King Fahd University of Petroleum & Minerals
College of Chemicals and Materials,Bioengineering Department
BIOE 455: Transport Phenomenon in Bioengineering (3-0-3)
Syllabus - Term 24A

Catalog Course Description: Physiological Fluid Mechanics, Conservation and Momentum Balances, Fluid Transport, Dimensional Analysis and Scaling, Momentum Transport, Fluid Flow, Mass Transport, Diffusion, Transvascular Transport, Transport across the Kidney and Lungs, Ligand-Receptor Kinetics, Transport of Drugs and Heat Transfer in Biological Systems.
Course Prerequisite: BIOE 211 **Co-requisite:** N/A

Textbook: Robert J. Roselli & Kenneth R. Diller, Biotransport: Principles and Applications, 1st Ed., Springer, 2011.
Instructor: Dr. Ahmed Dalaq /B7-R120-4 / Phone: 5527 / ahmed.dalaq@kfupm.edu.sa

Office Hours: UTR 10:00 AM−11:00 AM and by appointment

Course Learning Outcomes:
1. Identify and evaluate resources to learn independently
2. Apply new concepts, tools, or techniques within specific subject area
3. Explain the fundamental principles of transport phenomena (mass, momentum, and energy) and their application in bioengineering contexts.
4. Describe the rheological properties of biological fluids and their impact on flow behavior in physiological systems.
5. Understand the principles of heat transfer in biological systems, including macroscopic and microscopic approaches, and their role in thermoregulation.

The Grading Policy:

Classwork	**30%**	
Attendance	**0%**	(max can be allocated)
Assignments	**5%**	
Quizzes	**10%**	
Term Project	**15%**	**(Simulation problem)**
Major Exam I	**20%**	**(Date: 18th Sept 2025)**
Major Exam II	**20%**	**(Date: 6th Nov 2025)**
Final Exam	**30%**	**(TBA by the registrar)**

Important Notes:
- The students are encouraged to use any AI tool provided they highlight the parts written by such a tool and can answer any questions about it. **A proper citation for the exact name and version of the tool should be given.**
- Each student must be vigilant about academic integrity at all times.
- Only official excuses obtained from the Deanship of Students Affairs are accepted.
- If a student reaches more than 20% of unexcused absence (10 absences of the 45-lecture class or 7 absences of the 30-lecutre class), a DN grade will be issued.
- Excuses for officially authorized absences must be presented no later than one week following the resumption of class attendance.
- No makeup will be accommodated for missed quizzes or exams.
- Late assignments will not be accepted.
- A student caught cheating in any of the assignments will get ZERO in all assignments and other proper action will be taken that may eventually lead to the transfer of the student to student affairs.
- The instructor reserves the right to modify the course outline and policies mentioned in this syllabus at any time during the semester.
- Refer to the registrar website for the academic calendar and important deadlines: https://registrar.kfupm.edu.sa/academic-calendar/current-semester/

Course Topics

Week#	Ch.	Sections #	Topic
1	1	Part II: Ch 1, 2	Introduction to Physiological Fluid Mechanics
2	1	Part II: Ch 2	Conservation Principles, Transport Mechanisms, Constitutive Equations for molecular Transport, Macroscopic Transport Coefficients
3	4	Part II: Ch 3	Modeling and Solving Bio-transport problems, Buckingham Pi Theorem (Dimensional analysis)
4	5	Part III: Ch 4	Biofluid: Rheology of Biological Fluids
5	6	Part III: Ch 5	Biofluid: Macroscopic Approach for biofluid Transport, conservation of mass, momentum and energy, Engineering Bernoulli
6	2	Part III: Ch 6	Biofluid: friction loss in conduits, flow resistance in noncircular conduits, flow in packed beds
7	3	Part III: Ch 5	Biofluid: Macroscopic Approach II, Blood flow in Micro vessels, Steady flow through network of rigid conduits, Compliance and resistance of Flexible conduits, flow in collapsible tubes.
8	7	Part III: Ch 5	Biofluid: 1D differential analysis (microscopic approach), Differential form of conservation laws, constitutive relationships, Flow of a Newtonian fluid through blood vessel, Flow through an annulus, Casson fluid flow in cylindrical vessels.
9	8	Part III: Ch 6, 7	Biofluid: General microscopic analysis (differential analysis in 3D), conservation laws, Navier-Stokes equations, non-Newtonian fluids (Power law, Bingham, Casson and Herchel-Bulkely)
10	9	Part IV: Ch 8	Bioheat: Macroscopic heat transfer, thermal resistance, heat transfer coefficient, lumped analysis, thermal compartmental analysis, human thermoregulation
11	10	Part IV: Ch 9	Bioheat: Differential analysis in 1D, steady and unsteady heat transfer in slabs, cylinders and spheres.
12	11	Part V: Ch 12, 13	Biological Mass Transport: Diffusion, Phase equilibria, diffusion flux, Fick's law, external mass transfer coefficient, permeability