1. **Course number and name - CHBE 3205 – Fluid Mechanics *(required)***

2. **Credits and contact hours** - 2 credit hours, 2 lecture hours (2-0-0-2)

3. **Instructor's or course coordinator's name -** Dr. Victor Breedveld

4. **Textbook, title, author, and year**
   Fundamentals of Momentum, Heat and Mass Transfer, 7th edition, J.R. Welty, G.L. Rorrer and D.G. Foster, John Wiley & Sons Inc. (2019) (6th ed. also suitable)

5. **Specific course information**
   a. **Catalog Description -** The basic principles of fluid mechanics are introduced and the analysis and design of equipment using these principles is practiced.
   b. **Prerequisites or co-requisites** – CHBE 2100 Chemical Process Principles (grade "C" or better), MATH 2551 Multivariable Calculus (grade "C" or better); PHYS 2211 Introductory Physics I. Pre-requisite with concurrency: MATH 2552 Differential Equations (grade "C" or better).
   c. **Required, elective, or selected elective course** – Required

6. **Specific goals for the course**
   a. **Specific outcomes of instruction**:
   By the end of this course, a student should be able to:
      1) Apply the macroscopic balances of mass, momentum, and energy, as well as the differential continuity equation and the equations of motion to simple systems using both Cartesian and polar coordinates, using both analytical and numerical methods.
      2) Apply the concepts of boundary layer flow to interpret local momentum transfer and drag/friction in geometries for which analytical solutions are not readily available.
      3) Design/simulate the operation of process piping systems (estimate frictional losses, size pipes, size pumps, etc.) for the specific flow of liquids and gases, using analytical as well as numerical methods.
      4) Design/simulate the operation of packed beds, fluidized beds, and filters for specified fluid flow rates.
      5) Design flow models and interpret experimental data using dimensional analysis.
      6) Work in teams to perform experimental characterization of frictional losses in system containing pump and tubing.

b. **Connection with Student Outcomes**

CHBE 3205							
	Student Outcomes						
Course Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Course Outcome 1	**X**						
Course Outcome 2	**X**						
Course Outcome 3	**X**	**X**					
Course Outcome 4	**X**					**X**	
Course Outcome 5	**X**					**X**	
Course Outcome 6	**X**				**X**	**X**	

Student Outcomes

(1) *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics*
(2) *an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*
(3) *an ability to communicate effectively with a range of audiences*
(4) *an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*
(5) *an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*
(6) *an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions*
(7) *an ability to acquire and apply new knowledge as needed, using appropriate learning strategies*

7. **Brief list of topics to be covered**
   a. Fluid Statics
      1) Concepts of fluid stresses, pressure, surface tension
      2) Buoyancy
   b. Macroscopic Balance Equations of Fluid Motion
      1) Macroscopic mass balance
      2) Macroscopic momentum balance
      3) Macroscopic energy balance, Bernoulli's equation
   c. Shear Stress in Laminar Flow
      1) Shell momentum balance, velocity profile
      2) Non-Newtonian fluids, pipe flow

d. Differential Balance Equations of Fluid Motion
   1) Differential mass balance: continuity equation
   2) Shell momentum balance, non-Newtonian Fluids
   3) Differential momentum balance, Navier-Stokes equations
   4) Analysis of flow profiles, both analytical (1D) and numerical (2D)

e. Dimensional Analysis
   1) Similarity
   2) Buckingham Methods, Model Analysis

f. Theory and Applications of Viscous Flow
   1) Boundary layer theory, form drag
   2) Mechanical energy balance, frictional losses
   3) Piping network design (incl. numerical methods)
   4) Flow in packed and fluidized beds, filters
   5) Pumps, developed head, lift, cavitation