King Fahd University of Petroleum & Minerals
MECHANICAL ENGINEERING DEPARTMENT

ME 315: Heat Transfer

Catalogue Description: (3-0-3)

Introduction to heat transfer by conduction, radiation and convection. Electric network analogy. Steady state solution for heat conduction in plane and radial walls, composite walls, walls with energy generating sections, and extended surfaces (fins). Introduction to multidimensional conduction. Unsteady heat transfer to plates, cylinders and spheres. Blackbody and gray-body radiation systems. Practical hydraulic and thermal analysis of convection with applications to heat exchangers.

Status in Curriculum (Required or Elective): Required (offered Fall & Spring)

Prerequisites: ME 311

Co-requisites: None

PrerequisitesbyTopics:

- Thermodynamics (ME 203)
- Conservation of mass and energy (ME 203, ME 311)

Textbook: **Fundamentals of Heat and Mass Transfer by F. Incropera et al., John Wiley, Seventh Edition, 2012.**

References:

1. Heat and Mass Transfer by Y.A. Cengel, WCB/McGraw-Hill, 2010.
2. The WEBCT is full with a lot of useful references

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Goals: **(general objectives)**

1. To provide students with basic principles required for understanding conduction, radiation and convection heat transfer.
2. *To enable students to apply the basic principles (mentioned in 1) to engineering* problems.

Course Outline (Lecture Topics):

1. Introduction to heat transfer: *Physical origins and three modes of heat transfer, rate equation, etc.* (4 classes)
2. Introduction to conduction: *Conduction rate equation, boundary and initial conditions* (2 classes)
3. One-dimensional, steady-state conduction: *Plane wall, radial systems, conduction with thermal energy generation, heat transfer from extended surfaces* (6 classes)
4. Two-dimensional, steady-state conduction: *Conduction shape factor, finite-difference equations, nodal network, energy balance method* (3 classes)
5. Transient conduction: *Lumped capacitance method and its validity, spatial effects in plane wall and radial systems* (4 classes)
6. Introduction to convection: *Convection boundary layers, local and average coefficients, laminar and turbulent flow* (3 classes)
7. External flow: *Empirical method, flat plate in parallel flow, cylinder and sphere in cross flow* (4 classes)
8. Internal flow: *Hydrodynamic and thermal conditions, laminar flow and turbulent flow in circular tubes, convection correlations, concentric tube annulus* (5 classes)
9. Free convection: *Physical considerations, laminar free convection,combined free and forced convection* (2 classes)
10. Heat exchangers: *Types, overall heat transfer coefficient, heat exchanger analysis, use of the Log Mean Temperature Difference, effectiveness-NTU method* (6 classes)
11. Radiation: Processes and properties: *Basic concepts, blackbody radiation, radiation properties, gray surface* (3 classes)
12. Radiation exchange between surfaces: *View factor, blackbody radiation exchange, radiation exchange between gray surfaces* (3 classes)

Design Activities/Projects:

The aim of the project is to increase the student ability to solve real world problems that are ill-posed (i.e. the given data are not enough to solve the problem). There are two options: Option 1: It is practical option that involves designing simple experiment, building it, carrying out the experiment and analyzing the data. Option 2: is theoretical in nature (it may involve designing a heat transfer system or open ended heat transfer conceptual problems).

Computer Usage:

Students are encouraged to solve some assigned homework problems using the available engineering software, such as EES.

Laboratory: None

Assessment Tools:

i- Mid-term Examinations; Homework Assignments; Quizzes ; Final Exam

Course Learning Outcomes:

I- Students shall demonstrate a basic understanding of different modes of heat transfer.

II- Students shall be able to perform an energy balance to determine temperature and heat flux; calculate thermal resistances;

III- Demonstrate an understanding of one-dimensional conduction problems with and without heat generation;able to find heat transfer from/or to extended surfaces such as fins and use analytical solutions to1-D transient problems.

IV- Demonstrate ability touse appropriate correlations to determine convective heat transfer coefficients for single phase external and internal flows during forced and free convection.

V- Demonstrate ability to perform both design and evaluation of heat exchanger analysis.

VI- Students shall demonstrate a basic knowledge about radiation heat transfer and view factors between surfaces and compute the net radiative heat exchange between black bodies.

VII- Demonstrate ability to analyze multimode heat transfer problems.

Course Learning Outcomes mapped to Student Outcomes:

Student Outcomes	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
Course-to-Student outcome mapping	II, III	III, IV, V	V	--	III, IV, V, VI, VII	--	IV, V	II, III	II	---	IV, V, VI
Emphasis*	**M**	L	**L**		**S**	L	L	L	L		M

* **L**:: Little/None **M**: Moderate **S**: Strong

Status of Continuous Improvement review of this Course:

Date reviewed: 8 March 8, 2015
Prepared by: Dr. Mohammad Al-Qahtani

Reviewed by: Heat Transfer Group
Date prepared: ……………….