University Of California, Berkeley
Department of Mechanical Engineering

ME 151B–Convective Transport and Computational Methods (3 units)

Undergraduate Course

Syllabus

CATALOG DESCRIPTION

The transport of heat and mass in fluids in motion; free and forced convection in laminar and turbulent flow over surfaces and within ducts. Fundamentals of computational methods used for solving the governing transport equations will also be covered.

COURSE PREREQUISITES

Undergraduate courses in engineering thermodynamics, fluid dynamics and heat transfer (ME40, ME106 and ME109 or equivalent). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Example: *Convective Heat and Mass Transfer*, 4th edition, by W.M. Kays, M.E. Crawford and B. Weigand, McGraw Hill, 2005, or
Convective Heat Transfer, 3rd edition, by S. Kakac, Y. Yener and A. Pramuanjaroenkij, CRC Press, 2014, with
Mass Transfer, 2nd edition, by A.F. Mills, Pearson Education, 2001.

COURSE OBJECTIVES

This course will provide students with knowledge of the physics of convective transport and an introduction to computational tools that can model convective processes in important applications such as electronics cooling, aerospace thermal management. The course also teaches students to construct computational models of natural and forced convection processes in boundary layers nears surfaces, in enclosures and in ducts or pipes that can be used to design heat exchangers and thermal management equipment for applications.

DESIRED COURSE OUTCOMES

Students will gain a knowledge of the mechanisms of convective heat and mass transfer for flow over surfaces and within ducts, and will develop the ability to construct computer programs that implement computation methods that predict the flow and temperature fields and heat transfer performance for convective flows of interest in engineering applications.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS COVERED

See CLASS/LABORATORY SCHEDULE below.

CLASS/LABORATORY SCHEDULE

Two 1.5 hour lectures, and up to 6 hours work on a homework problem set or a project assignment per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

This course will provide students with knowledge of the physics of convective transport and computational tools that can model convective processes in important applications such as electronics cooling, aerospace thermal management and power system energy transport. Projects will introduce students to convective transport modeling and development of computational methods that can be used for heat transfer equipment performance modeling and design.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

The course grade will be based on homework assignments (5%), quizzes (10%), two midterm projects (25% each) and a final project (35%). Undergraduate and graduate students graded as separate groups.

GRADUATE ROOMSHARE INFORMATION

This course will be roomshared with ME 250B. Graduate students will be assigned additional, more challenging project tasks (about 20% additional work). Undergraduate and graduate students graded as separate groups.

SAMPLE OF WEEKLY AGENDA

Week	Topic
1	Conservation equations, solution characteristics
2	Laminar fully developed velocity and temperature fields for convection in ducts
3	Introduction to computational methods, numerical solution of the Laplace equation for modeling fully-developed convective transport
4	Laminar thermally developing flows
5	Laminar hydrodynamic boundary layers
6	Laminar thermal boundary layers, effects of viscous dissipation
7	Shooting methods for solving boundary layer similarity models
8	Natural convection boundary layers
9	Instability, transient natural convection flows
10	Implicit/explicit finite difference methods for predicting transient boundary layer flows
11	Fundamentals of modeling for turbulent transport

12 Fundamentals of convective mass transfer
13 Computationally modeling combined heat and mass transfer convection
14 Applications and special topics, final project assignment

PERSON(S) WHO PREPARED THIS DESCRIPTION

Van P. Carey
02/26/2018

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): CNV TRNS & CMP MTHD
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Fall and/or Spring
COURSES THAT WILL RESTRICT CREDIT: ME 252**,** ME 250B
INSTRUCTORS: Van P. Carey
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None.