ME Undergraduate Program Revision
Modification to Thermal/Fluids/Heat Transfer Sequence

Summary

It is proposed to change the ME Undergraduate program to replace ME230 and ME330, which are 4-credit courses, with a sequence of three, 3-credit courses: ME235: Thermodynamics I, ME320: Fluid Mechanics, and ME335: Heat Transfer. Since ME230/ME330 are required courses in the ME program, replacement of these courses constitutes a program change, which involves approval of the ME Advisory Committee, ME Faculty, College Curriculum Committee and the College Faculty (at a College Faculty Meeting).

Background and Discussion

The ME230/ME330 sequence was developed as part of the overall revision of the Mechanical Engineering Curriculum, under the Curriculum 2000 rubric. As part of our ongoing assessment process, data gathered for these courses consistently indicated concerns on the part of students (and now alumni) and faculty regarding these courses. In Winter 2002, a committee was appointed by Dennis Assanis to review our undergraduate course sequence in this area. The committee concluded the best option is to introduce a 3 course sequence of 3-credit classes comprising (1) thermodynamics, (2) fluid mechanics, (3) heat transfer. Their report is attached as Appendix B. Although this change does mean adding one more hour to this course sequence, this approach is, supported by the responses to Questions 2, 3, and 10(vi), as opposed to other options to partition the courses but maintain 8 hours in the curriculum.

On November 11, 2002, a meeting was called by Greg Hulbert, gathering the Thermal/Fluid Sciences instructional faculty; the PowerPoint presentation is attached as Appendix C. At that meeting, results from the Review Committee were presented and discussed, particularly regarding the Committee's recommendation. All in attendance were in agreement that the Committee's recommendation towards 3, 3-credit courses was the best option for our students.

Following the meeting, course leaders for the three proposed courses were identified and asked to prepare a syllabus and a "Step II" form for the proposed courses. The course leaders are: Thermodynamics I: Claus Borgnakke; Fluid Mechanics: Rayhaneh Akhavan; Heat Transfer: Massoud Kaviany. These materials were presented to the Thermal/Fluid Sciences instructional faculty and are presented in revised versions in Appendix A.

Also included in Appendix A is a sample schedule for progression of a new College of Engineering (CoE) student through the Mechanical Engineering Undergraduate Curriculum. It is significant to note that the first year (terms 1 and 2) have been left unchanged, maintaining the common first year program philosophy of the CoE. The additional hour necessary to change from 2, 4-credit to 3, 3-credit classes was obtained from the unrestricted electives, taken by decreasing from 4 hours to 3 hours the unrestricted electives advised in term 3 of our present sample schedule. The sample schedule proposes the sequence of 235, 320, and 335 to be taken in terms 4, 5, and 6. In this manner, the students have the flexibility in their senior year regarding the sequencing of 450/495, although 335 is to be taken prior to or concurrently with 495.

If approved, implementation of the plan would proceed as follows:

Last offering of ME230: Winter 2003 semester

Two offerings of ME330 will be proposed for Fall 2003 semester
One offering of ME330 will be given in Winter 2004 semester
Last offering of ME330: Winter 2004 semester

First offering of ME235: Spring 2003 half semester

Two sections of ME235 would be offered each Fall and Winter semester, beginning Fall 2003

The first offering of ME320 will be two sections in Winter 2004 semester.

The first offering of ME335 will be two sections in Fall 2004 semester.

We need to monitor the enrollment in ME320 and ME335, enrollment may suggest two sections one term and one section the alternate term, which will help reduce staffing requirements.

With the new sequence of courses, assessment of the course changes will be implemented so that we can gather information about the program change, following the model of continual assessment of our ME program.

Specific changes to our present courses, in terms of prerequisite/co-requisite requirements are as follows:

ME336. Thermodynamics II:
change prerequisite from ME230 to ME235

ME395. Laboratory I:
change prerequisite from ME230 to ME235
change co-requisite from ME330 to ME320

ME420. Fluid Mechanics II:
change prerequisite from ME330 to ME320

ME437. Applied Energy Conversion:
change prerequisite from ME230 to ME235

ME471. Computational Heat Transfer:
change prerequisite from ME330 to ME320

ME476. Thermal-Fluid Sciences in Bioengineering:
change prerequisite from ME330 to ME320

ME495. Laboratory II
add preceded or accompanied by ME335

ME505. Finite Element Methods in Mechanical Engineering
change prerequisite from ME330 to ME335

ME520. Advanced Fluid Mechanics I
change prerequisite from ME330 to ME320

ME530. Advanced Heat Transfer
change prerequisite from ME330 to ME335

ME532. Convection Heat Transfer
change prerequisite from ME330 to ME335

ME5323 Radiative Heat Transfer
change prerequisite from ME330 to ME335

ME536. Phase Change Dynamics
change prerequisite from ME330 to ME320, ME335

ME539. Heat Transfer in Porous Media
change prerequisite from ME330 to ME320, ME335

ME562. Dynamic Behavior of Thermal-Fluid Processes
change prerequisite from ME330 to ME320, ME335

ME631. Statistical Thermodynamics
change prerequisite from ME230 to ME235

APPENDIX A

ME Sample Schedule for Revised Curriculum
Syllabus and Step II Form for
ME235
ME320
ME335

Sample Schedule
B.S.E. Mechanical Engineering

	Term	1	2	3	4	5	6	7	8
MATH	16	4	4	4	4				
ENGR 100	4	4							
ENGR 101	4		4						
CHEM 125,130	5			5					
Physics 140/141, 240/241	10	5	5						
HUSS	16	4	4				4		4
Advanced Math	3					3			
EECS 314	4							4	
ME 211	4			4					
ME 235: Thermodynamics I	3				3				
ME 240	4				4				
ME 250	4				4				
ME 320: Fluid Mechanics I	3					3			
ME 350	4					4			
ME 360	4						4		
ME 382	4					4			
ME 395	4						4		
ME 335 Heat Transfer	3						3		
ME 450	4								4
ME 495	4							4	
Technical Electives	12							6	6
Unrestricted Electives	9			3		3		3	
Total	128	17	17	16	15	17	15	17	14
Number of courses in term		4	4	4	4	5	4	5	4

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

[redacted]

Form Number **1045**

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 2/3/2003

Effective Spring 2003

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	

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

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

B. REQUESTED LISTING

Home Department	MECHANICAL ENGINEERING
Div #	280
Course Number	235
Cross Listed Course Information	
Course Title	THERMODYNAMICS I
TITLE ABBREVIATION – Time Sched Max = 19 Spaces	THERMODYNAMICS I
TITLE ABBREVIATION – Transcript Max = 20 Spaces	THERMODYNAMICS I

Course Description for Official Publication (Max = 50 words)

Introduction to engineering thermodynamics. First law, second law system and control volume analyses; properties and behavior of pure substances; application to thermodynamic systems operating in a steady state and transient processes. Heat transfer mechanismis. Typical power producing cycles and refrigerators. Ideal gas mixtures and moist air applications.

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

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

Prerequisites: Chem130, 125 or Chem 210, 211, and Math 116
○ 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
Half term ☐ 1st ☐ 2nd
■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years

Cognizant Faculty Member: C. Borgnakke 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
Cross-listed Dept(s). ______

Form Number

1045

SUPPORTING STATEMENT

ME235 is the first in the new thermal, fluid, heat transfer sequence in the ME program. Additional supporting documentaiton for this program change is being provided to the College Curriculum Committee.

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

Detail the Special requirements

THE UNIVERSITY OF MICHIGAN
Department of Mechanical Engineering

ME 235 Thermodynamics I

Text: Fundamentals of Thermodynamics, 6th Ed.
R.E. Sonntag, C. Borgnakke and G.J. van Wylen
John Wiley & Sons, New York, 2003

Coverage: Text Chapters 1-9, Chapter 11 (selective), Chapter 12.
Chapter 2: Properties, units and control volumes
Chapter 3: Properties of pure substances, solid-liquid-vapor phases.
Chapter 4: Work and Heat as energy in transfer
Chapter 5: Continuity and energy equations
Chapter 6: General control volume analysis with continuity and energy equations.
Chapter 7: The second law of thermodynamics
Chapter 8: The entropy balance equation, reversible processes and irreversible processes
Chapter 9: General control volume analysis with continuity, energy and entropy equations. Reversible and irreversible processes with flow in steady state and transient modes.
Chapter 11: Cycle analysis for steam power plant, gas turbine, jet engine, gasoline engine, diesel engine and refrigerator. Selective coverage.
Chapter 12: Gas mixtures and moist air applications

Homework: Collected on a regular basis on Wednesday, each problem graded 0-1-2 (mainly based on effort).

Exams: Two one-hour exams plus a two-hour final
All exams are open-book, open notes in Rm ???.

Course grade: Four hours of exams 80%, homework 20%.

Home work solutions and schedule posted on the web by UM-coursetools

THE UNIVERSITY OF MICHIGAN
Department of Mechanical Engineering

ME 235 THERMODYNAMICS I

Week	Text	Coverage
1	Ch 1-2	Introduction
2	Ch 3	Properties, P-v-T, phase-diagrams, general tables, Ideal gas model, generalized compressibility
3	Ch 4-5	Work, Heat and Energy Equation
4	Ch 5	Energy Equation no flow
5	Ch 6	Energy Equation Steady Flow and Transients
6	Ch 6-7	Energy Equation and Second Law
7	Ch 7-8	Second Law and Entropy
7	Date tentative	**EXAM I**
8	Ch 8	Entropy, reversible and irreversible processes
8		**Spring break/ fall break**
9	Ch 8-9	Polytropic processes, Reversible flow processes
10	Ch 9	General Continuity, Energy and Entropy balance
11	Ch 9	equations for reversible and irreversible processes
12	Ch 11	Cycles: Heat Engines
13	Ch 11	Cycles: Heat Engines and Refrigerators
13	Date tentative	**EXAM II**
14	Ch 12	Mixtures and Moist air applications
Last day	Ch 12	Wrap up/Review. Last day of classes
Final		**FINAL EXAM 2 Hours**

STEP II: Mechanical Engineering Program

COURSE #: ME 235	**COURSE TITLE: Thermodynamics I**
TERMS OFFERED: Fall, Winter, Spring.	**PREREQUISITES:** Chem 130: General Chemistry; Chem 125: General & Inorganic Chemistry; **AND** Math 116: Calculus II.
TEXTBOOKS/REQUIRED MATERIAL: Fundamentals of Classical Thermodynamics by Sonntag, Borgnakke and van Wylen, Wiley 2003	**COGNIZANT FACULTY: C. Borgnakke** **DATE OF PREPARATION: 12/2/2002**
COURSE LEADER(S): C. Borgnakke	**SCIENCE/DESIGN:**
CATALOG DESCRIPTION: Introduction to engineering thermodynamics. First law, second law system and control volume analyses; properties and behavior of pure substances; application to thermodynamic systems operating in steady state and transient processes. Heat transfer mechanisms. Typical power producing cycles and refrigerators. Ideal gas mixtures and moist air applications.	**COURSE TOPICS:** 1. Pressure, temperature and general properties. 2. Work and heat transfer in processes, power. 3. Conservation principle for mass and energy. 4. Reversible processes. 5. The 2nd law of thermodynamics. 6. Steady state devices. 7. Transient processes. 8. Heat engines, power producing cycles. 9. Refrigerators and heat pumps. 10. Mixtures and moist air.

COURSE OBJECTIVES*	(numbers shown in brackets are links to department educational outcomes) 1. To make student familiar with basic concepts, devices and properties used in thermal science [3, 11]. 2. To teach the behavior of a simple pure substance including solid-liquid and gas phases [2, 5, 8]. 3. To teach evaluation of work, heat transfer and power in processes [1, 3]. 4. To teach the formulation of conservation laws for mass, energy and entropy for various physical systems [1, 3, 5, 9]. 5. To teach application of process knowledge to the analysis of complete systems [5, 8, 9, 11].

	6. To make students familiar with how various engines and refrigerators function [3, 8, 10, 11]. 7. To teach the behavior of gas mixtures and moist air [1, 3, 5, 11].
COURSE OUTCOMES*	(numbers shown in brackets are links to course objectives) 1. Identify different subsystems, indicate where there is work, heat transfer and the importance of temperature, pressure and density [1, 3]. 2. Given a set of properties, find the correct phase and remaining properties for a substance [2]. 3. Given a physical setup, find process and compute associated work/heat transfer that is the most reasonable approximation [2, 3]. 4. Given a physical device and process, compute the work and heat transfer [2, 3, 4]. 5. Given a physical setup, formulate the ideal approximation to the behavior and compute the corresponding work and heat transfer [4, 5, 6]. 6. Given an actual device, analyze the corresponding ideal device [4, 5, 6]. 7. Evaluate performance and power for simple heat engines/refrigerators [5,6]. 8. Evaluate the energy and water flow involved in a process with moist air [7]. 9. Treat a problem that involves a mixture of gases [4, 5, 7]. 10. To have an understanding of how processes affect the environment [3, 5, 6].
ASSESSMENT TOOLS	1. Regular homework problems. 2. Exams.

***The ABET99 Group suggests up to 6 objectives and 1-3 outcomes per objective.**

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

Print

Form Number: 1044

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 2/3/2003
Effective Winter 2004

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 ○ Tech Elective ○ Core Course ○ Other ○ Free 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 ___

B. REQUESTED LISTING

Home Department	Div #	Course Number
MECHANICAL ENGINEERING	280	320

Cross Listed Course Information

Course Title: FLUID MECHANICS I

TITLE ABBREVIATION		
	Time Sched Max = 19 Spaces	FLUID MECH I
	Transcript Max = 20 Spaces	FLUID MECH I

Course Description for Official Publication (Max = 50 words)

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 .

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

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

Prerequisites ME235, ME240, and Math 216 ○ 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 — Half term ☐ 1st ☐ 2nd
■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years

Cognizant Faculty Member: R. Akhavan **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
Cross-listed Dept(s).

Form Number

Form Number

1044

SUPPORTING STATEMENT

ME320 is the second course in the new thermal, fluids, heat transfer sequence in the ME program. Additional supporting documentation for this program change is being provided to the College Curriculum Committee.

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

Detail the Special requirements

ME 320 FLUID MECHANICS I

DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF MICHIGAN, ANN AROBOR

	SUBJECT	**READING**	**HW ASSIGNMENTS DUE**
Week One	•Fluid Properties, Fluid Forces, Flow Regimes	Chap. 1	
Week Two	•Fluid Statics and Rigid Body Motion	Chap. 2	HW # 1
Week Three	•Inviscid Flow: The Steady and Unsteady Bernoulli Equation	Chap. 3	HW #2
Week Four	•Control Volume Analysis: Reynolds Transport Theorem, Conservation of Mass	Sec. 4.3, 4.4, 5.1	HW #3
Week Five	•Control Volume Analysis: Conservation of Momentum, Conservation of Energy, Deforming and Moving Control Volumes	Chap. 5	HW # 4
Week Six	•Fluid Kinematics	Chap. 4	HW # 5
Week Seven	**•EXAM I** • Differential Analysis of Fluid Flow: Conservation of Mass and Momentum	Chap. 6	
Week Eight	•Inviscid Flow: Euler's Equations (the Bernoulli Equation revisited) •Viscous Flow: Exact Solutions of the Navier-Stokes Equations in Simple Geometries •Viscous Flow: Use of Exact Solutions in Complex Geometries	Chap. 6	HW # 6
Week Nine	•Dimensional Analysis, Similitude, and Modeling	Chap. 7	HW # 7
Week Ten	•Flow in Pipes and Piping Networks: Laminar and Turbulent Flow, the Moody Chart, the Head-Loss equation	Chap. 8	HW # 8
Week Eleven	•External Flow: Laminar and Turbulent Flow, Boundary Layer Concepts	Chap. 9	HW # 9
Week Twelve	•External Flow: Lift and Drag, Flow Separation, Streamlining **•EXAM II**	Chap. 9	HW # 10
Week Thirteen	•Introduction to Commercial CFD Packages, CFD Project		
Week Fourteen	•CFD Project		CFD Project

FINAL EXAM

STEP II: Mechanical Engineering Program

COURSE #: ME 235	COURSE TITLE: Thermodynamics I
TERMS OFFERED: Fall, Winter, Spring.	**PREREQUISITES:** Chem 130: General Chemistry; Chem 125: General & Inorganic Chemistry; **AND** Math 116: Calculus II.
TEXTBOOKS/REQUIRED MATERIAL: Fundamentals of Classical Thermodynamics by Sonntag, Borgnakke and van Wylen, Wiley 2003	**COGNIZANT FACULTY: C. Borgnakke** **DATE OF PREPARATION: 12/2/2002**
COURSE LEADER(S): C. Borgnakke	**SCIENCE/DESIGN:**
CATALOG DESCRIPTION: Introduction to engineering thermodynamics. First law, second law system and control volume analyses; properties and behavior of pure substances; application to thermodynamic systems operating in steady state and transient processes. Heat transfer mechanisms. Typical power producing cycles and refrigerators. Ideal gas mixtures and moist air applications.	**COURSE TOPICS:** 1. Pressure, temperature and general properties. 2. Work and heat transfer in processes, power. 3. Conservation principle for mass and energy. 4. Reversible processes. 5. The 2nd law of thermodynamics. 6. Steady state devices. 7. Transient processes. 8. Heat engines, power producing cycles. 9. Refrigerators and heat pumps. 10. Mixtures and moist air.

COURSE OBJECTIVES*	(numbers shown in brackets are links to department educational outcomes) 1. To make student familiar with basic concepts, devices and properties used in thermal science [3, 11]. 2. To teach the behavior of a simple pure substance including solid-liquid and gas phases [2, 5, 8]. 3. To teach evaluation of work, heat transfer and power in processes [1, 3]. 4. To teach the formulation of conservation laws for mass, energy and entropy for various physical systems [1, 3, 5, 9]. 5. To teach application of process knowledge to the analysis of complete systems [5, 8, 9, 11].

	6. To make students familiar with how various engines and refrigerators function [3, 8, 10, 11]. 7. To teach the behavior of gas mixtures and moist air [1, 3, 5, 11].
COURSE OUTCOMES*	(numbers shown in brackets are links to course objectives) 1. Identify different subsystems, indicate where there is work, heat transfer and the importance of temperature, pressure and density [1, 3]. 2. Given a set of properties, find the correct phase and remaining properties for a substance [2]. 3. Given a physical setup, find process and compute associated work/heat transfer that is the most reasonable approximation [2, 3]. 4. Given a physical device and process, compute the work and heat transfer [2, 3, 4]. 5. Given a physical setup, formulate the ideal approximation to the behavior and compute the corresponding work and heat transfer [4, 5, 6]. 6. Given an actual device, analyze the corresponding ideal device [4, 5, 6]. 7. Evaluate performance and power for simple heat engines/refrigerators [5,6]. 8. Evaluate the energy and water flow involved in a process with moist air [7]. 9. Treat a problem that involves a mixture of gases [4, 5, 7]. 10. To have an understanding of how processes affect the environment [3, 5, 6].
ASSESSMENT TOOLS	1. Regular homework problems. 2. Exams.

***The ABET99 Group suggests up to 6 objectives and 1-3 outcomes per objective.**

ME 335 HEAT TRANSFER

DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF MICHIGAN, ANN AROBOR

	SUBJECT	READING	PROBLEMS
Week One	•Introduction: Control Volume and Surface, Heat Flux Vector, Mechanisms of Heat Transfer, Energy Conservation Equation		HW # 1
Week Two	•Energy Equation for Differential Volume, Integral Volume, Combined Integral- and Differential-Length Volume, and Finite-Small Volume		HW # 2
Week Three	•Work and Energy Conversion: Mechanisms of Energy Conversion, Bounding-Surface Thermal Conditions, Methodology for Heat Transfer Analysis		HW #3
Week Four	•Conduction: Specific Heat and Thermal Conductivity of Matter, Steady-State Conduction: Conduction Thermal Resistance		HW #4
Week Five	•Steady-State Conduction: Composites, Thermal Circuit Analysis, Contact Resistance, Energy Conversion, Thermoelectric Cooling		HW # 5
Week Six	•Transient Conduction: Distributed Capacitance, Lumped Capacitance, Discretization of Medium into Small-Finite Volumes		HW # 6
Week Seven	•Surface Radiation: Surface Emission, Interaction of Radiation and Surface, Thermal Radiometry **•EXAM I**		HW #7
Week Eight	•Surface Radiation: Diffuse-Gray Enclosures, Radiation Resistances, Circuit Analysis, Prescribed Irradiation and Nongray Surfaces, Inclusion of Substrate		HW # 8
Week Nine	•Intramedium Convection: Conduction-Convection Resistance, Combustion and Joule Heating of Gases •Surface Convection (External Flow): Flow and Surface Characteristics		HW # 9
Week Ten	•Surface Convection (External Flow) Parallel Flow over Semi-Infinite Plate, Peclet and Nusselt Numbers, Surface-Convection Resistance, Prandtl and Reynolds Numbers, Parallel Turbulent Flow, Perpendicular Flows		HW # 10
Week Eleven	•Surface Convection (External Flow): Thermobuoyant Flows, Liquid-Vapor Phase Change, Nusselt Number Correlation		HW # 11
Week Twelve	•Surface Convection (External Flow): Inclusion of Substrate, Surface-Convection Evaporation Cooling •Surface Convection (Internal Flow): Flow and Surface Characteristics		HW # 12
Week Thirteen	•Surface Convection (Internal Flow): Tube Flow and Heat Transfer, Average Convection Resistance, Laminar and Turbulent Flows, Entrance Effect, and Phase Change **•EXAM II**		HW # 13
Week Fourteen	•Surface Convection (Bounded Fluid): Nusselt Number Correlations, Inclusion of Substrate, Heat Exchangers •Design of Thermal Systems		HW #14
	FINAL EXAM		

STEP II: Mechanical Engineering Program

COURSE #: ME 335	**COURSE TITLE: Heat Transfer**
TERMS OFFERED: Fall, Winter	**PREREQUISITES:** ME 320: Fluid Mechanics I ME 235: Thermodynamics I ME 240: Introduction to Dynamics and Vibrations; MA 216: Introduction to Differential Equations.
TEXTBOOKS/REQUIRED MATERIAL: Introduction to Heat Transfer, Incropera & DeWitt, Fourth Edition, 2002, Wiley. Or <u>Principles of Heat Transfer</u>, Kaviany, 2001, Wiley	**COGNIZANT FACULTY:** M. Kaviany **DATE OF PREPARATION:** 11/12/02
COURSE LEADER(S): M. Kaviany	**SCIENCE/DESIGN:**
CATALOG DESCRIPTION: Conservation of energy expressed in integral and differential form and containing heat transfer by conduction, convection, and radiation (as well as heat storage and energy conversion); physics of conduction heat transfer , steady-state and transient conduction, thermal circuit modeling and analysis, multidimensional conduction, analytical and numerical solutions; physics of radiation heat transfer, surface radiation properties, enclosure radiation exchange, nongray radiation, thermal circuit models including the bounding solid heat transfer; surface convection to fluid streams moving over objects, Nusselt, Prandtl, Reynolds, and Peclet numbers, laminar, turbulent, thermobuoyant (natural) flow and boiling and condensation, thermal circuit models including the bounding solid heat transfer; surface convection and convection in internal fluid streams, Number of Thermal Units and Effectiveness, heat exchangers; design of thermal systems using the principles of heat transfer and energy storage and conversion, use of solvers for problem solving and parametric studies (design).	**COURSE TOPICS:** 1. Conservation of energy, energy conversion, storage, and heat transfer 2. Integral- and differential-volume energy equations, overview of elements in the energy equation 3. Physics of conductivity, Steady-state and transient conduction, thermal resistance and thermal circuit models and analysis 4. Physics of surface radiation, surface radiation properties, surface enclosure radiation exchange, thermal circuit modeling, nongray surfaces, inclusion of the heat transfer through the substrate 5. Surface convection of fluid streams passing over objects, Nusselt, Prandtl, Reynolds, and Peclet numbers, analytical relations and correlations for the Nusselt number, thermal circuit diagram, inclusion of substrate heat transfer 6. Laminar, turbulent, parallel, perpendicular, and thrmobuoyant flows, boiling and condensation 7. Surface convection and convection of internal fluid streams, Number of Thermal Units and Effectiveness, Nusselt number correlations, heat exchangers 8. Design of thermal systems using solvers

COURSE OBJECTIVES*	(numbers shown in brackets are links to department educational outcomes) 1. To make students familiar with fundamental heat transfer concepts: conservation of energy, mechanisms of energy conversion, and mechanisms of heat transfer (conduction, radiation, and convection [1, 3, 5, 9]. 2. To teach balance of energy applied to integral- and differential-volumes and discuss finite-small volume applied in numerical analysis [1, 3, 5]. 3. To teach the physics of thermal conduction in fluids and in solids (metals, plastics, ceramics) and composites such as insulation and define thermal conduction resistance [1, 3, 5, 9]. 4. To teach the physics of thermal radiation and thermal surface properties, and define surface-grayness and view-factor resistance 1, 3, 5, 9]. 5. To show how is transferred by surface convection, between a moving fluid and a solid, and define surface convection resistance [1, 3, 5, 9] 6. To show how thermal circuit analysis can be used for thermal systems [2-9, 12] 7. To enable students to make analysis of practical problems using these concepts and solvers [1-10] 8. To teach the relation of thermal systems analysis to environmental concerns [8-10].
COURSE **OUTCOMES***	(numbers shown in brackets are links to departmental outcomes) 1. Formulate engineering and natural thermal systems in terms of conservation of energy [1, 3, 12]. 2. Related the rate of heat transfer to the potential for heat flow (difference in temperature) and thermal resistances [1, 3, 5, 8, 11, 12]. 3. Determine these resistances for conduction, radiation, and convection heat transfer, using the fundamental relationships and correlations [1, 5, 12]. 4. Learn to solve problems using solvers (multimode systems and design parameter sweep) [1, 3, 5, 7, 11, 12]. 5. Compare the various resistances, along with thermal energy conversion and storage, in the thermal systems and identifying the dominant resistance [1, 3, 5,12]. 6. Learn to design modern, innovative thermal systems for various applications [1, 5, 8, 11, 12]. 7. An understanding of how heat transfer and thermal engineering impact environmental concerns [8].
ASSESSMENT TOOLS	1. Regular homework problems. 2. Exams.

*The ABET99 Group suggests up to 6 objectives and 1-3 outcomes per objective.

APPENDIX B

Report from the TFS Review Committee

(Note: Name Attributions have been removed from survey responses)

COMMITTEE TO REVIEW THE THERMAL/FLUID UNDERGRADUATE COURSE SEQUENCE

FINAL REPORT

The present required undergraduate course sequence ME230/330 in thermal/fluid sciences was developed in 1999 as part of the revision of the Mechanical Engineering curriculum. These courses have now been taught for three years and a committee comprising Professors Akhavan, Borgnakke, Kaviany, Sick and Barber (chair) was convened in Winter 2002 to review their effectiveness. In particular, the Committee was charged to determine whether there is a structure for these courses that would be broadly acceptable to the entire Thermal/Fluids faculty. In other words, the objective is to seek a compromise 'inclusive' solution, rather than a 'majority' solution.

The committee held several extended meetings in Winter term 2002, involving wide ranging discussions of the objectives of undergraduate education, the place of thermal/fluid sciences in the ME curriculum, as well as details of the way the courses are taught and their interaction with other courses such as ME395.

A healthy diversity of views was expressed in these discussions and many alternative formats for the courses were suggested and debated. As a result of these discussions, the Committee formulated a set of questions to submit to the Thermal/Fluids faculty to get a broader sense of their experiences with and opinions of these courses. The response to these questions is tabulated and appended to this report.

The responses to Questions 8 and 9 are particularly instructive. Though the faculty recognize the benefits of showcasing the interconnections between Thermodynamics, Fluid Mechanics and Heat Transfer, they see many disadvantages with the present structure, notably that time and structure constraints encourage instructors to give less than adequate coverage to subjects that are not central to their personal interests, resulting in inconsistencies from term to term.

In the light of their discussions and of the broader faculty response, the Committee considers that the most satisfactory solution would be to revert to a sequence of three 3 credit hour courses in Thermodynamics, Fluid Mechanics and Heat Transfer respectively. Despite the quite diverse perspectives of the Committee members and the faculty respondents, there was broad agreement on this conclusion (see for example Question 10.(vi)). We recognize that this would disrupt the 4×4 curriculum structure and hence make it marginally harder for students to graduate in 8 semesters, but we consider that this disadvantage has to be set against the educational deficiencies of the present course sequence.

The Committee discussed one option which might alleviate the student credit hour problem. The new required 3 credit hour courses could be associated with an elective one hour project (or other additional assignments), giving the student a mechanism for maintaining a 16 credit per term load. Similar one credit electives might also be associated with other core undergraduate courses. However, full discussion of this and other aspects of the overall ME curriculum is most properly left to the Undergraduate Committee.

R.Akhavan
C.Borgnakke
M.Kaviany
V.Sick
J.R.Barber (chair)

18 September 2002.

QUESTIONNAIRE RESULTS

1. Overall how successful has the 230/330 structure been for teaching the required undergraduate material in Thermodynamics, Fluid Mechanics, and Heat Transfer?

Very Successful	0
Somewhat Successful	4
Neutral	1
Somewhat Unsuccessful	4
Very Unsuccessful	3

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2. Does the current 230/330 sequence provide adequate time to cover the required material in Thermodynamics, Fluid Mechanics, and Heat Transfer?

Adequate	2
Less than Adequate	3
Inadequate	5

Problem is structural, not time. Old habits also get in the way.... ... the time allocated to convection heat transfer was too little...

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3. Does the current 230/330 sequence provide adequate time and appropriate structure to introduce emerging topics in mechanical engineering (such as environmental-, bio-, macro-, nano-, eco-, etc.)?

Adequate	2
Less than Adequate	1
Inadequate	6
No opinion	1

..., but topics not really UG. Question not really meaningful, it implies we should cover it, I dont think so. ...as this can be integrated into lecture examples and homework.... There would have been enough time if people would give up some old concepts of teaching these topics.... There is no extra space in these classes for these topics. We need to develop electives to cover new areas.... I tried to cover... (these) issues ... could have done a better job if ... more time.

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4. How well does the current 230/330 sequence prepare the students for followup courses in thermal/fluid sciences (such as 395, 495, 450 and thermal/fluids electives)?

Very Well	0
Fairly well	1
Somewhat Poorly	6
Very Poorly	4

The course instructors probably offer decent preparation, but many students do not come prepared. So, do courses "prepare" students or do students learn from instructors?.... As an instructor of ME 395, I see first hand that students do not understand many simple TFS concepts (control volumes, heat and mass flows, fluid pressure, etc.). ... we are at a cross roads where the students should either get a whole year of each topic or they should be allowed to skip this stuff altogether. I do not think we are finding any worthwhile middle ground right now.... The students' understanding of heat transfer is very poor. ... needed to review conduction heat transfer in ME 330, which they were supposed to understand from ME 230.

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5. How well does the current 230/330 sequence prepare the students for Graduate study in the thermal/fluids area?

Very Well	0
Fairly well	1
Somewhat Poorly	4
Very Poorly	6

Not meaningful these courses are UG required courses. They are not [preparation] for graduate thermal science.... The courses probably offer decent preparation, but only a few students will come to grad school prepared. Students should supplement these courses if they plan to attend grad school with a concentration in thermal-fluids.... I gave a Ph.D. qualifying exam in the heat transfer ... and found that the students who graduated from our department did a very poor job in heat transfer. With the current heat transfer training in our department, our students wouldn't survive qualifying exams given at other competitive engineering schools, such as MIT, Stanford, and Berkeley.

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6. How well does the current 230/330 sequence prepare the students for non-engineering careers?

Very Well	1
Fairly well	3
Adequate	1
Somewhat Poorly	2
Very Poorly	1
No opinion	4

You need to know when the water boils for coffee!.... Too much steam cycles and other outdated stuff. ...(fairly well)... but this is a presumption, I do not have any facts to back it up.... If we want to give a thermal/fluid course to students pursuing non-engineering careers, we had better provide a more application-oriented introductory course without requiring advanced knowledge of math. The applications could include ecology, automotive, biology, and energy issues.

---

7. How successful have we been in integrating the three disciplines of Thermodynamics, Fluid Mechanics, and Heat Transfer in 230/330? (this was one of the main stated motivations for going to 230/330 from the 3-course sequence)

Very Successful	0
Somewhat Successful	2
Neutral	1
Somewhat Unsuccessful	3
Very Unsuccessful	4

With some cooperation it could have been better.... I believe that the department has completely degraded the heat transfer education by integrating these subjects.... Ranges from Somewhat Unsuccessful to Somewhat successful. Not consistent from year to year.

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8. List all the advantages you see with the current 230/330 sequence.

- The thermal sciences are inherently related and the 230-330 offered the opportunity to demonstrate the communication and commonality between the topics. Unfortunately, it has become a forum for faculty to teach their favorite topics and the expense of the other areas.
- Only 8 credit hours in thermal science [are] required. The rest can be for those that want it.
- The subjects can be streamlined and integrated presenting a better overall picture to the students.
- Potentially good structure to introduce students to the integrated nature of thermal-fluid sciences
- None
- None comes to mind!
- Can't think of any.

- Broad shallow coverage of topics is perfect for non-specialists. This approach should motivate students to take electives in this area.
- In its present form, none.
- You can get the students [to] graduate within a relatively shorter period of time.
- The 2-by-4 packaging helps with course scheduling and lowers teaching responsibilities. Furthermore, the three topics (thermodynamics, fluids, heat transfer) are part of an intellectual continuum and need not be separated except to satisfy organizational, historical, or personal preferences.
- Administrative convenience (?) — It may serve better to those who are not pursuing ME as major.
- It could unify the three topics more, especially if we had an adequate textbook.
- Opportunity to teach students how to combine knowledge from different areas.

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9. *List all the disadvantages you see with the current 230/330 sequence.*

- The courses gets squeezed, each subject a little less than we used to.
- No broad agreement on the syllabus between the thermal-fluids faculty
- Lack of uniformity – each faculty does it differently.
- In the best of circumstances, it is still three courses taught in two terms – no real integration..
- Few of the current instructors have really been sold on the concept.
- The classes are too shallow and the various topics are not all receiving equal weight from every instructor. Moreover, I do not believe the current ME faculty are unified in their approach to these classes. In particular there were serious divisions within the TFS group about the 3-by-3 to 2-by-4 conversion and there may be lingering animosity even today.
- In addition to the loss of material from combing topics, pressure from our students has lead to an overall mathematical dumbing-down of these classes (particularly 330). However, this trend may not be a product of the course changes alone since a general decline in student patience for mathematics seems nearly universal across all engineering disciplines.
- Students may be misled to think that heat transfer is an "extra" subject that sticks to thermo and fluids class
- Since the heat transfer is covered during the last few weeks of the semester, students are less motivated to learn the new subject.
- Although on paper it may look like we have only reduced from 9 hours to 8, in reality we end up covering much less than what we would do with 3 separate courses.
- It has broken apart and weakened the thermal/fluids group.
- Students are graduating without the basic skills in one of the three disciplines (which is omitted depends on the instructors the students had in their sequence - see above).

- Heat transfer is presented at a point where the students do not necessarily have the background (ODE's in particular) to perform any meaningful analysis.
- It has turned off students from choosing thermal/fluids as a major.
- It has made the best of our undergrads uprepared for graduate eduction in the thermal fluids area.
- It has weakened the whole thermal/fluids progarm at UM (at both the undergraduate and graduate levels).
- It has made undergraduate teaching in the thermal/fluids area painful.
- less time
- nonuniformity in the material covered
- I am not sure that the students enjoy it.
- Too much material in ME330 to reasonably cover. Also mixing mechanics and energy results in having no intuitive feel developed in the students.
- From the feedback of the students who took this course this year and last year, they generally have a difficulty in switching their minds from one subject to another at the nearly end of the semester. They keep telling me that they haven't much understood the heat transfer part.
- The textbook is not yet available.
- There is just not enough time anymore. Much is being skipped.
- Integration did not work as well as it should. Course content depends too much on individual instructors rather than on the syllabus that we have.

10(i). What is your reaction to the following statements:

The problems with 230/330 arise because in a 4-credit hour course one cannot cover 4/3 of the material in a 3-credit hour course.

Strongly Agree	2
Agree	4
Neutral	1
Disagree	4
Strongly Disagree	0

This is a problem but not the reason we are having problems. By the way we only have a problem with ME 330.... I agree that you cannot teach 4/3 of the material in a 4 unit class, however the more fundamental question is, is 4/3 of the material necessary in an integrated 230-330 course structure? .... We just have to push the students harder.... It is just not a matter of time. As to teaching heat transfer, these courses completely disrupt the connection between conduction, convection, and radiation heat transfer.... This is only part of the problem... . It's part of the problem, (see Question 9)....

10(ii). The problems with 230/330 arise because Thermodynamics, Fluid Mechanics and Heat Transfer are three distinct disciplines and cannot be successfully combined into two classes.

Strongly Agree	2
Agree	2
Neutral	0
Disagree	4
Strongly Disagree	4

10(iii). The problems with 230/330 arise because faculty are forced to teach outside of their area of expertise.

Strongly Agree	2
Agree	0
Neutral	1
Disagree	6
Strongly Disagree	3

I think faculty assigned to these classes are merely more likely to emphasize their own favorite subject area(s). All of the material for these classes is written down in textbooks. I doubt that any of my colleagues have trouble teaching this stuff because its outside their area of expertise.... These are fundamental ME undergraduate courses. As ME faculty, we are supposed to be able to teach all of them. .... If you cannot teach any UG thermal fluid course you do not really belong in the thermal fluids group.

10(iv). The problems with 230/330 can be resolved by team teaching these courses (i.e, having faculty of appropriate specialties rotate through 230/330 so they only teach the material related to their area of expertise)

Strongly Agree	0
Agree	0
Neutral	3
Disagree	6
Strongly Disagree	2

Possibly this might work.... I really have no idea whether that will improve it.... I think most of us are qualified to teach these three courses.

10(v). The problems with 230/330 can be resolved by restricting the teaching of these classes to those faculty who have bought into the 230/330 premise.

Strongly Agree	0
Agree	3
Neutral	2
Disagree	2
Strongly Disagree	5

(but it is the wrong solution).... I think its hard for someone to do something they do not believe is correct. Thus, faculty who oppose the current partition of topics are less likely to work to make it a success. Similarly, someone committed to making this partition work might be inclined to overlook any of its drawbacks.

10(vi). The problems with 230/330 can be resolved by going back to 3 separate required 3-credit hour courses in Thermodynamics, Fluid Mechanics, and Heat Transfer?

Strongly Agree	3
Agree	7
Neutral	1
Disagree	1
Strongly Disagree	0

...,but I think it is a pity that we have not managed to integrate the three subjects... ...although this would be an 'uncreative' solution and the UM should be a leader in creative and innovative solutions to teaching programs.

10(vii). The problems with 230/330 can be resolved by going back to 3 separate 4-credit hour courses in Thermodynamics, Fluid Mechanics, and Heat Transfer and making one course (of student's choice) an elective?

Strongly Agree	0
Agree	2
Neutral	4
Disagree	3
Strongly Disagree	2

We used to do 4 required credits for thermo we never did that for fluids or heat transfer. Unrealistic.... Define 'problem' here. If the problem is that students do not receive a thorough education in fluids, heat transfer and thermo, then this is not a viable solution. If the problem is students receive a superficial education in all three areas, then this may be a solution. .... Some - even diluted – knowledge of each course is essential for all ME's.... Neutral, but this is an interesting possibility. However I believe that ABET requirements may limit us from exploring this option.... (Only if heat transfer is the elective. However, heat transfer is one of the distinguishing characteristics of an ME.).

APPENDIX C

Powerpoint Presentation from
November 11, 2002 Meeting with
Themal/Fluid Sciences Instructional Faculty

AGENDA

- Expected outcomes from the meeting
- Summary of the committee report and review of survey data
- Proposal to move to three, 3 credit sequence of courses
  - proposed course sequence
  - sample schedule showing how this fits our curriculum
- Issues involved with change
  - impact on students
  - impact on staffing
  - transition from present sequence to new sequence
  - procedural issues involved
- Requests for and acceptance of responsibilities
  - Course leaders and requisite tasks
- Next steps/timeline for Fall 2003 implementation

Survey Results

- **Overall how successful has the 230/330 structure been for teaching the required undergraduate material in Thermodynamics, Fluid Mechanics, and Heat Transfer?**
  - Very Successful 0
  - Somewhat Successful 4
  - Neutral 1
  - Somewhat Unsuccessful 4
  - Very Unsuccessful 3

Survey Results

- **How successful have we been in integrating the three disciplines of Thermodynamics, Fluid Mechanics, and Heat Transfer in 230/330? (this was one of the main stated motivations for going to 230/330 from the 3-course sequence)**
  - Very Successful 0
  - Somewhat Successful 2
  - Neutral 1
  - Somewhat Unsuccessful 3
  - Very Unsuccessful 4

Survey Results

- **Does the current 230/330 sequence provide adequate time to cover the required material in Thermodynamics, Fluid Mechanics, and Heat Transfer?**
  - Adequate 2
  - Less than Adequate 3
  - Inadequate 5

Survey Results

- **How well does the current 230/330 sequence prepare the students for followup courses in thermal/fluid sciences (such as 395, 495, 450 and thermal/fluids electives)?**
  - Very Well 0
  - Fairly Well 1
  - Somewhat Poorly 6
  - Very Poorly 4

Survey Results

- **The problems with 230/330 can be resolved by team teaching these courses (i.e, having faculty of appropriate specialties rotate through 230/330 so they only teach the material related to their area of expertise)**
  - Strongly Agree 0
  - Agree 0
  - Neutral 3
  - Disagree 6
  - Strongly Disagree 2

Survey Results

- **The problems with 230/330 can be resolved by restricting the teaching of these classes to those faculty who have bought into the 230/330 premise.**

- Strongly Agree	0
- Agree	3
- Neutral	2
- Disagree	2
- Strongly Disagree	5

Survey Results

- **The problems with 230/330 can be resolved by going back to 3 separate required 3-credit hour courses in Thermodynamics, Fluid Mechanics, and Heat Transfer**
  - Strongly Agree 3
  - Agree 7
  - Neutral 1
  - Disagree 1
  - Strongly Disagree 0

Survey Results

- **The problems with 230/330 can be resolved by going back to 3 separate 4-credit hour courses in Thermodynamics, Fluid Mechanics, and Heat**
- **Transfer and making one course (of student's choice) an elective**

- Strongly Agree	0
- Agree	2
- Neutral	4
- Disagree	3
- Strongly Disagree	2

AGENDA

- Expected outcomes from the meeting
- Summary of the committee report and review of survey data
- Proposal to move to three, 3 credit sequence of courses
  - proposed course sequence
  - sample schedule showing how this fits our curriculum
- Issues involved with change
  - impact on students
  - impact on staffing
  - transition from present sequence to new sequence
  - procedural issues involved
- Requests for and acceptance of responsibilities
  - Course leaders and requisite tasks
- Next steps/timeline for Fall 2003 implementation

Issues

- Issues involved with change
  - impact on students
  - impact on staffing
  - transition from present sequence to new sequence
  - procedural issues involved

- 14 faculty
  - 7 slots per semester
  - Impact on tfs electives (UG and grad)
    - Teaching fellows?
    - Non-ME faculty?
  - 395/495 staffing (1 TFS faculty for both (3 total/term))
  - Class size?
    - Evaluate class numbers
    - Adjust cap on later sections?

Next steps/critical dates

- College Faculty Meetings
  - February 18
  - March 18
- College Curriculum Committee
- ME Faculty Meeting
- ME Advisory Committee
- ME UG Planning Committee

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January 27, 2003

To: COE Curriculum Committee

From: Gary D. Herrin
Chair, IOE Curriculum Committee

RE: IOE Undergraduate Program Change (truth in advertising)

Attached is an updated "Sample Schedule" of the IOE Undergraduate Curriculum Program Requirements.

We have listed the correct credit totals students earn for Phys 140, 141, Phys 240, 241 and Chem 125/130. The current listing in the COE Bulletin from Fall 2000 through 2002/2003 reflects the credit totals for Physics and Chemistry that were anticipated for Curriculum 2000, but never materialized.

The changes listed officially reduce our advertised free electives from 12 to 9 credits, which has been the reality since Fall 2000.

IOE Undergraduate Program

Program Requirements

Subjects Required by all programs	Hrs	1	2	3	4	5	6	7	8
Math 115, 116, 215, 214	16	4	4	4	4				
Engin 100, Intro to Engineering	8	4							
Engin 101, Intro to Computers	4		4						
Chemistry 125 / 130 with lab	5	5							
Physics 140 w/ lab, 240 w/ lab	10		5	5					
Humanities and Social Sciences	16		4			4	4	4	
total common core	55								
Related Engineering Subjects									
Non-IOE Engin courses *(note 1)*	12				4	4			4
Required Program Subjects									
IOE 201, Economic Decision Making	2			2					
IOE 202, Operations Modeling	2			2					
IOE 265, Probability and Statistics for Engineers	4			4					
IOE 333, Ergonomics	3				3				
IOE 334, Ergonomics Lab	1				1				
IOE 316, Intro Markov Processes	2				2				
IOE 366, Linear Statistical Models	2				2				
IOE 310, Intro to Optimization Methods	4					4			
IOE 373, Data Processing	4						4		
IOE Senior Design Course (424 or 481, or 499) (note2)	4								4
total required IOE subjects	*28*								
Technical Electives (note 3)	24					4	8	8	4
Free Electives	9	3						3	3
TOTAL	*128*	*16*	*17*	*17*	*16*	*16*	*16*	*15*	*15*

Notes:

1. Non-IOE Engineering courses: Select 12 hours; 4 hours from any three different groups:
   - ME 211 or CE 211 or ME 240
   - ME 230 or ChE 230
   - MSE 220 or ME 382
   - BIOE 458 or EECS 270 or EECS 314
   - CEE 260 or NERS 211
   - EECS 280 or EECS 283

2. Senior Design Courses are restricted to IOE students.

3. Technical Electives: Select at least 16 hours from IOE; at least 4 hours must be from three of the following five groups:
   - A—IOE 441, 447, 449
   - B—IOE 416, 460, 461, 465, 466
   - C—IOE 474
   - D—IOE 432, 436, 438, 439, 463
   - E—IOE 421, 422, 425, 452, 453

The remaining 8 hours may be selected from any 400-level IOE course and / or from an approved list of non-IOE courses.

Simultaneous Graduate/Undergraduate Study Program

Atmospheric Science

	Senior		Graduate	
Courses	Semester7	Semester8	I	II
AOSS475 Earth-Ocean Atmosphere Interactions*		3		
AOSS467 Biogeochemical Cycles	3			
AOSS462 Instrumentation for Atmospheric and Space Sciences		3		
AOSS532 Radiative Transfer			3	
AOSS563 Air Pollution Dispersion Modelling				3
AOSS580 Remote Sensing & Geographic Information System Project Laboratory				2
AOSS747 Atmospheric Science & Environmental Seminar			1	1
AOSS567 Chemical Kinetics			3	
AOSS605 Current Topics in Atmospheric, Ocean & Space Sciences			4	
Cognates				4
Totals	3	6	11	10

* AOSS 475 is a 4 hour course but 1 hour is devoted to technica communications

Simultaneous Graduate/Undergraduate Study Program

Space Science

	Senior		Graduate	
Courses	Semester7	Semester8	I	II
AOSS480 The Planets: Composition, Structure & Evolution		3		
AOSS432 Environmental Radiative Processes		3		
AOSS462 Instrumentation for Atmospheric and Space Sciences		3		
AOSS464 The Space Environment			4	
AOSS605 Current Topics in Atmospheric, Ocean & Space Sciences				4
AOSS582 Spacecraft Technology			3	
AOSS581 Space System Management				3
AOSS 585 Introduction to Remote Sensing & Inversion Theory				3
Cognates			4	
Totals	0	9	11	10