1. **Course number and name – CHBE 3215 – Heat and Mass Transfer *(required)***

2. **Credits and contact hours –** 4 credit hours, 4 lecture hours (4-0-0-4)

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 edition also suitable)

5. **Specific course information**
   a. **Catalog Description –** Fundamental principles and applications of heat and mass transfer. The analysis of chemical engineering processes and operations involving heat and mass transfer.
   b. **Prerequisites or co-requisites** – CHBE 3205 Fluid Mechanics (grade "C" or better), 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 Fourier's law of heat conduction to homogeneous and heterogeneous objects of various geometries, using analytical and numerical methods.
   2) Estimate temperature profiles and heat transfer rates inside/from/to objects such as tanks, pipes and buildings for steady-state and transient conductive heat transfer.
   3) Apply principles of radiative heat transfer to engineering problems.
   4) Determine concentration profiles and mass transfer rates using Fick's law for diffusive mass transfer at steady state and in transient processes, using analytical and numerical methods.
   5) Understand the theoretical basis of convective heat and mass transfer, and to use the analogies between momentum, heat, and mass transfer to interrelate rate constants.
   6) Analyze situations involving convective heat and mass transfer through natural and forced convection (internal and external flow).
   7) Analyze (incl. through numerical methods) systems that involve multiple individual heat and/or mass transfer processes to obtain overall transfer coefficients and apply these in a variety of design applications, including heat exchangers and multi-phase mass transfer processes.

b. **Connection with Student Outcomes**

CHBE 3215							
	Student Outcomes						
Course Outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Course Outcome 1	**X**						
Course Outcome 2	**X**	**X**					
Course Outcome 3	**X**						
Course Outcome 4	**X**						
Course Outcome 5	**X**					**X**	
Course Outcome 6	**X**					**X**	
Course Outcome 7	**X**	**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. Conductive Heat Transfer – Steady state
      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 (numerical methods)
   b. Conductive heat transfer - Transient processes
      1) Regimes of high, low and intermediate Biot number
      2) Heissler charts

c. Radiation Heat Transfer
   1) Black body radiation, Planck's law, Stefan-Boltzmann law
   2) Kirchhoff's law, radiation heat exchange between real bodies
d. Dimensional analysis
e. Convective heat transfer
   1) Blasius solution
   2) Boundary layer similarity
   3) Turbulence and momentum analogy
f. Heat transfer correlations
   1) Free/natural convection
   2) Forced convection (internal and external flow)
   3) Boiling and condensation
g. Heat exchanger design
   1) Overall heat transfer coefficients
   2) LMTD
h. Diffusion
   1) Molecular diffusion
   2) Fick's law
   3) Unimolecular diffusion and counter-diffusion
i. Differential Mass Balances
   1) Steady and pseudo-steady state mass transfer
   2) Transient diffusion - finite and semi-infinite media
   3) Mass transfer involving chemical reactions
j. Convective Mass Transport
   1) Mass-transfer coefficients and correlations
   2) Analogies between heat, mass and momentum transfer
   3) Simultaneous heat and mass transfer
   4) Penetration theory
   5) Interphase mass transport