Spring 2019

PHEN 502-102: Pharmaceutical Engineering Fundamentals III

Boris Khusid

New Jersey Institute of Technology

Otto H. York Department of Chemical and Materials Engineering

Course: PhEn 502 Pharmaceutical Engineering Fundamentals III (3 credits)

Prerequisites: PhEn 500, undergraduate courses in physical chemistry; physics; mathematics, including differential equations (covered in PhEn500).

Reason for course prerequisites: A mathematical background and understanding of material and energy balances (covered in PhEn501) is required to understand the basic concepts of fluid mechanics, heat transfer, and mass transfer taught in this course that underlie core courses in Pharmaceutical Engineering and Chemical Engineering MS programs.

Instructor: Dr. Boris Khusid
Professor**,** Otto H. York Department of Chemical and Materials Engineering
FMH 215, Tel: 973-596-3316, Fax: 973-596-8436, E-mail: khusid@adm.njit.edu
http://chemicaleng.njit.edu/people/khusid.php

Course description: The course covers the fundamentals of fluid mechanics, heat transfer, mass transfer and the design of unit operations involving these principles. This is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree or with an engineering background that did not include the topics covered in this course. The course is not counted toward degree credit related to the Pharmaceutical Engineering MS program and the Chemical Engineering MS program.

The course combines lectures and problem-solving to provide students the ability to do the following:

- Fundamentals of fluid mechanics, heat transfer and mass transfer
- Ability to communicate effectively the acquired knowledge in written & verbal form

Required textbook: James Welty, Gregory L. Rorrer, David G. Foster ,Fundamentals of Momentum, Heat, and Mass Transfer, Revised 6th Edition , http://www.wiley.com/WileyCDA/WileyTitle/productCd-EHEP003299.html

Course objectives: Identify the basic transport phenomena encountered in pharmaceutical engineering:

- Fluid Mechanics: Fluid statics, mass and momentum transfer, laminar and turbulent flows, fluid machinery
- Heat Transfer: Conservation law, conduction, convection, radiation, boiling and condensation, heat-transfer equipment
- Mass Transfer: Conservation law, molecular diffusion, convective mass transfer, mass-transfer equipment

Course outline and tentative weekly listing (15-week schedule)

Topic	Week	Outline	Book Chapter
Fluid Mechanics	1	Concept of continuum, fluid properties, fluid statics, fluid in motion, examples of fluid flow	1, 2, 3, 4, 5, 6, 7
	2	Conservation of mass and energy, Newton's second law of motion	4, 5, 6, 7
	3	Shear stress, Newtonian and non-Newtonian	7, 8, 9, 10

		fluids, examples of laminar flow, Navier-Stokes equations	
	4	Dimensional analysis and similitude boundary-layer concept, drag coefficients, description of turbulence, turbulent flow	11, 12
	5, 6	Flow in closed conduits, friction factors, pipe-flow analysis	12, 13
	7	Fluid machinery, scaling laws for pumps and fans, combined pump and system performance	14
Midterm exam 1	8		
Heat Transfer	9	Heat transfer processes, conduction, radiation, natural and forced convection, boiling and condensation	15, 16, 17, 18, 19, 20, 21
	10	Heat exchangers, analysis and design, radiation heat transfer	22, 23
Midterm exam 2	11		
Mass Transfer	12	Molecular diffusion, diffusion associated with chemical reaction, mass-transfer operations	24, 25, 26, 27
	13	Convective mass transfer, basic dimensionless parameters, boundary layer	28, 29, 30
	14	Mass-transfer transfer processes and equipment	30, 31
Final exam	15		

Measurable outcomes:

- Proficiency in using the basic principles of fluid mechanics, energy and mass transfer to describe transport processes in fluid machinery, heat-transfer and mass-transfer equipment

Homework assignment, format guidelines, and grading

- Homework is collected at the beginning of each lecture or should be emailed (in Word or PDF or image file format) to Teaching Assistant with Cc to Instructor before the lecture
- Late homework will not be accepted for grading
- Feedback on the homework will be provided during lectures, solutions will be discussed, and graded homework will be returned
- Each problem will be graded individually
- Structure the solution into the following sections:
  - *Known* - The problem is posed
  - *Find* - The quantities to be found are stated
  - *Sketch* - The physical situation and/or diagram
  - *Assumptions* – The significant assumptions in solving the problem are stated
  - *Properties* - The materials properties needed to solve the problem are listed
  - *Analysis* - The problem is solved in a systematic manner, showing all steps, the fundamental equations from which the calculation begins are included, and all numerical values (including units) are shown
  - *Discussion* - Comments are made on the results, as appropriate
- Arrange problems in numerical order
- Print your name at the top of each page
- Write only on 8½" x 11" paper; start each problem on a new page

- Staple all pages together and bring a hard copy to class or email files in *.doc* or *.pdf* formats to Instructor with Cc to Teaching Assistant.

Midterm and final exams

- There will be open book and lecture notes midterm exams. Exact date of midterm exams will be announced a week before.
- An open book and lecture notes comprehensive final exam will cover all material in the course.
- The midterm and final exams must be completed individually, in accordance with the NJIT Honor Code.
- Each problem on the midterm and final exams will be graded individually.

A missed midterm exam will be averaged into the final grade as *zero*, unless permission is obtained from the instructor prior to the exam. Permissions are granted **only** for very serious circumstances attested to by the Dean of Student Office. A student who has been excused will be required to take a makeup exam.

Assessment criteria and grading

The course has been designed so that lectures, homework assignments, midterm and final exams are integral and essential parts of the learning process. Final grades will be determined from scores as follows:
Midterm exam 1: 25% Midterm exam 2: 25% Homework: 20% Final Exam: 30%

The final grade will be assigned on the basis of "*a curve*".

Course materials

Textbook, lecture notes, relevant publications and websites

Course delivery:

PhEn 502 will be delivered in the converged learning model. You will be able to physically come to class as you normally would, but you can also choose to stay home (or a location or your choice) and join the classroom through a video conferencing tool called WebEx. We understand that many of you signed up for an "online" version of this class, so we are taking this initiative to give you more flexibility in how you come to class.

You do not have to choose one option or the other. You can choose how you want to attend each individual class session. For example, you can come to class the first Saturday, join class via WebEx the next two class sessions, and then come to class the following session. No matter how you choose to attend class, you will still be expected to participate in the content and contribute your thoughts and understanding of the material presented in class.

Here's what you'll need to successfully join the WebEx sessions:
- a strong internet connection
- a quiet location to join the session
- a laptop or desktop with a webcam
- a headset or earbud/mic set with a mic (this will give you better audio than the integrated laptop or desktop mic)

You will have a WebEx link on your Moodle course; you can click on the link each class if you would like to join class through virtual means. The class will have a technical assistant that you can communicate with using WebEx's "Chat" feature if you encounter issues. Before you join class for the

first session, it is strongly encouraged that you watch the following short video on joining class via WebEx--it will go over all the basics: http://webex.njit.edu If you need help learning more about WebEx, see the extended PDF tutorial on this website.

Exams policy. Exams will be administered either at NJIT or at testing centers, as described below. In addition to the exam policy for your course, please list the dates and times of exams. Also, for exams given at NJIT please indicate when and where these exams will be given (but see below regarding who should/could take the exams where). It is advisable to schedule exams at NJIT on the same week day in which the corresponding class period for the face-to-face course (if any) is scheduled. For exams administered at locations other than NJIT, the policy is as follows (please feel to incorporate this in your syllabus):

According to NJIT policy, all students taking online classes but living within 50 miles of NJIT must take the required exams at the NJIT main campus in Newark, NJ. Students living outside this area can take exams at predefined testing locations. The National College Testing Association (NCTA; http://www.ncta-testing.org) lists the participating institutions nationwide where students can take proctored tests according to the rules set up by the NJIT course instructor (e.g., closed-book). Students should visit this website, identify the testing location where they plan to take the exams, and inform the course instructor within two weeks from the beginning of classes of which testing location they have selected. ***Students should be aware that they will be required to pay a fee to the chosen testing center for each exam that they take there****. Such a fee is typically on the order of $25-$50 per exam, depending on the testing center. Prior to each exam, students should make arrangements with the selected testing center to ensure that they can take the exam at the predefined location at a given day and time.*

Accommodations due to disability

If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.