ME 119b Heat and Mass Transfer

2006

INSTRUCTOR

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GRADING

The grades for the course will be determined by homework (35%), midterm (20%) and final (45%). You may discuss homework problems with other students; however, I expect each student to turn in work that represents his or her own efforts.

ME 119b

In ME 119b, the course develops the full energy equation, and continues with high speed flows with viscous dissipation, introductory concepts from turbulent heat transfer, natural convection, mass transfer, and heat transfer with phase change. There will be an emphasis on problems that combine heat transfer modes. The course also include aspects of micro-scale heat transfer, the radiative transfer equation, and radiative transport with participating media and participating media.

HOMEWORK

Given approximately once per week and will include pencil-and-paper problems plus numerical solutions. Discussion of homework with other students is encouraged; however, each student is responsible for his/her own work. Each student should attempt individually the homework problems before consulting your peers. Please do not seek homework advice from students who have previously taken this course. The solutions will be placed in a binder in Fairchild Library.

LATE HOMEWORK

Homework should be handed in on time. If it turned in late (except for cases of medical or family emergencies), mark on the homework the number of days late. The number of late days will be tabulated at the end of the quarter. If the total

number of days late exceeds my threshold, your final grade will be lowered. Homework that is due before the midterm, must be turned in before the midterm due date. Homework will not be accepted after the due date of the final.

HONOR CODE

All members of the Caltech community are expected to adhere to the Honor Code, which states "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community." Honor Code violations will be reported to the appropriate governing body. Students are also reminded that "every member must share the responsibility of protecting the Caltech community and perpetuating the Honor System."

REFERENCE TEXTS ME 20/ME 119ab

F.P. Incropera & D.P. DeWitt, **Fundamentals of Heat and Mass Transfer**, John Wiley & Sons, 2002.

V.S. Arpaci, **Conduction Heat Transfer**, Addison-Wesley Publishing Co., Reading, MA, 1966.

M. Quinn Brewster, **Thermal Radiative Transfer and Properties**, John Wiley & Sons, New York, 1992.

H.S. Carslaw and J.C. Jaeger**, Conduction of Heat in Solids**, Oxford University Press, Oxford, 2nd edition, 1959.

E.R.G. Eckert and R.M. Drake, Jr. **Analysis of Heat and Mass Transfer**, Hemisphere Publishing Co., New York, 1987

R. Siegel, and J.R. Howell, **Thermal Radiation Heat Transfer**, Hemisphere Publishing, 4th edition, 1981.

W.M. Kays and M.E. Crawford, Convective Heat and Mass Transfer, McGraw-Hill, 3rd edition, 1993.

COURSE OUTLINE ME 119b

I Viscous Dissipation

1. Derivation of the full energy equation
2. Boundary layers
3. Lubrication

II Natural Convection

1. laminar, boundary layers
2. internal flows
3. mixed convection

III. Turbulent Convection

1. Mixing layer concepts
2. Boundary layers for natural and forced convection

IV. Mass Transfer

1. diffusion equation
2. Fick's law
3. binary diffusion
4. thermal diffusion

V. Phase Change Phenomena – Convection

1. evaporation
2. condensation
3. freezing, melting and ablation
4. boiling

VI. Non-Fourier conduction

1. Conduction at short time scales
2. Conduction in small (microscale) length scales

VII. Radiative transfer

1. radiative transfer equation
2. emission, absorption, scattering
3. participating media: gases, particles
4. band models
5. scattering
6. conduction plus radiation