Course Type	Course Code	Name of Course	L	T	P	Credit
OE	MEO593	Biofluid Mechanics	3	0	0	9

Course Objective:

The objectives of this course are:

- To understand the application of fluid mechanics principles to major human organ systems.
- To understand and integrate fluid mechanics engineering concepts to comprehend the biological flows in the human body.
- To understand the underlying fluid mechanics employed in the diagnostic and treatment methods used in the clinical practice.

Course Outcomes

Upon successful completion of this course, students will:

- Understand the physiology and anatomy of biological systems.
- Formulate the problems related to fluid mechanics in human body system and solve by engineering concepts.
- Identify specific diseases in the human body and how fluid mechanics is involved in disease progression.
- Have the capability to carry out a research project based on the real biomedical problems with a perspective towards the design and development of new medical devices.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Review of fundamental fluid mechanics, Biorheology (Constitutive equations. NonNewtonian fluid models: Power-law fluid, Bingham Plastic fluid, Casson's fluid, Blood: Physical properties and viscous behavior of blood), Blood vessel mechanics	6	At the end of this module, students will be familiarized with basic fluid mechanics and its application to biofluids, Understanding the behavior of Newtonian and NonNewtonian fluids and the role of various dimensionless numbers in biofluid mechanics, Understanding of hematology and blood rheology, Formulation and explanation of rheological models of the blood.
2	Circulatory system physiology. Function of circulatory system, circulation in heart, Hemorheology, Models for blood flow: Steady flow in tubes, Oscillatory Flow in a rigid tube, Pulsatile flow in a rigid and elastic tube, Wave propagation in elastic tubes. Flow within curved vessels: secondary flows (Dean vortices and Lyne vortices), flow separation and recirculation, wall shear stress (WSS), oscillatory shear index (OSI), Applications in circulatory system: Flow hemodynamics in diseased arteries: stenosis and aneurysms. Heart-valve hemodynamics: Hemodynamic flow across an aortic valve.	11	At the end of this module, students will gain insights regarding the blood circulation system and different types of models used to study the blood flow in arteries, veins and capillaries. Understanding the flow dynamics through blood vessels and heart valves. Understanding the changes in blood flow through diseased arteries.
3.	Flow and mass transport in biological systems. Steady and unsteady state diffusion in dilute as	11	At the end of this module, students will be familiarized with the transport mechanisms

	well as concentrated solution, Trans-vascular and transmembrane transport, Mass transport and biochemical interactions in tissues, Transport of gases between blood and tissues.		behind various solutes and solvents, which are responsible for cellular metabolism and energy generation inside the human body
4	Fluid transport in different human organs: Respiratory system physiology, Air flow in the lungs Mechanics of breathing, Synovial joints physiology. Functions, properties and applications of synovial fluid flow. Transport in kidneys, Glomerular filtration and tubular reabsorption. Ocular fluid transport and intraocular flow. *Insilico*, *invitro* and *invivo* case studies related to biofluid mechanics.	11	At the end of this module, students will be acquainted with the fluid flow mechanism in major organs of the human body. Additionally, state of the art research in the field of bio-fluid mechanics will be discussed that can cater the students pursue research in this interdisciplinary field.

Text Books:

1. Chandran, K.B., Rittgers, S.E. and Yoganathan, A.P., 2012. Biofluid mechanics: the human circulation. CRC press.
2. Truskey, G. A., Yuan, F. and Katz, D. F. “Transport Phenomena in biological systems”, second edition, Prentice Hall, 2009.

Reference Books:

1. Kleinstreuer, C., 2016. Biofluid dynamics: Principles and selected applications. CRC Press.
2. Waite, L., 2005. Biofluid mechanics in cardiovascular systems. McGraw Hill Professional.
3. Zamir, M. and Ritman, E.L., 2000. The physics of pulsatile flow (pp. 49-50). New York: AIP Press.