1. **Course number and name - CHBE 3200 – Transport Phenomena I *(required)***

2. **Credits and contact hours** - 3 credit hours, 3 lecture hours (3-0-0-3)

3. **Instructor's or course coordinator's name -** Dr. Christian Cuba-Torres

4. **Textbook, title, author, and year**
   Fundamentals of Momentum, Heat and Mass Transfer, 6th edition, J.R. Welty, G.L. Rorrer and D.G. Foster, John Wiley & Sons Inc. (2014) (5th edition also suitable)

5. **Specific course information**
   a. **Catalog Description -** The basic principles of fluid mechanics and heat transfer are introduced and the analysis and design of equipment using these principles is practiced.
   b. **Prerequisites or co-requisites** – MATH 2551 Multivariable Calculus (grade "C" or better); MATH 2552 Differential Equations (grade "C" or better); PHYS 2211 Introductory Physics I (grade "C" or better); CHBE 2130 Chemical Engineering Thermodynamic I (grade "C" or better); CHBE 2120 Numerical Methods in Chemical Engineering (grade "C" or better).
   c. **Required, elective, or selected elective course** (as per Table 5-1) – 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) Design/simulate the operation of process piping systems (estimate frictional losses, size pipes, size pumps, etc.) for the specific flow of liquids and gases.
      2) Design/simulate the operation of packed beds, fluidized beds, and filters for specified fluid flow rates.
      3) Design flow models and interpret experimental data using dimensional analysis.
      4) 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.
      5) Apply the Fourier law of heat conduction to homogeneous and heterogeneous objects of various shapes.
      6) Estimate transient and steady state heat transfer rates from/to object such as tanks, pipes, buildings, etc.
      7) Apply principles of radiative heat transfer.

b. **Connection with Student Outcomes**

CHBE 3200							
	Student Outcomes						
Course Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Course Outcome 1	**X**	**X**					
Course Outcome 2	**X**					**X**	
Course Outcome 3	**X**					**X**	
Course Outcome 4	**X**						
Course Outcome 5	**X**						
Course Outcome 6	**X**	**X**					
Course Outcome 7	**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) Concept of fluid stresses, pressure
      2) Buoyancy

   b. Macroscopic Balance Equations of Fluid Motion
      1) Macroscopic mass balance
      2) Macroscopic momentum balance
      2) 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
      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

   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 networks
   4) Flow in packed and fluidized beds
   5) Filtration
   6) Pumps, developed head, lift, cavitation

g. Steady-state Heat Transfer
   1) Fourier's law of heat conduction, Newton's law of cooling (convection)
   2) Differential energy balance, steady-state limit
   3) One-dimensional heat conduction, heat transfer from extended surfaces
   4) Multi-dimensional heat transfer

h. Transient Heat Transfer
   1) Heat transfer in the regimes of high, low and intermediate Biot number
   2) Boundary layer approach to heat conduction

i. Radiation Heat Transfer
   1) Black body radiation, Planck's law, Stefan-Boltzmann law
   2) Kirchhoff's law, radiation heat exchange between real bodies