SAWA UNIVERSITY

ميكانيك الموائع الحيوية

Biofluid Mechanics

جامعة ساوة الأهلية

الكلية التقنية الهندسية

قسم هندسة تقنيات الفيزياء الطبية والعلاج الاشعاعي

المرحلة الثانية

السنة الدراسية: 2025 – 2026 / الفصل الأول

المحاضرة الأولى: المقدمة وتعريفات أساسية في ميكانيك الموائع

COURSE INFORMATION

مدرس المادة: **م.د. محمد باقر ناجي**

البريد الالكتروني: **mohammed.baqer@sawauniversity.edu.iq**

الساعات المكتبية: **السبت، والاحد، والاثنين من كل أسبوع. راجع جدول الدروس الاسبوعي لمعرفة ساعات التواجد.**

للتواصل وطرح الاسئلة خارج الساعات المكتبية، استعمل البريد الالكتروني أعلاه لطفاً:

- أرسل رسالة تحتوي الاسم الثلاثي للطالب في عنوانها (Subject).
- في متن الرسالة يرجى ذكر الشعبة (الكروب)، ثم كتابة الاسئلة والمداخلات.

Grading System

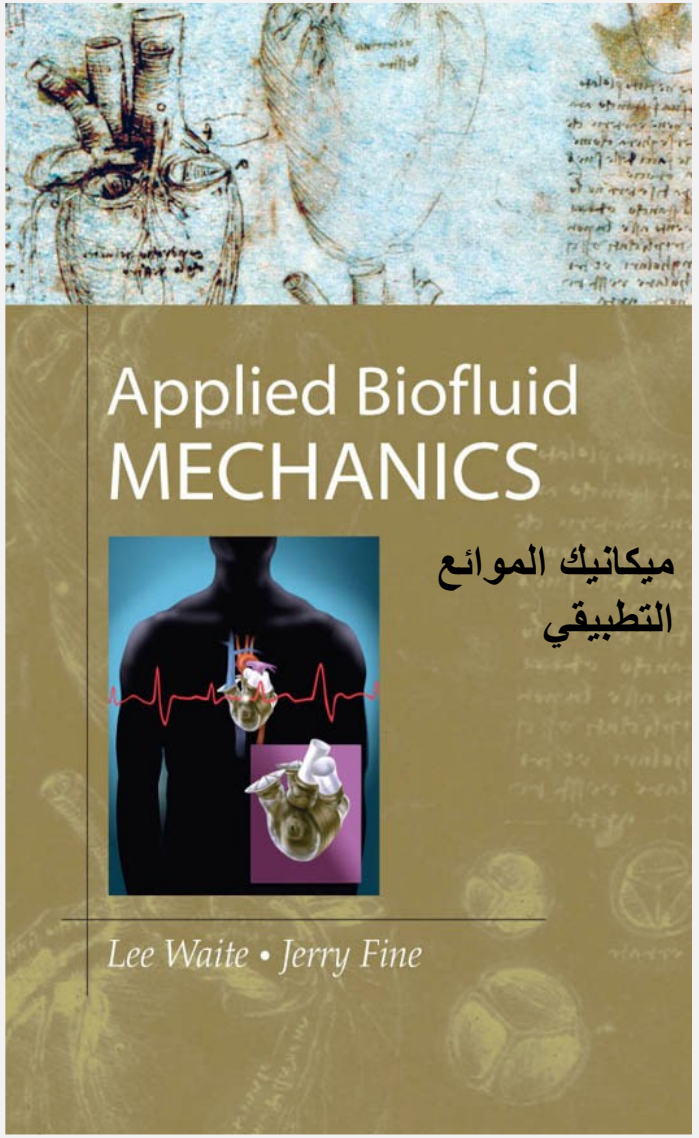
Activity	Time/ Number	Marks
Quizzes	2	10
Assignments	2	10
Project	1	10
Report	1	10
Mid-term Exam	**2 hr**	**10**
Final Exam	**3 hr**	**50**
Total Assessment:		**100**

TEXTBOOK AND REFERENCES

Main Textbook: **Lee Waite and Jetty Fine, "Applied Biofluid Mechanics", McGraw Hill, 2007.**

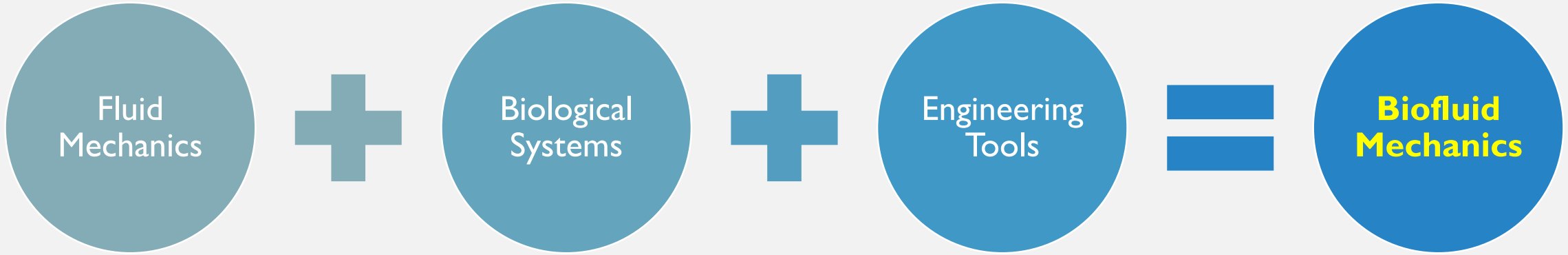
Other references:

- Ali Ostadfar, "**Biofluid Mechanics: Principles and Applications**", Elsevier Inc., 2016.
- Krishan B. Chandran, Ajit P. Yoganathan, and Stanley E. Rittgers, "**Biofluid Mechanics: The Human Circulation**", Taylor and Francis Group, 2007.
- David Rubenstein, Wei Yin, and Mary D. Frame, "**Biofluid Mechanics: An introduction to fluid mechanics, macrocirculation, and microcirculation**", Elsevier Inc., 2012.



INTRODUCTION

- **Biofluid Mechanics** is a field of study that focuses on the behavior and flow of biological fluids (such as blood, air, and other bodily fluids) within living organisms. It combines principles of fluid mechanics with biology to understand the physiological functions of fluids in the body, particularly in the cardiovascular, respiratory, and lymphatic systems.



- Fluid properties.
- Flow types.
- Flow Equations.

- Blood flow through arteries.
- Air flow through lungs.
- Fluid flow in tissues.

- Mathematics.
- Programming .
- Engineering Analysis and Design.

FLUID CHARACTERISTICS

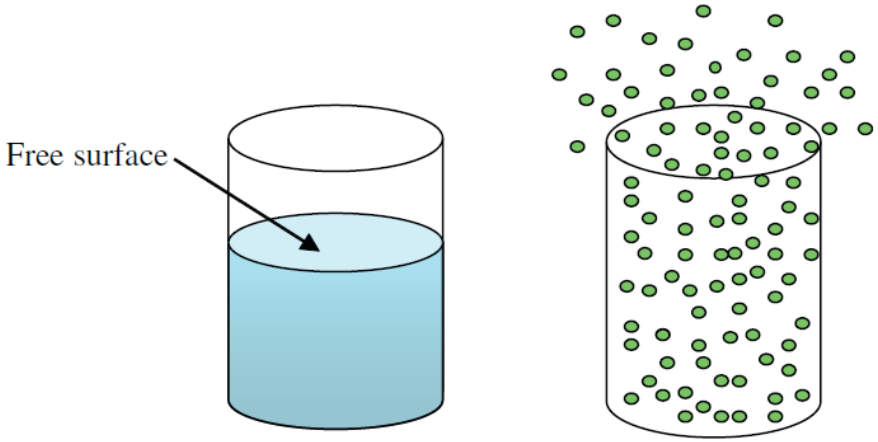
A fluid is defined as a substance that deforms continuously under application of a shearing stress, regardless of how small the stress is. Blood is a primary example of a biological fluid. To study the behavior of materials that act as fluids, it is useful to define a number of important fluid properties, which include density, specific weight, specific gravity, and viscosity.

Density is defined as the mass per unit volume of a substance and is denoted by the Greek character ρ (rho). The SI units for ρ are kg/m^3, and the approximate density of blood is 1060 kg/m^3. Blood is slightly denser than water, and red blood cells in plasma[2] will settle to the bottom of a test tube, over time, due to gravity.

Specific weight is defined as the weight per unit volume of a substance. The SI units for specific weight are N/m^3. Specific gravity s is the ratio of the weight of a liquid at a standard reference temperature to the weight of water. For example, the specific weight of mercury $S_{Hg} = 13.6$ at 20°C. Specific gravity is a unitless parameter.

*While **density** and **specific weight** are measures of the "heaviness" of a fluid, another property of fluids that influences the flow behavior is **viscosity**.*

Fluid = Liquid + Gas



A liquid is formed from relatively compressed molecules with powerful cohesive forces. A liquid has a tendency to retain its volume and will shape a free surface under a gravitational field. Gases are the opposite to liquids. Gas elements are generally separated from one another and gases have no defined volume or free surface.

المائع Fluid: هو تلك المادة التي تتشوه باستمرار تحت تأثير إجهادات القص، بعبارة أخرى هو تلك المادة التي لا تبدي أية مقاومة للتغيرات التي تطرأ على شكلها.

الكثافة density: هي كتلة وحدة الحجوم لمادة ما، ويرمز لها عادة بالرمز ρ وتقاس بوحدة kg/m^3

$$\rho = \frac{mass}{volume} \quad \frac{\mathbf{kg}}{\mathbf{m^3}}$$

الكثافة الوزنية (أو الوزن النوعي) Specific Weight: وزن وحدة الحجوم لمادة ما، ويرمز لها عادة بالرمز γ أو w وتقاس بوحدة N/m^3

$$\gamma = \frac{weight}{volume} \quad \frac{\mathbf{N}}{\mathbf{m^3}} = \boldsymbol{\rho * g}$$

$$\textbf{weight: } W = \boldsymbol{m * g}$$

$$\mathbf{N = kg * \frac{m}{s^2}}$$

الكثافة النوعية Specific Gravity: هي النسبة بين كثافة المائع إلى كثافة الماء عند درجة الحرارة القياسية.

$$Specific\ Gravity, S = \frac{\rho}{\rho_w} = \frac{\gamma}{\gamma_w} \quad \text{(no units)}$$

QUIZ

A container holds 500 g of oil with a volume of 0.00055 m^3. Find the density, specific weight, and specific gravity of the oil.

Solution:

Density: $\rho = \frac{m}{Vol} = \frac{0.5}{0.00055} = \mathbf{909.091\ kg/m^3}$

Specific weight: $\gamma = \rho * g = 909.091 * 9.81 = \mathbf{8918.182\ N/m^3}$

Specific gravity: $S = \frac{\rho}{\rho_w} = \frac{909.091}{1000} = \mathbf{0.9091}$

Example (1): Find the mass of 3.5 m^3 of water.

Example (2): Find the mass of 2 liter of blood (density of blood is 1060 kg/m^3).

Example (3): Find the density, specific weight, and specific gravity of a fluid having a volume of 70 cc and a mass of 50 g.

Example (4): Find the density of a fluid having a specific gravity of 2.1.

Example (5): A metal sphere has a diameter of 0.2 m and a mass of 15 kg. Find its density, specific weight, and specific gravity.

Example (6): A liquid has a specific gravity of 0.8. A container holds 0.5 m^3 of this liquid. Find the mass, weight, and specific weight of the liquid.

Additional Problems

Example (7): Calculate the specific weight, density, and specific gravity of one liter of a liquid which weighs 7 N.

[**Ans.** $\gamma = 7000\ \mathrm{N/m^3}$, $\rho = 713.5\ \mathrm{kg/m^3}$, $S = 0.7135$]

Example (8): Calculate the density, specific weight, and weight of one liter of petrol of specific gravity = 0.7.

[**Ans.** $\rho = 700\ \mathrm{kg/m^3}$, $\gamma = 6867\ \mathrm{N/m^3}$, $W = 6.867\ \mathrm{N}$]

Example (9): One liter of crude oil weighs 9.6 N. Calculate its specific weight, density, and specific gravity.

[**Ans.** $\gamma = 9600\ \mathrm{N/m^3}$, $\rho = 978.6\ \mathrm{kg/m^3}$, $S = 0.978$]