GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3723114
Semester – II
Subject Name: Cardiovascular System & Dynamics

Type of course: Core

Prerequisite: Cardiovascular System & Dynamics

Rationale: To attain comprehensive knowledge and understanding of the vascular system, the heart and the blood system in terms of function and basic structure. This will enable the students to understand the types of blood flow that occurs into the blood vessel and how blood interacts with the walls of the blood vessel. The reason for emphasizing on the fundamental aspects is that it will provide a detailed understanding of the properties associated with the system, at a level which students and teachers at this age range can feel comfortable with.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Cardiovascular system of human body, Electrical system of the heart, Mechanical events in cardiac cycle, correlation between mechanical and electrical events in the heart, coronary circulation, Microcirculation	6
2	Kinetic energy, pressure-volume relations in ventricles, cardiac valve dysfunction, blood pressure regulation and controlling factors, heart failure, Blood hematology and blood Rheology, Blood characteristics, Abnormalities of blood, Blood types, Plasma viscosity, blood pH	8
3	Introduction to fluid mechanics, fluid properties, basic laws of conservation of mass, energy and momentum, Stress, Strain, Elasticity, Hook's law, Newton's laws of viscosity, Power law constitutive model for blood, Fluid characteristics and viscosity, calculation of yield stress for blood	8
4	Types of fluid flow , Laminar blood flow, Turbulent blood flow, Importance of turbulence, Newtonian fluids, Non Newtonian fluids, Laminar Flow of Non Newtonian Fluids, Flow of Newtonian and non Newtonian fluid in rigid, flexible and collapsible tubes, blood flow	12

	through arteries and veins, methods for measuring viscosity, forces that drive or resist blood flow, Vascular resistance to blood flow, Reynolds number, Poiseuille's law, Application of Poiseuille's law, Bernoulli equation, Pulsatile Flow.	
5	Anatomy and physiology of blood vessels, Wave phenomena in blood vessels, Types of vessels, Mechanics of arterial walls, Compliance, Windkessel model, vascular pathologies, coronary artery bypass grafting (CABG), Intra Aortic Balloon Pump (IABP).	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**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 above table.

Reference Books:

1. Biomechanics: Circulation By Y.C.Fung. Pub. Springer Verlay. New York.
2. Biofluid Dynamics , P. Nithiarasu , School of Engineering, Swansea University, SWansea SA2 8PP
3. Biofluid Mechanics: By Jagan. N. Mazumdar Pub. World scientific
4. Biofluid Mechanics: The Human Circulation 2nd Edition, Krishna B. Chandran, Stanley E. Rittgers, Ajit P. Yoganathan, CRC Press
5. Biofluid mechanics in cardiovascular system: By Lee Waite Pub. Mc Grawhill
6. Snapshots of Hemodynamzics: By Nico Westerof Pub. Springer
7. Cardiovascular Fluid Mechanics - lecture notes - F.N. van de Vosse and M.E.H. van Dongen, Eindhoven University of Technology
8. The Cardiovascular System: Mathematical Modeling, Numerical Algorithms, Clinical Applications Quarteroni, A.; Manzoni, A.; Vergara, C., Politecnico di Milano, Milano (Italy)

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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the physiology and anatomy of the heart and circulatory system	**20**
CO-2	Influence of pressure in maintaining the blood pressure and heart rate	**20**
CO-3	To analyse the Fluid characteristics and viscosity	**15**
CO-4	Integrate fluid dynamics engineering concepts to examine and to model the biological flow in human body	**25**
CO-5	Development of mathematical models of the cardiovascular system	**20**

List of Experiments:

1. To study a Web based interactive cardiovascular model
2. To use the Web based cardiovascular model to study the various cardiac malfunctions
3. To perform Blood flow simulation in ANSYS Fluent
4. To study the evaluation of compliance of artificial blood vessel graft
5. Multiscale modeling of cardiovascular function
6. Dynamics of a cardiovascular model obtaining measurable pulsatile pressure output

Major Equipment:

- Computer system with advanced simulation software for computational fluid dynamics (blood flow)

List of Open Source Software/learning website:

https://www.ansys.com/academic - ANSYS free student software
http://virtualrat.org/research-projects/cardiovascular-systems-dynamics-etiology-hypertension
https://www.bartleby.com/essay/The-Circulatory-System-and-Fluid-Dynamics-FKUMJ6SVC
https://web.stanford.edu/group/biodesign/cgi-bin/bmesource/sample-page/engineering/biomechanics/
http://www.mathworks.com.au/academia/student_center/tutorials/index.html