University of Jordan
School of Engineering
Chemical Engineering Department

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1. **COURSE NUMBER AND NAME: (0915341) TRANSPORT PHENOMENA I**
2. **Prerequisite: Fluid Mechanics (0905241)**
3. **Class schedule:** 3 credits
   a. Time and place: Specified according to schedule of the semester
   b. Office hours: : Specified according to schedule of the semester
4. **Instructor:** Determined later
5. **TEXT BOOK:**
   1. Christie John Geankoplis, Transport processes and separation process principles, 5edition Prentice Hall; (2018)
   2. INCROPERA F., DEWITT D. , BERGMAN, LAVINE, FUNDAMENTALS OF HEAT AND MASS TRANSFER,7TH EDITION, JOHN WILEY SON, NEW YORK, 2011
6. **References:**

1. James Welty, Charles E. Wicks Gregory L. Rorrer, Robert E. Wilson, Fundamentals of Momentum,Heat and Mass Transfer, 5th Edition, Wiley, 2014
2. Yunus A. Çengel, Heat and Mass Transfer: A Practical Approach (5th edition), McGraw-Hill, 2011

7. **COURSE INFORMATION:**

Momentum transfer: Newton's law of viscosity and the mechanism of momentum transfer. Fluid Physical properties Shell momentum balance, Application of shell momentum balance. Velocity distribution in laminar flow (steady state), flow of falling film, flow through circular pipe, flow throughannulus. Introduction to boundary layer theory. Introduction to turbulence. Universal velocity profile inturbulent flow.

Energy transfer: Basic concept of heat transfer and heat transfer mechanisms: (conduction, convection, and radiation). Shell energy balance and its applications: Heat conduction equation, steady-state conduction, the temperature distribution in solids and in laminar flow. Convection heat transfer and the concept of heat transfer coefficient. Definition and use of thermal resistances Unsteady state heat transfer in solids. Introduction to radiation heat transfer.

8. **COURSE OBJECTIVE:**
   1. Teach students the basic principles of momentum transfer
   2. Teach students how to setup shell balances for conservation of momentum and employ shellbalance equations to obtain desired profiles for velocity
   3. Teach students the characteristics of Newtonian and non-Newtonian fluids.
   4. Teach students to solve the appropriate equations of change to obtain desired profiles forvelocity and solve appropriate macroscopic balances for conservation of momentum
   5. Teach students the basic principles of heat transfer by conduction, convection, and radiation

6. Teach students how to identify, formulate, and solve engineering problemsinvolvingconduction, convection, and radiation
7. Teach students how to apply energy balances and rate equations to model and analyze thermalsystems
8. Teach students how apply calculus and linear algebra procedures appropriate to solve specificheat transfer problems in an engineering setting
9. Teach students to recognize and apply analogies between momentum, heat and mass transfer

9. COURSE OUTCOMES:

By the end of the course, the student should be able to:

1. Conduct shell balances for conservation of momentum (O1)
2. Employ shell balance equations to obtain desired profiles for velocity (O1)
3. Apply interphase transport relationships and apply flux laws in balances (O1)
4. Reduce and solve appropriate macroscopic balances for conservation of momentum (O1)
5. Comprehend Fourier's law of heat conduction, Newton's law of cooling, and theStefan-Boltzmann lawof radiation heating (O1)
6. Recognize the relationship between thermo-physical properties and heat transfer O1)
7. Solve one dimensional steady-state and transient heat conduction problems (O1)
8. Use empirical correlations to solve forced and free convection heat transfer forinternal and externalflows (O1)
9. Predict heat transfer by radiation from ideal and actual surfaces and enclosures (O1)
10. Perform energy balances for control volumes or surfaces (O1)
11. Select appropriate conservation equations and boundary conditions to model a givenphysical situation(O1)
12. Use appropriate analytical or numerical solution techniques to find temperaturedistributions and heatflows in thermal systems (O1)
13. Have knowledge of enhanced heat transfer by phase (O1)
14. Use calculus, differential equation and linear algebra procedures appropriate tosolve specific heattransfer problems in an engineering setting (O1).

10. Topics covered:

Content	Week	Outcomes
Principles of Momentum Transfer and OverallBalances General Molecular Transport Equation forMomentum, Heat, and Mass Transfer. Newton's law of viscosity for fluids.Continuity Equation. Overall Momentum Balance, ShellMomentumBalance	1+2	1
	3	2
Principles of Momentum TransferandApplications Velocity profiles, volume flow rates,friction at surfaces	4	3
Differential Equations of Continuity,Differential Equations of Momentum Transfer or Motion, Use of Differential Equations of Continuity and Motion, Other Methods for Solution of Differential Equations of Motion	5	1+2
Boundary-Layer Flow and Turbulence, Dimensional Analysis in Momentum Transfer	6+7	3
Introduction to heat transfer ***Topics Covered****:* Definitions, physicalorigins andrate equations. Modes of heat transfer. Conservation of energy	8	5
Heat Conduction ***Topics Covered****:* The conduction equation.Thermal properties. Heat diffusion equation. Boundary and initial condition	9	
One Dimensional, steady state conduction *Topics Covered:* The plainwall. Alternativeconduction analysis. Radial systems. Conduction with energy generation. Fins performance.	10	
Transient Conduction ***Topics Covered:*** The lumped capacitancemethod.Spatial effects for slab, cylinder, sphere and semi-infinite domain.	11	

Introduction to Convection ***Topics Covered:*** The convection heat transfer. Theconvection boundary layer and the boundary layer equations. Free and forced convection	**12+13**	
Internal and External flow ***Topics Covered:*** The empirical method.Convection heat transfer coefficient and boundary layer thickness over different geometries and for different flow and boundary conditions types.	14	
Free Convection ***Topics Covered:*** Heat Transfer on a Vertical Plate,Empirical Relations for FreeConvection for Vertical Plates and Cylinders, Free Convection from Different Geometries	15	
Final exams	16	

11. **Minimum student materials:** Text book, class handouts, engineering calculator,and an access toPersonal Computer with MATLAB and/or Excel.

12. **INSTRUCTIONAL METHODS:**
Lectures, group assignments, class discussion and problem solving projects and assignments

13. **HOMEWORK ASSIGNMENTS:**
Assignments are due at the beginning of the class period on the specified date; late homework will NOT be accepted. Name and ID number should be clearly written onfirst page. Start each problem on a new page. Clearly mark your answers in a box (Never use a red pen in your work). Staple the pages together.

14. **Assessment & Grading:**

Quizzes & Assignments	:	20%
Midterm Exam	:	30%
Final exam	:	50%
Total	***:***	***100%***

15. **Relationship to Program Outcomes (%)**

O1	O2	O3	O4	O5	O6	O7
√						

16. **Relationship to Chemical Engineering Program Objectives**

PEO1	PEO2	PEO3	PEO 4
√	√	√	√

17. Notes:

a. Discuss the assignments among yourselves. This is helpful to the learning process. However, direct copying of others work will NOT be allowed or tolerated and will result in a reduction of grade.
b. All cases of academic dishonesty will be handled in accordance with university policies and regulations.
c. There will be a number of unannounced quizzes during the semester. Students are expected to be ready to take a quiz any time they have a class. There will be no make-up quizzes.
d. Students are expected to attend <u>EVERY CLASS SESSION</u> and they are responsible for all material, announcements, schedule changes, etc., discussed in class. The university policy regarding the attendance will be strictly adhered
e. Any students with disabilities who need accommodations in this course are encouraged to speak with the instructor as soon as possible to make appropriate arrangements for these accommodations.
f. Exams are scheduled as shown in the syllabus and last 90 minutes. The exams are close textbook and notes. It is your responsibility to bring a calculator, pencils and paper. If you MUST miss one of these exams for an emergency situation, please let me know as soon as possible. If you oversleep or skip an exam you will not have an opportunity to make it up. If you have a valid (according to me) time conflict and you let me know in advance, there is the possibility of taking an exam at an alternate time.

18. ABET Criteria : Outcomes and Assessment: Engineering programs must demonstrate that their graduates have

O1 Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

O2 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.

O3 Communicate effectively with a range of audiences.

O4 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.

O5 Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

O6 Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

O7 Acquire and apply new knowledge as needed, using appropriate learning strategies.

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