices.	15

List of Open Source Software/learning website:

http://www.biotransport.net/course1.html
https://ocw.mit.edu/courses/biological-engineering/
https://www.mdpi.com/1996-1944/3/4/2412
https://onlinelibrary.wiley.com/doi/pdf/10.1002/tl.254