1. MME 3306 Rate Processes

2. 3 credits and 3 contact hours per week

3. Namsoo Peter Kim

4. E. Kreyszig, " Advanced Engineering Mathematics," Wiley 9th edition
   K.N. Han, "Fundamentals of Aqueous Metallurgy," SME/AIME, 2002.
   Geankopilis, "Transport Processes" Pearson Education, 4th edition

5. Specific course information
   a. Rate Process in Materials Systems (3-0) Introduction to reaction kinetics, fluid flow, and heat transfer applied to materials systems
   b. MME1301, MME1101, CHEM1306, MATH2326, with a grade of "C" or better.
   c. Required course

6. Specific goals for the course
   a. Specific Learning Outcomes

      At the end of this course, students will have a fundamental concept of kinetics in the principles of metal extraction, chemical reaction, and cell-cultivation. Students will be able to:
      - Understand the concepts associated with thermodynamics, kinetics, steady state and equilibrium (Exam I, II)
      - Analyze reaction kinetics using boundary conditions and ordinary differential equations (Exam I)
      - Use matrices to determine optimization of rate constant (Exam I)
      - Apply Fourier's heat transfer Equation to calculate the heat flux, heat conductivity, heat transfer coefficient at given conditions (Exam I)
      - Apply kinetics and diffusion concepts to cell cultivation in a bioreactor (Exam I, III)
      - Apply Fick's 1st and 2nd laws for materials systems and temperature effects. (Exam II, III)
      - Analyze rate data using the integral method, linear regression and differential method using MathCAD, Excell or LABVIEW (Exam III)
      - Identify the rate controlling step by the shrinking core model (film diffusion control, product layer diffusion control and chemical reaction control) (Exam III)
   b. Student Outcomes addressed by the course: *Outcome 1 at a high level*
      - an ability to identify, formulate, and solve Kinetics/ Ordinary equations by applying principles of engineering, science, and mathematics

7. Brief list of topics to be covered
    - Introduction of Process Kinetics: Objectives; Scope
    - Definitions and nomenclatures (mechanisms; active center; elementary; molecularity; order of reaction; rate expression; limiting and excess reactants; extent of reaction; fractional conversion)
    - Rate theories (Collision, transition state, Arrhenius, Temperature effect) Searching for mechanisms
    - Analysis of rate equations: Integral method; linear regression; Differential method
    - Heterogeneous reactions, physical properties of solids, physical and
    - Chemical adsorption, gas solid reaction systems, effect of surface area, Langmuir adsorption, Mass transfer vs. surface chemical reaction
    - Introduction of Transport Phenomena: Objectives; Scope Momentum, Heat and Mass Transfer - First Laws
    - Equations of continuity; general equations of motion – applications in falling film, flow through circular pipes, flow near the leading edge, laminar and turbulent flows; dimensional analysis and its applications
    - Heat conduction - flat plates, cylinders through composite walls
    - Transient systems; Heat transfer with forced and natural convection; Heat radiation
    - Molar and mass flux; Diffusion in solids; Langmuir effusion; Diffusion from or to rotating disc; -- Mass transfer in fluid systems