ME 20 Heat Transfer/ME 119ab 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. The grades for ME 20 will be calculated separately from the grades for ME 119a.

ME 20/ME 119a

ME 20/ME 119a covers fundamental aspects of heat transfer, including conduction, convection and radiation.

ME 119b

In ME 119c, 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 phase change phenomeneon. There will be an emphasis on problems that combine heat transfer modes. The course also includes 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."

OMBUDSPERSON

The class will select an ombudsperson. In addition, the ME faculty have chosen Professor Chris Brennen to act as an ombudsperson for the option.

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.

COURSE OUTLINE ME 119a/ME 20

I. Introductory concepts

1. Rate laws - Fourier, Fick, Newton, Stefan-Boltzmann
2. Basic energy equation

II Thermal Radiation Principles

1. Nomenclature
2. Photon gas
3. Radiation intensity, emissive power, irradiation
4. Blackbody radiation, Planck's distribution
5. Emission, absorption, reflection, transmission
6. Kirchhoff's law
7. Films; thick and thin

III Diffuse Radiative Exchange

1. View factor
2. Blackbody exchange
3. Diffuse, gray surface exchange
4. Networks, N-surface problems

IV. Steady-State Heat Conduction

1. Fourier's law
2. One dimensional network analysis; heat sources fins
3. Multi-dimensional
4. Finite difference
5. Superposition

III Transient Heat Conduction

1. Lumped analysis
2. Multi-dimensional finite and semi-infinite; Heissler charts
3. Finite difference

VI Convective Transport

1. Governing equations
2. Nusselt number relations
3. Laminar boundary layers

VII Internal Flows

1. Fully developed flows
2. Developing flows