The University of Michigan
College of Engineering
Curriculum Committee

Agenda
January 09, 2007
1:30-3:00 p.m.
GM Room
Fourth Floor Lurie Engineering Center

1. Approval of Minutes from December 12, 2006 Meeting
2. The Diversity and Outreach Committee Presentation
3. Course Approvals

University of Michigan
College of Engineering
Curriculum Committee Meeting
Tuesday December 12, 2006
1:30-3:00 p.m.
Lurie Engineering Center GM Room
Minutes

Richard Robertson called the meeting to order at 1:40 p.m.

Members Present: R. Robertson, J. Boyd, G. Hulbert, D. Karr, K. Kearfott, C. Lastoskie, Y. Liu, P. Mazumder, H. Peng, R. Rogers, M. Solomon, R. Sulewski T. Teorey, A. Yagle

Members Absent: L. Bernal, A. Hunt, G. Herrin, S. Pang, K.Patel

Guests: Ted Spencer (Associate Vice Provost and Executive Director, Undergrad Admissions), Chris Lucier (Director of Recruitment and Operations), Feodies Shipp (Assistant Director)

Motion to approve the minutes of the last meeting

The minutes of the last meeting were approved

Creation of Subject area for the Financial Engineering Degree Program – Huei Peng

Information regarding this was included in the meeting packet.
Huei Peng spoke requesting a new course, Fin Eng 591, emphasizing that this is only a new course and not a new program.

"As a result of its interdisciplinary nature, the College of Engineering Financial Engineering program is actively engaged in expanding its curricular activities. This includes the development of various study templates, the development of new courses, such as our new, mandatory summer program, and the cross-listing of a variety of courses with the Ross Business School and the Math and Statistics Departments. To be able to engage in these activities expeditiously, the Financial Engineering program needs to have its own subject area."

Dick Robertson asked for a motion to approve this course. Moved and Seconded.
This course, Fin Eng 591, was approved.

Course Approval Forms

Richard Robertson called for a motion to approve the following courses. This was moved and seconded.

These Courses Were Approved

AOSS 101 (X-Listed with ASTRO 103) New Course

AOSS 480 New Course

FINENG 591   New Course

<u>Undergraduate Admissions Overview – Christopher Lucier</u>

Information Packets were handed out regarding this information.
Christopher Lucier, Ted Spencer and Feodies Shipp, from the Office of Undergraduate Admissions, presented this information geared toward the College of Engineering. Members of this Committee were invited to ask questions.

<u>Adjournment:</u> Motion to adjourn was made and seconded
<u>Motion carried (approved)</u>

Next Meeting January 9, 2007
GM Room – Fourth Floor LEC

COURSE APPROVAL FORMS

For January 09, 2007 CoE CC Meeting

ME 320	Modification – Changing Prerequisites from: ME 235 and ME 240 ***to: MATH 215, ME 235 and ME 240***.
ME 450	Modification – Changing Credit Restrictions from: ME 495 is not to be elected concurrently. Not open to graduate students. ***to: May not be taken concurrently with ME 495. Not open to graduate students.***
ME 495	Modification – Changing Prerequisites from: ME 360, ME 395; preceded or accompanied by ME 350 ***to: ME 360, ME 395, P/A ME 335 and ME 350***; Changing Credit Restrictions from: Recommend ME495 not be elected concurrently. Not open to graduate students ***to: May not elect ME 450 concurrently. Not open to graduate students.***
ME 539	Modification – Changing Title from: Heat Transfer in Porous Media ***to: Heat Transfer in Physics;*** Changing Description; Changing Prerequisites from: ME 335 or equivalent ***to: ME 235, 335***.
ME 574	New Course
ME 580	New Course

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1786

Action Requested

- ○ New Course
- ⦿ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 11/9/2006
Effective Winter 2007

A. CURRENT LISTING	B. REQUESTED LISTING
☐ Home Department / Div # / Course Number:	Home Department: Mechanical Engineering; Div #: 280; Course Number: 320
Cross Listed Course Information:	Cross Listed Course Information:
☐ Course Title:	Course Title: Fluid Mechanics I
TITLE ABBREVIATION — Time Sched (Max = 19 Spaces):	TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): Fluid Mechanics I
TITLE ABBREVIATION — Transcript (Max = 20 Spaces):	TITLE ABBREVIATION — Transcript (Max = 20 Spaces): Fluid Mechanics I
☐ Course Description:	Course Description for Official Publication (Max = 50 words): Control volume analysis; continuity, momentum, angular momentum, and energy equation. Dimensional analysis and similitude. Introduction to differential analysis; kinematics; fluid statics; inviscid flow; potential flow; simple viscous incompressible flow; lift and drag. Steady one-dimensional compressible flow.
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	PROGRAM OUTCOMES: ☒a ☐b ☒c ☐d ☒e ☒f ☐g ☒h ☒i ☒j ☒k
Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective
☒ Prerequisites: ME235 and ME240 — ○ Enforced ○ Advised	Prerequisites: MATH215, ME235, and ME240 — ○ Enforced ⦿ Advised
☐ Credit Restrictions:	Credit Restrictions:
☐ Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: — Max: —; Contact Hrs/Wk: —; Number of Wks: —	Level of Credit: ☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: 3 Max: 3; Contact Hrs/Wk: 3; Number of Wks: 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ○ No
Maximum Hours? ____ Maximum Times? ____
Can it be repeated in the same term? ○ Yes ○ No

Printing Information (Optional): ☐ Print the course in the Bulletin ☐ Print the course in the Time Schedule

☐ **Class Type(s)**: ☐ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ____
Graded Section: ○ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other
Grading: ☐ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y
Location: ☐ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering: ■ I ■ II ☐ IIIa ☐ IIIb ☐ III — ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years
Half term ☐ 1st ☐ 2nd

Cognizant Faculty Member: R. Akhavan **Title** Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

- ☐ Curriculum Comm.
- ☐ Faculty
- ☐ Rackham
- ☐ Cross listed Unit 1
- ☐ Cross listed Unit 2

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. Mechanical Engineering
Cross-listed Dept(s).

[signature]

Form Number

1786

SUPPORTING STATEMENT

MATH 215 introduces vector algebra, vector functions, functions of several variables, partial differentiation; line, surface and volume integrals and their applications; Green's theorem and Stokes theorem. These are important concepts for students to have learned prior to taking ME320.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

Detail the Special requirements

ME320 COURSE PROFILE

DEGREE PROGRAM: Mechanical Engineering

COURSE NUMBER: ME320	**COURSE TITLE:** Fluid Mechanics I
REQUIRED COURSE OR ELECTIVE COURSE: Required	**TERMS OFFERED:** Fall, Winter
TEXTBOOK / REQUIRED MATERIAL: Fundamentals of Fluid Mechanics, B.R. Munson, D.F. Young, T.H. Okiishi, (4th edition) 2002, Wiley	**PRE / CO-REQUISITES:** ME235: Thermodynamics I; ME240: Introduction to Dynamics and Vibrations; MA215: Calculus III; MA216: Introduction to Differential Equations
COGNIZANT FACULTY: R. Akhavan **BULLETIN DESCRIPTION:** Fluid statics; conservation of mass, momentum, and energy in fixed and moving control volumes; steady and unsteady Bernoulli's equation; differential analysis of fluid flow; dimensional analysis and similitude; laminar and turbulent flow; boundary layers; lift and drag; introduction to commercial CFD packages; applications to mechanical, biological, environmental, and micro-fluidic systems.	**COURSE TOPICS:** 1. Fluid properties, fluid forces, and flow regimes. 2. Fluid statics. 3. Flow kinematics. 4. Conservation of mass, momentum and energy in fixed, deforming, and moving control volumes. 5. The steady and unsteady Bernoulli equation along and normal to a streamline. 6. Similitude, dimensional analysis, and modeling; important non-dimensional groups in fluid mechanics. 7. Conservation of mass and momentum expressed through differential analysis. 8. Viscous flow in pipes and channels (laminar and turbulent flow regimes, the Moody chart, head-loss equation). 9. External flow 9boundary layer concept, lift and drag, pressure and friction drag, streamlining and drag reduction). 10. Introduction to commercial CFD package. 11. Sample applications to mechanical biological, environmental, and micro-fluidic systems.
COURSE STRUCTURE/SCHEDULE: Lecture: 2 days per week at 1.5 hours	

COURSE OBJECTIVES: for each course objective, links to the Program Outcomes are identified in brackets.	1. To teach basic fluid properties (density, viscosity, bulk modulus), flow forces (pressure, shear stress, surface tension), and flow regimes (laminar/turbulent, compressible/incompressible, steady/unsteady) [1, 5]. 2. To teach how force is transmitted in static fluids [1, 5]. 3. To teach conservation of mass, momentum, and energy in fixed, deforming, and moving control volumes [1, 5, 12]. 4. To teach the use and limitations of steady and unsteady Bernoulli equation along and normal to a streamline [1, 5]. 5. To teach conservation of mass and momentum through differential analysis in simple geometries [1, 5, 12]. 6. To teach techniques of dimensional analysis, similitude, and modeling, and introduce the important non-dimensional groups in fluid mechanics [1, 2, 5, 9]. 7. To teach application of the above concepts to internal and external flows, and introduce the boundary layer concept, lift and drag, flow separation, and drag reduction fundamentals [1, 3, 5, 9, 10]. 8. To teach the use of commercial CFD packages [4, 6, 9, 10, 11]. 9. To teach examples of applications of above concepts in mechanical, biological, environmental, and micro-fluidic systems [8, 9, 10, 11].
COURSE OUTCOMES: for each course outcome, links to the Course Objectives are identified in brackets.	1. Ability to identify or predict the flow regime in a given engineering system based on consideration of the governing non-dimensional groups [1, 6, 8, 9]. 2. Ability to calculate the hydrostatic forces and moments on planar and curved submerged and floating surfaces [1, 2, 8]. 3. Ability to construct an appropriate (fixed, deforming, or moving) control volume for a given engineering system and apply the principles of conservation of mass, momentum, and energy to this control volume [1, 2, 3]. 4. Ability to decide when appropriate to use ideal flow concepts and the Bernoulli equation [1, 3, 4]. 5. Ability to present data or governing equations in non-dimensional form, design experiments, and perform model studies [6, 1, 7]. 6. Ability to solve for internal flow in pipes and channels through simple solutions of the Navier-Stokes equations, the Moody chart, the head-loss equation, or commercial CFD packages [5, 6, 7, 8]. 7. Ability to solve for external flow, evaluate lift and drag, know when there is possibility of flow separation, apply streamlining concepts for drag reduction by using experimental correlations or commercial CFD packages [7, 8]. 8. An understanding of how fluid mechanics applies to mechanical, biological, environmental, and micro-fluidic systems [9].
ASSESSMENT TOOLS: for each assessment tool, links to the course outcomes are identified	1. Regular homework assignments 2. Exams

PREPARED BY: R. Akhavan
LAST UPDATED: November 2, 2006

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1736

Action Requested

- ○ New Course
- ⦿ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 4/21/2006
Effective Winter 2007

A. CURRENT LISTING

☐ Home Department: | Div #: | Course Number:

Cross Listed Course Information:

☐ Course Title:

TITLE ABBREVIATION — Time Sched Max = 19 Spaces: | Transcript Max = 20 Spaces:

☐ Course Description:

PROGRAM OUTCOMES:
☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements ⦿ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective

☐ Prerequisites ME350, ME360, and ME395
○ Enforced ⦿ Advised

X Credit Restrictions ME495 is not to be elected concurrently. Not open to graduate studentss.

☐ **Level of Credit**
☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours Min: Max:
Contact Hrs/Wk:
Number of Wks:

B. REQUESTED LISTING

Home Department: Mechanical Engineering | Div #: | Course Number: 450

Cross Listed Course Information:

Course Title: Design and Manufacturing III

TITLE ABBREVIATION — Time Sched Max = 19 Spaces: Des & Mfg III | Transcript Max = 20 Spaces: Des/Mfg III

Course Description for Official Publication (Max = 50 words)
A mechanical engineering design project by which the student is exposed to the design process from concept through analysis to layout and report. Projects are proposed from the different areas of study within mechanical engineering and reflect the expertise of instructional faculty and industrial representatives. Three hours of lecture and two labs.

PROGRAM OUTCOMES:
☒ a ☐ b ☒ c ☒ d ☒ e ☒ f ☒ g ☒ h ☒ i ☐ j ☒ k

Degree Requirements ⦿ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective

Prerequisites
⦿ Enforced ○ Advised

Credit Restrictions May not be taken concurrently with ME495. Not open to graduate students.

Level of Credit
☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours Min: 4 Max: 4
Contact Hrs/Wk: 8
Number of Wks: 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ⦿ No
Maximum Hours? Maximum Times?
Can it be repeated in the same term? ○ Yes ○ No

Printing Information (Optional) ☒ Print the course in the Bulletin ☒ Print the course in the Time Schedule

☐ **Class Type(s)** ☒ Lec ☐ Rec ☐ Sem ☒ Lab ☐ Dis ☐ Ind ☐ Other ____

Graded Section ⦿ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other

Grading ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y

Location ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering ■ I ■ II ☐ IIIa ☐ IIIb ☐ III — ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years
Half term ☐ 1st ☐ 2nd

Cognizant Faculty Member: S. Skerlos **Title** Assoc. Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval
☐ Curriculum Comm.
☐ Faculty
☐ Rackham
☐ Cross listed Unit 1
☐ Cross listed Unit 2

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. Mechanical Engineering [signature]
Cross-listed Dept(s).

Form Number

1736

SUPPORTING STATEMENT

The ME program does not recommend that students take ME450 and ME495 concurrently. For the past couple of years, this has been communicated to students on an individual basis when the come to the ASO to talk about their studies. For students who wish to take both at the same time, they are asked to see the UG Program Director to talk about their situation and why they need/desire to take this undesirable combination of courses. Typically, their course load is evaluated so that it, at most, includes 450, 495 and no more than one technical course.

At issue is that the 450/495 course combination not only adversely impacts the particular student taking these two courses, but even more importantly can adversely impact the group member of that student in both of the courses.

The proposed change would formalize the existing advising process and better help students develop their plan of study.

Are any special resources or facilities required for this course? ☒ Yes ☐ No

Detail the Special requirements

Unchanged since 1997-98

ME450 COURSE PROFILE

DEGREE PROGRAM: Mechanical Engineering

COURSE NUMBER: ME450

COURSE TITLE: Design and Manufacturing III

REQUIRED COURSE OR ELECTIVE COURSE: Required

TERMS OFFERED: Fall, Winter

TEXTBOOK / REQUIRED MATERIAL: N/A

PRE / CO-REQUISITES: ME 350: Design and Manufacturing II, ME 360: Modeling, Analysis and Control of Dynamic Systems, ME 395: Laboratory I. May not be taken concurrently with ME 495. Not open to graduate students.

COGNIZANT FACULTY: S. Skerlos

BULLETIN DESCRIPTION: A mechanical engineering design project by which the student is exposed to the design process from concept through analysis to layout and report. Projects are proposed from the different areas of study within mechanical engineering and reflect the expertise of instructing faculty. Three hours of lecture and two laboratories.

COURSE TOPICS:

1. Generation of project specifications and solutions in a team environment. Systematic design procedures include: Definition of project requirements; Research of design problem background and state-of-the art; Development of project proposal with defined targets and scope of work; Development of quantitative design specifications from qualitative problem statement; Generation and selection of creative design concepts using formal and informal methodologies; Development of simple mathematical models for final design concept; Utilization of rough prototyping methods; Consideration of safety, ethical, and environmental issues; Understanding when to select off-the-shelf components versus when to fabricate custom components; Understanding the relationship between design and manufacturing, incuding the selection of appropriate manufacturing processes
2. Use of physical and/or virtual prototypes of sufficient detail to serve the purpose of proof-of-concept and recommendations for design improvement
3. Presentation and reporting of final project outcomes and recommendations

COURSE STRUCTURE/SCHEDULE: Lecture: 2 days per week at 1.5 hours, Laboratory: 2 days per week at 3 hours

COURSE OBJECTIVES: for each course objective, links to the Program Outcomes are identified in brackets.	1. Solve an open-ended mechanical engineering design problem including considerations of performance, cost, and societal considerations. The problem must provide opportunities for creative mechanical design, fundamental analysis, and proof-of-concept prototyping. Each student team works on a different project and everyone participates in project proposal development, reporting, and final design presentations [3, 4, 5, 6, 7, 8, 10] 2. Apply a design process appropriate to the engineering problem at hand, including unstructured creativity as part of a structured design problem [3, 5] 3. Generate and evaluate design concepts after gaining a sound understanding of the problem background and existing design concepts [1, 3, 5] 4. Identify a set of design variables and governing equations for the selected design concept that can be utilized to improve the design [3, 5, 11]
COURSE OUTCOMES: for each course outcome, links to the Course Objectives are identified in brackets.	1. Given a qualitative and open-ended "real-world" engineering design problem, suggest a solution based on technical analysis 2. Learn to work effectively in engineering teams to resolve conflict and meet quantitative engineering objectives established during the project. Learn to communicate effectively with peers, project sponsors, advisors, and/or mentors 3. Learn to consider unstructured creativity as a natural part of a structured design process and to systematically generate concepts using methods such as brainstorming and decomposition 4. Learn to make appropriate assumptions and exercise engineering judgment in solving an open-ended problem 5. Manage and plan large design projects using time management tools, and be able to handle uncertain and incomplete information effectively to meet project goals 6. Learn to clearly request and exchange quantitative information, and to communicate project results, to audiences of varying expertise levels 7. Learn patent and literature search methods, benchmarking, and other general forms of background independent learning 8. Integrate past course material to advance basic system concepts to a prototyping level, providing support for all design decisions by defensible engineering analysis and reasoning
ASSESSMENT TOOLS: for each assessment tool, links to the course outcomes are identified	1. Regular written and/or oral design reviews 2. Project exposition 3. Peer review

PREPARED BY: S. Skerlos

LAST UPDATED: September 22, 2006

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1750

Action Requested

- ○ New Course
- ◉ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 6/29/2006

Effective Fall 2006

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department: / Div #: / Course Number:	Home Department: Mechanical Engineering / Div #: / Course Number: 495
Cross Listed Course Information:	Cross Listed Course Information:
Course Title:	Course Title: LAB II
TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): ; Transcript (Max = 20 Spaces):	TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): LAB II; Transcript (Max = 20 Spaces): LAB II
Course Description:	Course Description for Official Publication (Max = 50 words): Weekly lectures and extended experimental projects designed to demonstrate experimental and analytical methods as applied to complex mechanical systems. Topics will include controls, heat transfer, fluid mechanics, thermodynamics, mechanics, materials, and dynamical systems. Emphasis on laboratory report writing, oral presentations, and team-building skills, and the design of experiments.
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	PROGRAM OUTCOMES: ☒a ☒b ☐c ☒d ☐e ☐f ☒g ☐h ☐i ☐j ☒k
Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	Degree Requirements: ◉ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective
[X] Prerequisites: ME360, ME395; preceded or accompanied by ME350 — ⊙ Enforced ○ Advised	Prerequisites: ME360, ME395, P/A ME335 and ME350 — ⊙ Enforced ○ Advised
[X] Credit Restrictions: Recommend ME495 not be elected concurrently. Not open to graduate students	Credit Restrictions: May not elect ME450 concurrently. Not open to graduate students.
Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: __ Max: __; Contact Hrs/Wk: __; Number of Wks: __	Level of Credit: ☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: 4 Max: 4; Contact Hrs/Wk: 5; Number of Wks: 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ⊙ No
Maximum Hours? ____ Maximum Times? ____
Can it be repeated in the same term? ○ Yes ⊙ No

Printing Information (Optional) ☒ Print the course in the Bulletin ☐ Print the course in the Time Schedule

Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☒ Lab ☐ Dis ☐ Ind ☐ Other ____

Graded Section: ⊙ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other

Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering: ☒ I ☒ II ☐ IIIa ☐ IIIb ☐ III — Half term ☐ 1st ☐ 2nd
☒ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years

Cognizant Faculty Member: A.M. Sastry — **Title** Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

☒ Curriculum Comm.

☐ Faculty
☐ Rackham
☐ Cross listed Unit 1
☐ Cross listed Unit 2

Submitted By: ☒ Home Dept. ☐ Cross-listed Dept.

Name, Signature & Department

Home Dept. Mechanical Engineering

Cross-listed Dept(s).

Form Number

1750

SUPPORTING STATEMENT

Adding preceded or accompanied by ME335 is necessary because ME495 includes one or more heat transfer based laboratories. Consequently, students need to have a working knowledge of heat transfer for these labs.

The ME program does not recommend that students take ME450 and ME495 concurrently. For the past couple of years, this has been communicated to students on an individual basis when they come to ASO to talk about their studies. For students who want to take both, they are asked to seek the approval of the UG Program Director by discussing their situation; why they want/need to do so. Typically, the course load is evaluated so that it, at most, includes ME450, ME495 and no more than one more technical course.

At issue is that the ME450/ME495 combination not only adversely impacts the particular student taking these courses, but even more importantly, can adversely impact the group members in each of these courses.

The proposed change would formalize the existing advising process and better help students develop their plan of study.

Are any special resources or facilities required for this course? ☒ Yes ☐ No

Detail the Special requirements

Unchanged since 1998-99

ME495 COURSE PROFILE

DEGREE PROGRAM: Mechanical Engineering

COURSE NUMBER: ME495	**COURSE TITLE:** Laboratory II
REQUIRED COURSE OR ELECTIVE COURSE: Required	**TERMS OFFERED:** Fall, Winter
TEXTBOOK / REQUIRED MATERIAL:	**PRE / CO-REQUISITES:** ME 395: Laboratory I; ME 360: Modeling, Analysis, and Control of Dynamic Systems; preceded or accompanied by ME 335. May not elect concurrently with ME 450: Design and Manufacturing III
COGNIZANT FACULTY: A. M. Sastry **BULLETIN DESCRIPTION:** Weekly lectures and extended experimental projects designed to demonstrate experimental and analytical methods as applied to complex mechanical systems. Topics will include controls, heat transfer, fluid mechanics, thermodynamics, mechanics, materials, and dynamical systems. Emphasis on laboratory report writing, oral presentations, and team-building skills, and the design of experiments.	**COURSE TOPICS:** 1. Frequency Response Analysis of a Flexible Torsional System 2. Choose either a or b: (a) Evaluation of a Vapor/Compression Cycle; (b) Dynamic Compensation of a Subwoofer Speaker System 3. Choose either a, b, or c: (a) Performance of a Single Cylinder Engine; (b) Injection Molding of Plastic Parts; (c) Evaluation of the Welding Process 4. Student Designed Laboratory
COURSE STRUCTURE/SCHEDULE: Lecture: 2 days per week at 1.5 hours, Laboratory: 1 day per week at 3.0 hours	

COURSE OBJECTIVES: for each course objective, links to the Program Outcomes are identified in brackets.	1. To teach students to analyze complex engineering systems [1, 11] 2. To provide students with practical illustration of concepts taught in the core classes [1] 3. To teach students how to propose and execute an experimental and analytical program [2] 4. To teach students to present results in different scientific and industrial written formats [7] 5. To teach students to present their results orally [7] 6. To teach students to work in teams [4]
COURSE OUTCOMES: for each course outcome, links to the Course Objectives are identified in brackets.	1. Investigate how to compare the mathematical model of a dynamic system with its experimental performance [1, 2] 2. a. Evaluate the thermal efficiency and cooling capacity of a vapor compression cycle, evaluate the effectiveness of the condenser and evaporator, and evaluate the isentropic efficiency of the compressor over a range of operating conditions [1, 2]. b. Experimentally measure the frequency response of a subwoofer speaker, obtain a simplified model of the speaker through "curve fitting," design a feedforward compensator, design a feedback/feedforward compensator, implement the compensators using analog circuits, and verify the performance of the compensated speaker [1, 2] 3. a. Determine the thermal and mechanical efficiency of a single cylinder engine. Compare indicated and brake engine power. Evaluate the effect of air/fuel, load, and compression ratios on engine performance and emissions. Evaluate engine losses due to friction [1, 2]. b. Determine how clamping force and injection pressure influence the outcome of an injection molding process. Examine the dimensional stability of injection molded parts. Determine the residual stresses and flow patterns in clear parts using optical methods. Examine how process parameters influence the mechanical strength of weld lines [1, 2]. c. Determine how welding process parameters such as feed rate and input power influence the heat effected zone for MIG and spot-welding processes. Section and microscopically examine the welded zone. Determine how process parameters influence the strength of the welded joint [1, 2] 4. Create a proposal for an experimental program [3] 5. Plan and execute an experimental program [3] 6. Be able to use a variety of industrial and scientific formats to present the results and conclusions of an experimental project in a clear, readable, succinct, and informative written format [4] 7. Present a proposal for a project in an oral form [5]
ASSESSMENT TOOLS: for each assessment tool, links to the course outcomes are identified	1. Lab reports containing an abstract, results, discussion, conclusions, and figures for each laboratory 2. Oral reports 3. Full length report for the final lab project 4. Examination of lab books to verify correct recording and analysis of data 5. Self-evaluation by team members 6. Evaluation of oral presentation(s) by teams

PREPARED BY: W. Schultz
LAST UPDATED: September 22, 2006

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1749

Action Requested

- ○ New Course
- ◉ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 6/29/2006
Effective Winter 2007

	A. CURRENT LISTING	B. REQUESTED LISTING
☐	Home Department: Mechanical Engineering; Div #: ; Course Number: 539	Home Department: Mechanical Engineering; Div #: ; Course Number: 539
	Cross Listed Course Information:	Cross Listed Course Information:
X	Course Title: Heat Transfer in Porous Media	Course Title: Heat Transfer Physics
	TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): ; Transcript (Max = 20 Spaces):	TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): Heat Transfer Phys; Transcript (Max = 20 Spaces): Heat Transfer Phys
X	Course Description: Heat transfer and fluid flow in porous media are examined based on conservation principles. Local volume-averaging is developed and applied to conduction, convection, mass transfer, radiation, and two-phase flows. Several single-phase and two-phase problems are examined.	Course Description for Official Publication (Max = 50 words): This course combines fundamentals of statistical thermodynamics, quantum mechanics, transport theories, computational molecular dynamics, solid-state physics, and radiation transport, as related to heat transfer and thermal energy conversion. It presents a unified theory of heat transfer physics in its modern applications.
	PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k
	Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective
X	Prerequisites: ME335 or equivalent; ○ Enforced ○ Advised	Prerequisites: ME235, ME335; ○ Enforced ◉ Advised
☐	Credit Restrictions:	Credit Restrictions:
☐	Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: ; Max: ; Contact Hrs/Wk: ; Number of Wks:	Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☒ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min: 3; Max: 3; Contact Hrs/Wk: 3; Number of Wks: 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ◉ No
Maximum Hours? ____ Maximum Times? ____
Can it be repeated in the same term? ○ Yes ○ No

Printing Information (Optional): ☐ Print the course in the Bulletin ☐ Print the course in the Time Schedule

☐ Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ____
Graded Section: ◉ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other
Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y
Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; Half term ☐ 1st ☐ 2nd
☐ Yearly ■ Alter Years ☐ Even Years ☐ Odd Years

Cognizant Faculty Member: M. Kaviany Title: Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

☐ Curriculum Comm. ____
☐ Faculty
☐ Rackham ____
☐ Cross listed Unit 1 ____
☐ Cross listed Unit 2 ____

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. Mechanical Engineering
Cross-listed Dept(s). ____
[illegible signature]

Form Number

1749

SUPPORTING STATEMENT

This new course is in response to instructional need for a unified, atomic understanding of heat transfer and its modern, quantum-mechanics based applications. The course objection, key concepts, and syllabus are attached. The course was taught in Winter 2005 and Winter 2006 with enthusiastic response (Q1=4.0, Q2=4.0) and is planned for Winter 2007.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

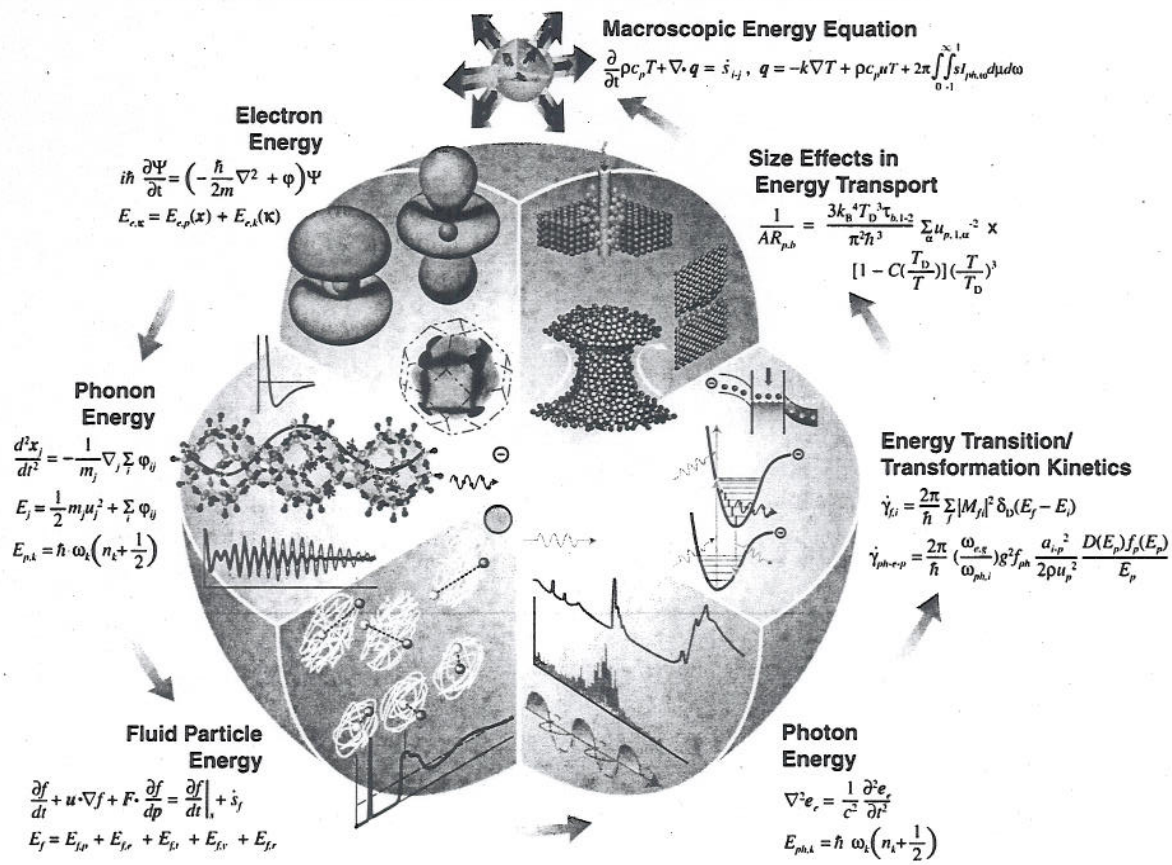
Detail the Special requirements

ME 599-001, HEAT TRANSFER PHYSICS, Winter 2007
Tu & Th, 11:30-1:00, 1371 G.G. Brown
3 Credits, Prerequisite: Heat Transfer (ME 335 or equivalent), Instructor: M. Kaviany
Department of Mechanical Engineering, University of Michigan, Ann Arbor

OBJECTIVE

Heat transfer physics describes the kinetics of storage, transport, and transformation of microscale energy carriers (phonon, electron, fluid particle, and photon). Sensible heat is stored in the thermal motion of atoms, in various phases of matter. The atomic energy states and their populations are described by the classical and the quantum statistical mechanics (partition function) and the combinatoric energy distribution probabilities. Transport of thermal energy by the microscale carriers is based on their particle, quasi-particle, and wave descriptions, their diffusion, flow and propagation, and their scattering and transformation they encounter as they travel. The mechanisms of energy transitions amongst these energy carriers, and their rates (kinetics), are governed by the match of their energies, their interaction probabilities, and the various hindering-mechanism rate limits. Conservation of energy describes the interplay amongst energy storage, transport, and conversion, from the atomic to the continuum scales. The figure below renders the fundamentals of heat transfer physics.

Heat Transfer Physics
(Kinetics of Storage, Transport, and Transition of Microscale Energy Carriers)



The course combines the fundamentals (through survey summaries) of interatomic potential, statistical thermodynamics, computational molecular dynamics (include lattice dynamics, with computer codes) quantum mechanics, transport theories (including Boltzmann and stochastic transport), solid-state physics (including semiconductors), and radiation transport (including spontaneous and stimulated emissions), as related to heat transfer and thermal energy conversion. The aim is to present a unified theory of heat transfer physics and its modern applications (through case studies). The course is suitable for students in engineering, applied physics, and physical chemistry. The prerequisite is undergraduate education in engineering or science. The outline of the course is given below.

OUTLINE

1 ***Introduction and Preliminaries***
1.1 Phonon, Electron, Fluid Particle, and Photon
1.2 Combinatorial Probabilities and Energy Probability Distribution Function
1.3 Particle, Wave, Wave Packet, and Quasi-Particle
1.4 A History of Contributions towards Heat Transfer Physics
1.5 Energy in Classical and Quantum Mechanics
1.6 Periodic Table of Elements
1.7 Heat Transfer Physics
1.8 Scope
2 ***Interatomic Potentials, Molecular Dynamics, and Quantum Energy States***
2.1 Interatomic Forces and Potential Well
2.2 Interatomic Potential Models
2.3 Molecular Ensembles, Temperature, and Thermodynamic Relations
2.4 Classical Mechanics, Hamiltonian, and Partition Function
2.5 Molecular Dynamics Simulations
2.6 Schrödinger Equation and Quantum Mechanics
3 ***Carrier Energy Transport and Transformation Theories***
3.1 Boltzmann Transport Equation
3.2 Energy Transformation Kinetics and Fermi Golden Rule
3.3 Maxwell Electromagnetic Wave Propagation Equations
3.4 Onsager Transport Coefficients
3.5 Stochastic Particle Dynamics and Transport
3.6 Green-Kubo Transport Theory
3.7 Macroscopic Fluid Dynamics Equations
3.8 Macroscopic, Elastic Solid Mechanics
4 ***Phonon Energy Storage, Transport and Transformation Kinetics***
4.1 Phonon Dispersion in One-Dimensional, Classical Lattice Vibration
4.2 Phonon Density of States
4.3 Reciprocal Lattice and Brillouin Zone
4.4 Three-Dimensional Lattice Dynamics and Dispersion Relation
4.5 Quantum Theory of Lattice Vibration
4.6 Examples of Phonon Dispersion and DOS
4.7 Debye Lattice Specific Heat Capacity
4.8 Atomic Displacement in Lattice Vibration
4.9 Phonon BTE and Callaway Conductivity Model
4.10 Einstein and Cahill-Pohl Minimum Conductivities
4.11 Phonon Conductivity from MD and G-K Autocorrelation
4.12 Quantum Corrections to MD Predictions
4.13 Phonon Conductivity from BTE: Variational Method
4.14 Optical Phonon Contribution to Conductivity
4.15 Experimental Data on Phonon Conductivity
4.16 Phonon Boundary Resistance
4.17 Absorption of Ultrasound Waves in Solids

5 *Electron Energy Storage, Transport and Transformation Kinetics*
5.1 Electron Band Structure in Crystals
5.2 Electronic Energy Bands in One-Dimensional Ionic Lattice
5.3 Three-Dimensional Bands Tight-Band Approximation
5.4 Electron Band Structures for Semiconductors and Effective Mass
5.5 Fermi Energy
5.6 Drude-Sommerfeld Electron Gas Model for Metals
5.7 Density of Electronic Energy States for Semiconductors
5.8 Electron Specific Heat Capacity
5.9 Electron BTE for Semiconductors
5.10 Scattering Potential, Fermi Golden Rule, and Relaxation Time
5.11 Average Relaxation Time for Power-Law Energy Dependent Relaxation Time
5.12 Transport Coefficients in Coupled Electrical and Thermal Currents
5.13 Semiconductor Electro-Thermal Transport Properties using $\boldsymbol{j}_e$ and Gradient of T
5.14 Magnetic Field and Hall Factor
5.15 Phonon Scattering of Electron
5.16 Electro-Thermal Transport Properties Data for Semiconductors and Metals
5.17 Electron and Phonon Transport Equations under Thermal Non-Equilibrium
5.18 Cooling Length in Electron- Lattice Thermal Non-equilibrium
5.19 Electronic Energy States of Rare-Earth Ion Doped Crystals
5.20 Electronic Energy States of Gases
6 *Fluid Particle Energy Storage, Transport and Transformation Kinetics*
6.1 Fluid Particle Quantum Energy States and Partition Functions
6.2 Idea-Gas Specific Heat Capacity
6.3 Dense-Fluid Specific Heat Capacity
6.4 Fluid Particle BTE and Average Molecular Speed
6.5 Elastic Binary Collision Rate of Ideal Gas
6.6 Ideal Gas Mean-Free Path
6.7 Relaxation Time Approximation of Gas BTE
6.8 Thermal Conductivity of Ideal Gas
6.9 Thermal Conductivity of Liquids
6.10 Effective Conductivity with Suspended Particles in Brownian Motion
6.11 Interaction of Fluid Particle and Surface
6.12 Turbulent-Flow Structure and Transport
6.13 Thermal Plasmas
7 *Photon Energy Storage, Transport and Transformation Kinetics*
7.1 Quasi-Particle Treatment: Photon Gas and Planck Emission
7.2 Laser and Narrow-Band Emissions
7.3 Classical and Semi-Classical Treatments of Photon-Matter Interaction
7.4 Photon Absorption and Emission in Two-Level Electron Energy System
7.5 Photon BTE: Scattering, Absorption, and Emission
7.6 Equation of Radiative Transfer
7.7 Continuous and Band Photon Absorption in Solids
7.8 Continuous and Band Photon Emission in Solids
7.9 Spectral Surface Emission
7.10 Radiative and Non-Radiative (with Phonon Emission) Decays and Quantum Efficiency
7.11 Anti-Stokes Fluorescence and Photon-Electron-Phonon Couplings
7.12 Role of Phonon in Photovoltaic
7.13 Role of Fluid-Particle Motion in Gas-Phase Lasers and Laser Cooling of Gases

Course Materials: Course Pack: *Heat Transfer Physics*, 2006, is provided (pdf).

Key Concepts in *Heat Transfer Physics* (ME 599-001)

Atomic Description of Energy and Its Transport and Transformation

- Four microscale carriers: phonon, electron (hole), fluid particle, and photon
- Particle, waves, ,wave packets, and quasi-particle behaviors: quantum mechanics
- Interatomic potential (Schrödinger equation-ab initio calculations) and its models
- Molecular dynamics simulations and scales in molecular motion
- Schrödinger equation and quantum harmonic oscillator and electron gas
- Boltzmann transport equation (BTE), particle scattering (interaction)
- Scattering (interaction) rate kinetics and Fermi golden rule
- Onsager coupled-transport theorem
- Stochastic particle dynamics and transport (Langevin equation)
- Green-Kubo transport coefficients (fluctuation-dissipation correlations)
- Maxwell equations (including EM wave equation and relation to photon)
- Macroscopic conservation equations (energy, fluid dynamics, and elastic solid mechanics)

Phonon Energy Storage, Transport and Transformation Kinetics

- Lattice and its vibration (phonon dispersion, band gap, and density of states)
- Phonon heat capacity (Debye model)
- Phonon BTE and thermal conductivity (Callaway model)
- Phonon scattering mechanisms and relaxation time models
- Einstein and Cahill-Pohl minimum thermal conductivity models
- Phonon conductivity from MD and Green-Kubo autocorrelation
- Phonon conductivity from variational principles
- Phonon boundary resistance (diffuse and specular) using photon treatment

Electron Energy Storage, Transport and Transformation Kinetics

- Electrons in solids, allowed states, band gaps and band-gap models
- Electron density of states and heat capacity
- Electron BTE and electro-thermal transport properties
- Electron-phonon interaction rate and the Fermi golden rule
- Other mechanisms of electron scattering and their relaxation time models
- Electronic thermal conductivity of solids (Wiedemann-Franz-Lorenz relation)
- Thermoelectricity (Seebeck and Peltier coefficients) and its figure of merit
- Electron-phonon thermal nonequilibrium and cooling length

Fluid Particle Energy Storage, Transport and Transformation Kinetics

- Gas and liquid heat capacity (energy partition function)
- Gas particle BTE, collision rate, relaxation time, and mean-free path
- Gas thermal conductivity from BTE
- Liquid thermal conductivity (random, localized motion)
- Conductivity of suspended particles in liquid (Brownian motion and nanofluid conductivity)
- Gas molecule-surface interaction (fluid flow regimes and accommodations and slips)
- Solid particle thermophoresis in gases
- Physical surface adsorption and desorption of gas molecules
- Turbulent-flow structure and transport
- Thermal plasmas

Photon Energy Storage, Transport and Transformation Kinetics

- Harmonic oscillator and blackbody photon emission intensity
- Laser emission
- Photon absorption and emission (spontaneous and stimulated) in two-level electronic systems
- Photon BTE (photon and phonon Equation of Radiative Transfer)
- Mechanisms of spectral absorption in solids (including semiconductors and metals)
- Mechanisms of spectral absorption in gases
- Radiative and non-radiative (with phonon emission) decays and quantum efficiency
- Photon-electron-phonon couplings and laser cooling of solids
- Role of Phonon in photovoltaic and extraction of hot electrons
- Role of Fluid-particle kinetic energy in gas laser (including laser cooling of atomic gases)

ME 599-001 (*Heat Transfer Physics*), Tu & Th 11:30-1:00, Winter 2007, 1371 G.G. Brown
Department of Mechanical Engineering, University of Michigan

WEEK	SUBJECT	READING (Chapter. Section)	HOMEWORK (Assigned)
January 1	**Introduction**; Macroscopic Energy Equation and Role of Microscale (Atomic-Level) Heat Carriers: Electron, Phonon, Fluid Particle, and Photon; Atomic-level Energy Kinetics: Length, Time, and Energy Scales; Scope of Heat Transfer Physics	1.1 - 1.8	HW # 1
January 8	**Interatomic Potentials, Molecular Dynamics, and Quantum Energy States**; Interatomic Forces, Potentials and Models; Ab Initio Interatomic Potential Calculations and Models; Statistical Ensembles, Energies, Temperature, and Partition Function; Hamiltonian Mechanics	2.1 - 2.4	HW # 2 Interatomic Potential Gaussian Code
January 15	Computational, Classical Molecular Dynamics Simulation; Schrödinger Equation; Quantum Simple Harmonic Oscillator and for Free Electron Gas	2.5 - 2.6	HW # 3 2-D MD Gas Particle Code
January 22	**Carrier Transport and Interaction Theories**; Boltzmann Transport Equation (BTE); In- and Out-Scattering; Relaxation Time Approximation; Scattering Rate Approximation, Energy Interaction Rates and Fermi Golden Rule	3.1 - 3.2	HW # 4
January 29	Maxwell Equations; Onsager Transport Coefficients; Stochastic Transport Processes (Langevin Equation); Green-Kubo (G-K) Autocorrelation Decay and Thermal Conductivity; Macroscopic Fluid Dynamics Equations; Elastic Solid Mechanics Equations	3.3 - 3.8	HW # 5 3-D MD-GK Code for Ar FCC Phonon k
February 5	**Phonon**; Dispersion in Harmonic Lattice Vibration (Acoustic and Optical Phonons); Phonon Density of States; Reciprocal Lattice Space and Brillouin Zones; Dynamical Matrix **SELECTION OF PROJECT TOPIC**	4.1 - 4.6	HW # 6 3-D Ar FCC Phonon Dispersion Code
February 12	Lattice Specific Heat Capacity; Phonon BTE and Callaway Conductivity Model (Single Mode Relaxation Time); MD-GK (Heat Current Autocorrelation); Cahill-Pohl Minimum Conductivity, Variational Method; Phonon Boundary Resistance	4.7 - 4.16	HW # 7 Case Study I
February 19	**Electron**; Band Structure in Crystals; Tight-Binding Approximation; Full and Model Band Structures and Effective Electron Mass in Semiconductors; Fermi Energy in Electron Gas Model, Electron Density of States; Drude-Sommerfeld Model for Metals; Electron Specific Heat Capacity **ABSTRACT OF PROJECT**	5.1 - 5.8	HW # 8 Fermi Surface Code 3-D SiC Electronic Band Structure Code
February 26	**SPRING RECESS**		

March 5	Electron BTE for Semiconductors; Energy-Dependent Relaxation Time; Semiconductor and Metal Electro-Thermal Transport Coefficients (Electrical Conductivity, Seebeck Coefficient, Peltier Coefficient, and Electronic Thermal Conductivity); Electron Scattering by Phonon; Electron-Lattice Thermal Non-Equilibrium and Cooling Length	5.9 - 5.22	HW # 9 Case Study II
March 12	**Fluid Particle**; Quantum Fluid Particle Electronic, Translational, Vibrational, and Rotational Energy States and Partition Functions; Fluid Particle Specific Heat Capacity (Ideal Gas and Dense Fluids); Fluid Particle BTE; Equilibrium Energy Distribution Function; Binary Collision Rate; Relaxation Time and Mean-Free Path	6.1 - 6.7	HW # 10 3-D Liquid MD Code for Fluid Particle Trajectory
March 19	Ideal Gas Thermal Conductivity from BTE; Liquid Thermal Conductivity; Brownian Motion of Solid Particles and Effective Conductivity; Fluid Particle-Surface Interaction and Flow Regimes; Thermophoresis; Adsorption and Desorption; Turbulent-Flow Structure and Transport; Thermal Plasmas	6.8 - 6.13	HW # 11 3-D Surface Accommodation Coefficient MD Code
March 26	**Photon**; Planck Distribution for Photon Gas (Blackbody Radiation); Lasers and Narrow Band Emission; Photon Absorption and Stimulated and Spontaneous Emissions in Two-Level Electronic Transition System; Electronic Population Rage Equation; Photon BTE and Equation of Radiative Transfer Using Absorption, Emission, and Scattering Cross Sections; Radiant Thermal Conductivity **DRAFT REPORT ON PROJECT**	7.1 - 7.6	HW # 12
April 2	Spectral Continuous and Band Photon Absorption and Emission in Solids; Absorption Coefficient for Metals and Semiconductors; Relation between Absorption and Emission in Multi-Level Electron System	7.7 - 7.9	HW # 13
April 9	Radiative and Non-Radiative (Involving Phonon Emission) Decays and Quantum Efficiency; Anti-Stokes Fluorescence and Photon-Electron-Phonon Couplings (Laser Cooling of Solids); Role of Phonon in Photovoltaic; Role of Fluid Particle Motion in Gas Lasers (Laser Cooling of Gases)	7.10 - 7.13	Case Study III
April 16	Review, Course Evaluation **Last Day of Class: Tuesday, April 17**		
April 23	**FINAL REPORT ON PROJECT DUE TUESDAY APRIL 24**		
Instructor:	**Massoud Kaviany**, Office: 3108 G.G. Brown, Phone: 936-0402, E-mail: kaviany@umich.edu		
Office Hours:	MW: 12:30 - 1:30, and by Appointment		
Grade Policy:	Homework: 70% Project: 30% (Projects will be graded based on heat transfer physics content)		
Course Pack:	*Heat Transfer Physics* , Course Pack, M. Kaviany, 2006		

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1772

Action Requested

- (◉) New Course
- ( ) Modification of Existing Course
- ( ) Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 10/10/2006
Effective Winter 2007

A. CURRENT LISTING

Home Department	
Div #	
Course Number	
Cross Listed Course Information	
Course Title	
TITLE ABBREVIATION – Time Sched (Max = 19 Spaces)	
TITLE ABBREVIATION – Transcript (Max = 20 Spaces)	
Course Description	

B. REQUESTED LISTING

Home Department	Mechanical Engineering
Div #	
Course Number	574
Cross Listed Course Information	
Course Title	Nano/Micro Structure Evolution
TITLE ABBREVIATION – Time Sched (Max = 19 Spaces)	Nano/Micro Struct Evol
TITLE ABBREVIATION – Transcript (Max = 20 Spaces)	Nano/Micro Struct Evol

Course Description for Official Publication (Max = 50 words)

This course will focus on scientific understanding and computational techniques. Students will have the opportunity to develop a program to implement the methods to simulate nanostructure evolution. Topics covered include: configurational forces, formulation of migration, simulation of structural evolution, surface roughening, motion of thin film, composition modulation, electromigration, and assembly.

PROGRAM OUTCOMES: (Current Listing)

☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective

Prerequisites ○ Enforced ○ Advised

Credit Restrictions

Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours: Min ___ Max ___ | Contact Hrs/Wk ___ | Number of Wks ___

PROGRAM OUTCOMES: (Requested Listing)

☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective

Prerequisites: Graduate Standing and seniors by PI ○ Enforced ◉ Advised

Credit Restrictions

Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☒ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours: Min 3 Max 3 | Contact Hrs/Wk 3 | Number of Wks 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ◉ No
Maximum Hours? ___ Maximum Times? ___
Can it be repeated in the same term? ○ Yes ○ No

Printing Information (Optional) ☒ Print the course in the Bulletin ☐ Print the course in the Time Schedule

Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ___

Graded Section: ◉ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other

Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; ☐ Yearly ■ Alter Years ☐ Even Years ☐ Odd Years; Half term ☐ 1st ☐ 2nd

Cognizant Faculty Member: W. Lu Title Asst. Prof..

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval
- ☐ Curriculum Comm.
- ☐ Faculty
- ☐ Rackham
- ☐ Cross listed Unit 1
- ☐ Cross listed Unit 2

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. Mechanical Engineering
Cross-listed Dept(s).

D. Assanis [signature]

Form Number

1772

SUPPORTING STATEMENT

This course prepares the engineering student to meet the ever-increasing educational demands of the rapidly growing nanotechnology field. The application of nanotechnology may revolutionize many engineering fields and our society. However, it relies heavily on the education of future engineers. This course is designed for graduate students from various engineering programs. It is self contained. The concepts, way of thinking, and methods of attacking problems are applicable to a wide range of disciplines. Due to its interdisciplinary nature, the course has integrated phenomena and processes in several fields, including solid mechanics, materials, physics and electronics. The focus of the course is scientific understanding and computational techniques. The key element of my nanotechnology education is vigorous participation of students in class discussion of the subjects at hand.

A group project is an important component of this course. The studentis encouraged to choose any nano-related topic relevant to the research fields of the group members, as long as the topic can be addressed with the approaches taught in the class. These projects have demonstrated high quality, and contributed to students' research work. This course has provided a unique opportunity for students with different backgrounds to work together.

The course was first taught in W02 and has been taught four (4) times, which enthusiastic response (Average Q1=4.51 and Q2=4.49 and Highest Q1=4.88 and Q2=4.88) and is planned for W07. The course syllabus is attached. For previous projects, please check website: http://www-personal.umich.edu/~weilu/me599/

Senior undergraduate students may also join the class by instructor permission.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

Detail the Special requirements

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Print

Form Number: 1652

Action Requested

- ◉ New Course
- ○ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

Date 9/20/2006
Effective Winter 2007

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Div # / Course Number:	Home Department: Mechanical Engineering / Div #: / Course Number: 580
Cross Listed Course Information:	Cross Listed Course Information:
Course Title:	Course Title: Transport Phenomena in Materials Processing
TITLE ABBREVIATION — Time Sched (Max = 19 Spaces):	TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): Transp Phenomena
TITLE ABBREVIATION — Transcript (Max = 20 Spaces):	TITLE ABBREVIATION — Transcript (Max = 20 Spaces): Trans Phenom in Mtls Proc
Course Description:	Course Description for Official Publication (Max = 50 words): Proficiency in the fundamental understanding of materials processing techniques. Lectures will cover: techniques for model development and simplification with an emphasis on estimation and scaling; 'classical' analytic solutions to simple problems, physical phenomena in materials processing including non-Newtonian fluid flow, solidification, and microstructure development. Techniques for measurement of monitoring of important process variables for model verificaton and process control. Case studies (heat treatment; welding; polymer extrusion and molding; various metal casting processes; crystal growth).
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k
Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	Degree Requirements: ○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective
Prerequisites: ○ Enforced ○ Advised	Prerequisites: Senior or Graduate Standing ○ Enforced ◉ Advised
Credit Restrictions:	Credit Restrictions:
Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work	Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☒ All Credit types ☐ Rckhm Grad w/add'l Work
Credit Hours Min: __ Max: __; Contact Hrs/Wk: __; Number of Wks: __	Credit Hours Min: 3 Max: 3; Contact Hrs/Wk: 3; Number of Wks: 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation:
Is this course repeatable? ○ Yes ◉ No
Maximum Hours? ____ Maximum Times? ____
Can it be repeated in the same term? ○ Yes ○ No

Printing Information (Optional) ☒ Print the course in the Bulletin ☒ Print the course in the Time Schedule

Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ____

Graded Section: ◉ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other

Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; ☐ Yearly ☐ Alter Years ■ Even Years ☐ Odd Years

Half term ☐ 1st ☐ 2nd

Cognizant Faculty Member: J. Mazumder — **Title** Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

- ☐ Curriculum Comm. ____________
- ☐ Faculty ____________
- ☐ Rackham ____________
- ☐ Cross listed Unit 1 ____________
- ☐ Cross listed Unit 2 ____________

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. Mechanical Engineering Arvind Atreya
Cross-listed Dept(s). ____________

Form Number

1652

SUPPORTING STATEMENT

ME599-Transport Phenomena in Manufacturing Processes has been taught several times in the past eight years. The primary objective of the course is to make students proficient in the fundamental understanding of various materials processing techniques through the development and use of physically-based mathematical models and associated measurement techniques for model verification and process monitoring. After completing the course, students should be able to determine whether or not a model is valid, anticipate the usefulness and limitations of a model, identify appropriate monitoring systems for the measurement of important process parameters, and develop their own processes. These skills are essential for any student wishing to pursue advanced studies in Materials Processing. Course feedback from students indicates that they find the knowledge gained to be not only useful for its connections with other advanced ME courses, but also a solid building block for more detailed study in pursuit of advanced degrees with emphasis in Materials Processing.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

Detail the Special requirements