Ph.D. Qualifying Exam Guidance

- This guidance applies to the May 2021 round of Ph.D. qualifying exam.
- All topical exams are written exams.
- For the May 2021 round, the written exams will take place in the week of May 10, 2021. Detailed exam schedule will be announced by April 23, 2021.
- The total time for each exam is 2.5 hours.
- The *default* exam format is closed-book and closed-notes without using calculators. Individual topical exam may have different formats, e.g., open-book, open-notes, or allowing calculator. For the *actual* format of a specific topical area exam for the May 2021 round, please refer to the instructions given in this guidance.
- Except for the Applied Math Examination that involves a graduate course ME 5507, for other topical exams that a candidate chooses to take, the candidate is expected to possess "graduate knowledge of undergraduate courses" according to the ME graduate handbook. This guidance contains the representative syllabus by instructor and/or standard syllabus for each topical area, which is intended to help candidates prepare for the exams.
- For each topical exam, this guidance lists the name of *faculty point-of-contact*, to whom candidates may contact to ask questions pertaining to the specific exam. Candidates should be aware that the faculty point-of-contact may not be always available, and thus are suggested to ask questions (if any) as early as possible.
- For general clarification, please contact Prof. David M. Pierce (david.pierce@uconn.edu; (860) 486-4109).

<u>Applied Math Examination</u>

Exam format: default format; closed-book, closed-notes, calculator not allowed.

Faculty point-of-contact: Professor Matheou

Topics are typically covered in ME 5507, MATH 2210, and MATH 3410. Two sample instructor's syllabi of ME 5507 are attached.

ME 5507 sample instructor syllabus 1

Course: ME5507 Engineering Analysis I

Text: Kreyzig, E., **Advanced Engineering Mathematics, 9th Ed.**, John Wiley & Sons, New York, 2006.

Week	Date	Topic	Kreyzig	Hildebrand
1	8/26	Tensors, Matrices, Vectors	3	6.1-6.4
2	9/2	Linear algrebra, Partials, Integrals, Eigenvalues, Eigenvectors, Vectors	8	1.2
3	9/9	Vector Calculus, Coordinate Systems	9, 10	6.5-6.16 6.17-6.18
4	9/16	O.D.E.: 1st Order Equations, Variation of Parameters	1	1
5	9/23	O.D.E.: 2nd Order Equations, B.V.P., I.V.P.	2, 3	4, 5
6	9/30	Special Functions: Gamma, Beta, Bessel, Legendre, LaGuerre, etc. [Reschedule]	4, 5	4.8-4.9, 4.12 5.14-5.15, 2.9
7	10/7	Mid-Term Examination		
8	10/14	Orthogonal Functions, Eigenvalues & Orthogonal Expansions	5	4.5
9	10/21	P.D.E Inro, Physical Problems, Background, Separation of Variables		8
10	10/28	P.D.E. Classes of Problems: Dimensionality, Steady/Unsteady, Coordinates, B.C.'s, Characteristics	12	8
11	11/4	PDE Applications: Hyperbolic (Unsteady)- Wave Equation	12.2-12.4 12.7-12.8	9.9, 9.12-9.13
12	11/11	PDE Applications: Parabolic (Unsteady)- Heat Conduction	12.6	9.2
13	11/18	PDE Applications: Elliptic (Steady)- Laplace…….	12.9-12.12	9.3-9.4 9.6-9.8
	11/25	Thanksgiving Break		
14	12/2	Green's Functions, Laplace Trasforms, Fourier Transforms	6, 11	3
15	12/9	Final Examination		

ME 5507 sample instructor syllabus 2

ME 5507 Engineering Analysis I (Fall 2011)

Class Meeting: MW 3:30 – 4:45 pm / Location: EII-323

Instructor: Tai-Hsi Fan, Associate Professor

Office: UTEB 386 / Office Hours: MW 4:45 – 6:30 pm or by appointment

Email: thfan@engr.uconn.edu / Phone: 860-486-0553

Text: R. Haberman, *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems*, Pearson Education.

References:

E. Kreyszig, *Advanced Engineering Mathematics*, Wiley.
M. Greenberg, *Advanced Engineering Mathematics*, Prentice-Hall.
T. Myint-U and L. Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, Birkhauser.
F.B. Hildebrand, *Advanced Calculus for Applications*, Prentice-Hall.
C.C. Lin and L.A. Segel, *Mathematics Applied to Deterministic Problems in Natural Science*, SIAM.

Course Description: This course is designed for the first-year ME graduate students who are familiar with ordinary differential equations and linear algebra, and have had introductory course in applied mechanics or heat and mass transfer. We will review and introduce important engineering mathematical techniques, and provide analysis and interpretation of the mathematical models underlying realistic engineering problems.

Homework: Homework assignments will be made on an approximately bi-weekly basis. Students are encouraged to discuss homework problems with classmates, but the collected works must be individual effort. No late homework will be accepted. Selected homework problems will be practiced during the lectures or recitations after the class. There will be no computer programming in this course, however, using symbolic mathematical software for plotting or to validate analytical work is encouraged. There will be no term project in this course, the semester grade will primarily be determined by the scores of three 2hr-exams (closed book, open note).

Course Outlines:

1. Review of ODEs, matrix algebra, series solutions, special functions, and classical ODEs
2. Variation of parameter method, Green's function for ODEs
3. Fourier series and Fourier integral
4. Introduction to parabolic, hyperbolic, and elliptic PDEs, method of separation of variables
5. Eigenvalue problems, Sturm-Liouville theory and applications, boundary-value problems, Eigenfunction expansion method
6. Fourier integral transform and applications
7. Green's function and fundamental solution for PDEs

Selective topics such as variational method, Euler-Lagrange equation, adjoint operators, Duhamel integral method, scaling and perturbation analysis for boundary layer problems will be introduced if the schedule permits.

Grade Determination: Homework (10%), mid-term I (30%), mid-term II (30%), comprehensive final exam (30%). No make-up exam will be given except as required per university policy.

<u>Solid Mechanics Examination</u>

Exam format: closed-book, one equation sheet provided by the exam committee can be used (the equation sheet will be emailed to students about two weeks before the exam), calculator is allowed.

Faculty point-of-contact: Professor Pierce

Topics are typically covered in CE 2110 and CE 3110. The specific exam guideline, a sample instructor's syllabus of CE 2110, and a sample instructor's syllabus of CE 3110 are attached.

Solid Mechanics qualifying exam: guideline

The exam will be based primarily on the course CE 3110 which uses CE 2110 fundamentals extensively. Specifically the mechanics of materials book by Beers Johnston, DeWolf and Mazurek 5th edition contains the essential material. The overall concept governing the development of the exam is that students should be familiar with the fundamental concepts of these two courses and be able to apply them to new problems. Among other things, this means that the student understands the derivation of the stress formula and can derive these formula as is or using the same principles on modified problems to get new results. The basic principles include:

1. Know force equilibrium equations including dealing with net forces coming from stresses or distributed forces where integration is needed.
2. Know moment equilibrium equations including how to calculate net moments coming from stresses or distributed forces where integration is needed.
3. Know and be able to use the definition of stress, definition of strain; normal and shear.
4. Know the use of stress-strain relations to relate stress and strain including 3 D hooks law.
5. Know qualitatively stress-strain relation beyond linear elasticity and how to incorporate them into derivations of stress equations.
6. Know how to use the moment curvature relation $d^2Y/dX^2=-M(x)/EI$
7. Know how to get the centroid of a composite body
8. Know how to calculate moments of inertial I and polar moments of inertia J by integration or by the composite body method.
9. Realize stress is not a vector and that Mohr's circle is needed to find stress on different planes in 2 D stress states and be able to do so.
10. Be able to use the principle of superposition for among other uses, finding the net stress state on an element with combined loading such as bending with torsion, find the deflection of a beam by superposition.

CE 2110 sample instructor syllabus page 1/2

CE 2110-001 Applied Mechanics I

Department of Civil and Environmental Engineering
School of Engineering
University of Connecticut

Spring Semester 2010

Course Description (from undergraduate catalog):
Fundamentals of statics using vector methods. Resolution and composition of forces; equilibrium of force systems; analysis of forces acting on structures and machines; centroids; moment of inertia.

Required Text: *Vector Mechanics for Engineers: Statics* (or Combined Static and Dynamics) by F.P. Beer, E.R. Johnston, D.F. Mazurek, and E.R. Eisenberg, 9th Edition, McGraw-Hill, 2009.

Instructor: Jaehun Ahn, jahn@engr.uconn.edu, CAST 202

TA: Aditi Misra, adm09005@engr.uconn.edu

Lectures: Monday, Wednesday, Friday, 1:00 – 1:50 pm, CAST 212

Office Hours: TA (Samantha): Tuesday, Thursday, 9:00 – 11:00 am, CAST 301
TA (Aditi): Tuesday, Thursday, 1:00 – 3:00 pm, CAST 301

Course Requirements:

- Attendance: Attendance will be checked. 10% of final course grade.
- Homework: Homework is graded based on completeness. Late homework will not be accepted. Homework should meet the following requirements to be graded. 10% of final course grade.
  - Use only one side of the letter size (8.5''×11'') paper. Use the pencil. Write the course number/section, your name, the assignment/problem number. Begin each problem on a new page. Staple!
- Pop Quiz: Announced/unannounced pop quizzes will be given over the semester. 5% of final course grade.
- Quiz: Two 50-minute quizzes will be given. 25% of final course grade for each quiz.
- Final Exam: More information will be announced before the exam. 35% of final course grade.

Grading: Total score is 110 out of 100.

Homework	10%
Attendance	10%
Pop Quizzes	5%
Quiz 1	25%
Quiz 2	25%
Final Exam	35%

CE 2110 sample instructor syllabus page 2/2

Course Schedule: Updated on 2/12

Dates	Class No.	Sections	Topics	Homework Problem and Due	
1/20	1	1.1-6	Introduction		
1/22	2	2.1-8	Addition and Resolution of Forces		
1/25	3	2.9-11	Equilibrium of a Particle	No 1	2.9,18,34
1/27	4	2.12-14	Forces in Space	No 2	2.46,57,70
1/29	5	2.15	Equilibrium in Space	No 3	2.75,90,95
2/1	6		Review and **Pop Quiz**	No 4	2.101,109,119
2/3	7	3.1-8	Vector Product: Moment about a Point		
2/5	8	3.9-11	Scalar product: Moment about an Axis	No 5	3.1,2,14,26
2/8	9	3.12-16	Couples	No 6	3.37,45,53
2/10			**Class canceled due to inclement weather**		
2/12	10	3.17-20	Equivalent Systems of Forces	No 7	3.79,87,93
2/15	11	4.1-4	Equilibrium in Two Dimensions	No 8	3.98.115.123
2/17	12	4.1-5	Equilibrium in Two Dimensions	No 9	4.4,21,23
2/19	13	4.6-7	Two and Three Force Bodies (Make-up class)	No 10	4.14,35,45
2/22	14		Review for Quiz 1 (or Make-up Class)	No 11	4.67,78,92
2/24	16		**Quiz 1**		
2/26	17	4.8-9	Equilibrium in Three Dimensions		
3/1	18	4.8-9	Equilibrium in Three Dimensions	No 12	4.104,116,120
3/3	19	6.1-5	Trusses: Method of Joints	No 13	4.100,144,146
3/5	20	6.7	Trusses: Method of Sections	No 14	6.1,11,30
			Spring Recess		
3/15	21		Review and **Pop Quiz**	No 15	6.45,57,63
3/17	22	6.9-11	Frames and Machines		
3/19	23	6.12	Frames and Machines	No 16	6.86,94,100
3/22	24	5.1-5	Centroids of Areas and Lines	No 17	6.129,141
3/24	25	5.6-7	Centroids by Integration	No 18	5.4,14,25
3/26	26	5.8	Beams: Distributed Loads	No 19	5.32,48,53
3/29	27		Review for Quiz 2 (or Make-up Class)	No 20	5.62,64,69
3/31	28		Review for Quiz 2 (or Make-up Class)		
4/2	29		**Quiz 2**		
4/5	30	5.10-12	Centroids of Volumes		
4/7	31	9.1-5	Moment of Inertia of Areas	No 21	5.99,109,114
4/9	32	9.6-7	Composite Areas	No 22	9.1,13,21
4/12	33	9.8-9	Product of Inertia	No 23	9.35,38,50
4/14	34	9.10	Mohr's Circle	No 24	9.75,82,88
4/16	35	7.1-2	Internal Forces in Members	No 25	9.94,102,109
4/19	36	7.3-5	Internal Forces in Beams	No 26	7.6,15,21
4/21	37	7.6	Internal Forces in Beams	No 27	7.34,37,39
4/23	38	8.1-4	Laws of Friction	No 28	7.62,68,71
4/26	39	8.5,10	Wedges and Belt Friction	No 29	8.6,11,16
4/28	40		Review for Final (or Make-up Class)	No 30	8.49,51,118
4/30	41		Review for Final (or Make-up Class)		
TBA			**Final Exam**		

** As things tend to get hectic during the semester, <u>the actual schedule may change</u>.

CE 3110 sample instructor syllabus page 1/2

CE 3110-001 Mechanics of Materials

Department of Civil and Environmental Engineering
School of Engineering
University of Connecticut

Spring Semester 2010

Course Description (from undergraduate catalog):
Simple and combined stress, torsion, flexure and deflection of beams, continuous and restrained beams, combined axial and bending loads, columns.

Required Text: *Mechanics of Materials* by F.P. Beer, E.R. Johnston, J.T. DeWolf, and D.F. Mazurek, 5th Edition, McGraw-Hill, 2009.

Instructor: Jaehun Ahn, jahn@engr.uconn.edu, CAST 202

TAs: Rahul Dantulwar, rad08003@engr.uconn.edu
Binu Shrestha, binu.shrestha@engr.uconn.edu

Lectures: Monday, Wednesday, Friday, 11:00 – 11:50 am, CAST 212

Office Hours: TA (Binu): Tuesday, Thursday, 9:00 – 11:00 am, CAST 301
TA (Rahul): Tuesday, Thursday, 1:00 – 3:00 pm, CAST 301

Course Requirements:

- Attendance: Attendance will be checked. 10% of final course grade.
- Homework: Homework is graded based on completeness. Late homework will not be accepted. Homework should meet the following requirements to be graded. 10% of final course grade.
  - Use only one side of the letter size (8.5''×11'') paper. Use the pencil. Write the course number/section, your name, the assignment/problem number. Begin each problem on a new page. Staple!
- Pop Quiz: Announced/unannounced pop quizzes will be given over the semester. 5% of final course grade.
- Quiz: Two 50-minute quizzes will be given. 25% of final course grade for each quiz.
- Final exam: More information will be announced before the exam. 35% of final course grade.

Grading: Total score is 110 out of 100.

Homework	10%
Attendance	10%
Pop Quizzes	5%
Quiz 1	25%
Quiz 2	25%
Final Exam	35%

CE 3110 sample instructor syllabus page 2/2

Course Schedule: Updated on 2/12

Dates	Class No.	Sections	Topics	Homework Problem and Due	
1/20	1	1.1-10	Stresses Under Axial Load		
1/22	2	1.11-13	Components of Stress + Factor of Safety	No 1	1.1,9,16
1/25	3	2.1-8	Stress-Strain Diagram	No 2	1.30,35,38
1/27	4	2.9-10	Statically Indeterminate Problems	No 3	2.3,17,25
1/29	5	2.11-15	Generalized Hooke's Law	No 4	2.35,45,51
2/1	6		Review and **Pop Quiz**	No 5	2.64,70,79
2/3	7	2.17-20	Stress Concentrations + Plastic Behavior		
2/5	8	3.1-4	Stresses in Torsion	No 6	2.95,101,113
2/8	9	3.5-6	Angle of Twist + Statically Indeterminate Shafts	No 7	3.8,11,21
2/10			**Class canceled due to inclement weather**		
2/12	10	3.7-8	Transmission Shafts + Stress Concentrations	No 8	3.36,38,51
2/15	11	4.1-5	Stresses and Deformations in the Elastic Range	No 9	3.69,77,87
2/17	12	4.6-7	Members Made of Several Materials	No 10	4.3,9,24
2/19	13		**Engineering Week Lecture by Scott Case** (Founder of 'Priceline.com') Time: 11am, Location: ITE C80		
2/22	14	4.12	Eccentric Axial Load (Make-up Class)	No 11	4.33,37,47
2/24	16		**Quiz 1**		
2/26	17	4.13-14	Unsymmetric Bending	No 12	4.102,103,122
3/1	18	5.1-3	Shear and Bending Moment Diagrams	No 13	4.131,134,142
3/3	19	5.4	Design of Prismatic Beams	No 14	5.2,27,28
3/5	20	6.1-5	Shearing Stresses in a Beam	No 15	5.43,45,56
			Spring Recess		
3/15	21		Review and **Pop Quiz**	No 16	6.1,7,21
3/17	22	6.6-7	Shearing Stresses in Thin-walled Members		
3/19	23	7.1-3	Transformation of Plane Stress	No 17	6.32,35,36
3/22	24	7.4	Mohr's Circle	No 18	7.5,9,20
3/24	25	7.5-6	3-D Stress	No 19	7.31,53,60
3/26	26	7.9	Pressure Vessels	No 20	7.66,75,78
3/29	27	8.1-3	Principal Stresses in Beams + Design of Shafts	No 21	7.100,112,124
3/31	28		Review for Quiz 2 (or Make-up Class)	No 22	8.1,3,19
4/2	29		**Quiz 2**		
4/5	30	8.4	Combined Loadings		
4/7	31	9.1-4	Deflections of Beams by Integration	No 23	8.32,40,49
4/9	32	9.5	Indeterminate Beams	No 24	9.1,3,6
4/12	33	9.7-8	Method of Superposition	No 25	9.19,20,25
4/14	34	9.9-11	Moment-Area Method	No 26	9.66,77,82
4/16	35	9.12-13	Unsymmetric Loadings	No 27	9.100,105,111
4/19	36	9.14	Indeterminate Beams	No 28	9.126,129,131
4/21	37	10.1-4	Euler's Column Formula	No 29	9.147,150,152
4/23	38	11.1-5	Elastic Strain Energy	No 30	10.5,12,20
4/26	39	11.7-10	Impact Loadings; Deflections	No 31	11.11,29,34
4/28	40	11.11-13	Castigliano's Theorem	No 32	11.42,50,68
4/30	41		Review for Final (or Make-up Class)	No 33	11.83,94,96
TBA			**Final Exam**		

** As things tend to get hectic during the semester, the actual schedule may change.

<u>Dynamics Examination</u>

Exam format: closed-book, one equation sheet provided by the exam committee can be used (the equation sheet will be emailed to students about two weeks before the exam), non-programmable calculator is allowed.

Faculty point-of-contact: Professor Norato

Topics are typically covered in CE 2120. A sample instructor's syllabus of CE 2120 is attached.

CE 2120 sample instructor syllabus page 1/2

Applied Mechanics II: Dynamics

CE 2120 Spring 2017

Course Description

This is the study of moving objects and the how they interact.

Course Expectations

Students are expected to quantitatively describe the motion of objects using calculus and Newton's laws of motion. Students should be able to identify degrees of freedom and solve for unknown quantities.

Instructor: Prof. Ryan C. Cooper (ryan.c.cooper@uconn.edu)

Prerequisite: CE 2110 and MATH 2110 or 2130

Required book: McGraw-Hill Connect - Vector Mechanics for Engineers: Dynamics, F. P. Beer, E. R. Johnston, Jr.,P. J. Cornwell, B. P. Self. 11th Ed, McGraw-Hill, 2016

Course Schedule (which is subject to change based upon feedback and pace of course)

Week	Date	Section	Topic
1	8/27	N/A	Introduction
	8/29		Intro/ Vector methods
	8/31	11.1	Vectors con'd/Particle Kinematics
2	9/3	N/A	Labor Day
	9/5	11.2	Relative Motion in 1D
	9/7	11.4	Curvilinear Motion in 2D and 3D
3	9/10	11.4-5	Non-Cartesian Coordinate Systems
	9/12	11.4-5	Non-Cartesian Coordinate Systems
	9/14	12.1	Newton's Second Law of Motion
4	9/17	12.2	Angular momentum and orbital motion
	9/19	12.2	Angular momentum and orbital motion
	9/21	13.1	Kinetics of Particles
5	9/24	13.1	Kinetics of Particles
	9/26	13.1	Work and Energy
	9/28	13.1	Work and Energy
6	10/11	13.1	Work and Energy
	10/3	13.2	Conservation of Energy
	10/5	13.2	Conservation of Energy
7	10/8	13.3	Impulse and Momentum
	10/10	13.4	Impacts
	10/12	13.4	Impacts
8	10/15	14.1	Newton's Second law of motion for systems of particles
	10/17	14.1	Newton's Second law of motion for systems of particles
	10/19	14.2	Energy and Momentum in Systems of particles
9	10/22	15.1	Kinematics of rigid bodies
	10/24	15.1	Kinematics of rigid bodies
	10/26	15.2	General Plane Motion of Rigid Bodies
10	10/29	15.2	General Plane Motion of Rigid Bodies

CE 2120 sample instructor syllabus page 2/2

Week	Date	Section	Topic
	10/31	15.4	General Plane Motion of Rigid Bodies
	11/20	15.4	General Plane Motion of Rigid Bodies
11	11/5	16.1	Kinetics of a Rigid body
	11/7	16.1	Kinetics of a Rigid body
	11/9	16.1	Kinetics of a Rigid body
12	11/12	16.2	Constrained Plane motion
	11/14	16.2	Constrained Plane motion
	11/16	17.1	Energy Methods for a Rigid Body
14	11/19		Thanksgiving Break
	11/21		Thanksgiving Break
	11/23		Thanksgiving Break
15	11/26	17.1	Energy Methods for a Rigid Body
	11/28	17.2	Momentum methods for a Rigid Body
	11/30	17.2	Momentum methods for a Rigid Body
16	12/3	17.3	Eccentric Impact
	12/5		Rigid body motion review
	12/7		Final Review
17	12/10	Finals	Finals Best of Lucks!

<u>Vibrations Examination</u>

Exam format: closed-book, one equation sheet is allowed (one piece of paper letter size, front and back pages OK), calculator not allowed.

Faculty point-of-contact: Professor Tang

Topics are typically covered in ME 3220. The departmental syllabus of ME 3220 and a sample instructor's syllabus are attached.

ME 3220 departmental syllabus page 1/3

ME 220 – Mechanical Vibrations

Catalog Description:

Free and forced vibrations, with damping, of linear systems with one and two degrees of freedom. Transient vibrations. Vibration isolation. Rigid rotor balancing. Elements of Laplace transforms.

Prerequisites:

- ME 253 - Linear Systems Theory
- MATH 210Q - Multivariable Calculus
- CE 212 - Applied Mechanics II
- MATH 211Q - Elementary Differential Equations

Texts:

- Required Text: *Engineering Vibrations*, by D. Inman, Prentice Hall, 2001.

Course Objectives:

An introductory course in linear mechanical vibrations where students acquire the ability to (1) formulate mathematical models of problems in vibrations using Newton's second law or energy principles, (2) determine a complete solution to mechanical vibration problems using mathematical or numerical techniques, and (3) determine physical and design interpretations from the results.

Topics:

- Review of 2nd order ODE's, linearity solution methods
- Single degree of freedom oscillators
- Two degrees of freedom oscillators
- Effective springs and masses
- Transient vibrations
- Impulse response
- Solutions to differential equations
- Modal analysis
- Vibration absorption
- Measurement of frequencies

Design Project: not applicable

Computer Use:

Students must be familiar with a high level programming language, such as Fortran or C++. They may, however, use software packages such as MATLAB and relevant toolboxes.

Evaluation Method:

Homework, Semester Exams, Final Exam

Contribution to Professional Component:

The course builds on the fundamental principles learned in Physics I, Dynamics, Linear Systems Theory and Strength of Materials. These principles are used to develop an understanding of the response characteristics of basic mechanical vibratory systems. The implications of such phenomena as resonance for engineering problems are discussed. Students learn to analyze and interpret the behavior of such systems in a design setting.

Relationship of Course Objectives to Program Educational Objectives:

This fundamental Mechanical Engineering course emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving problems using mathematical, scientific and engineering principles and tools," and Program Educational Objective #2: "our alumni approach engineering decisions with an informed consideration of global and societal contexts and consequences."

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
This course requires students to apply knowledge of mathematics, science and engineering to the solution of practical linear mechanical vibration problems.

b) an ability to design and conduct experiments, as well as analyze and interpret data: *not applicable*

c) an ability to design a system, component, or process to meet desired needs:
Students use the fundamental principles of mechanics to examine the performance of a mechanical system and redesign the system to improve its response characteristics.

d) an ability to function on multi-disciplinary teams: *not applicable*

e) an ability to identify, formulate, and solve engineering problems:
Students learn to identify, formulate and solve basic engineering problems using the fundamental principles of mechanics and mathematical approximation.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively: *not applicable*

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context:
The societal implications of detrimental vibrations in everyday structures are discussed; including such critical factors as safety, cost, and design feasibility.

i) a recognition of the need for, and an ability to engage in life-long learning: *not applicable*

j) a knowledge of contemporary issues: *not applicable*

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students learn to use numerical, mathematical and presentation tools in the solution of practical engineering problems, and have relevant software packages available for use in completing work.

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to construct the equations of motion from free-body diagrams.
2) Students will be able to solve for the motion and the natural frequency of (1) a freely vibrating single degree of freedom undamped motion and (2) a freely vibrating single degree of freedom damped motion.
3) Students will be able to construct the governing differential equation and its solution for a vibrating mass subjected to an arbitrary force.
4) Students will be able to decompose any periodic function into a series of simple harmonic motions using Fourier series analysis.
5) Students will be able to solve for the motion and the natural frequency for forced vibration of a single degree of freedom damped or undamped system.
6) Students will have an ability to obtain the complete solution for the motion of a single degree of freedom vibratory system (damped or undamped) that is subjected to non-periodic forcing functions.
7) Students will be able to solve vibration problems that contain multiple degrees of freedom.
8) Students will be able to obtain design parameters and indicate methods of solution for a complicated vibratory problem.

ME 3220 departmental syllabus page 3/3

Approval Block:

Prepared by: K. Murphy and J. Tang, January 2007
Reviewed by: E. Jordan, January 2007
Revised by: K. Murphy and J. Tang, February 2007
C&C Approval: N. Olgac, June 2007
Department Head Approval: B. Cetegen, June 2007

ME 3220 sample instructor syllabus

Mechanical Vibrations
ME 3220

Textbook: Daniel Inman — Engineering Vibration (Third Edition)
Prentice Hall, 2008, ISBN 0-13-228173-2

Syllabus

- Introduction and use of physical principles (Chapter 1) — 1 wk
- Free vibration and damping (Chapter 1) — 1 ½ wks
- Response to harmonic excitation (Chapter 2) — 2 ½ wks
    a) Harmonic responses of un-damped and damped systems
    b) Base excitation, rotating imbalance, and FRF
- Response to general excitation (Chapter 3) — 3 ½ wks
    a) Impulse response and step response
    b) Arbitrary inputs: Fourier series
    c) Random inputs and shock spectrum
- Multiple-DOF systems (Chapter 4) — 4 wks
    a) Two-DOF systems
    b) Eigenvalue problem, frequencies and mode shapes
    c) Free and forced vibration analysis
- Vibration suppression techniques (Chapter 5) — 1 wk
    a) Vibration isolation
    b) Vibration absorbing

Optional textbook: Singiresu S. Rao, Mechanical Vibrations

<u>Systems Examination</u>

Exam format: default format; closed-book, closed-notes, calculator not allowed. Laplace transform of specific functions will be provided in the exam if used, but none of the theorems will be provided.

Faculty point-of-contact: Professor Olgac

Topics are typically covered in ME 3253. The departmental syllabus of ME 3253 and a sample instructor's syllabus are attached.

ME 3253 departmental syllabus page 1/3

ME 253 – Linear Systems Theory

Catalog Description:

Mathematical modeling of dynamic systems, linearization of nonlinear behavior, Laplace domain representation of dynamics, transfer functions, block diagram algebra, signal flow graphs, Mason's rule, transient analysis of system response, convolution integral, Duhamel's integral, Green's function, stability of linear systems, Routh-Hurwitz method, root locus, frequency response, Bode and polar representations, introduction to feedback systems.

Prerequisites:

- CE 212 – Applied Mechanics
- MATH 211Q – Elementary Differential Equations

Texts:

- Required Text: *System Dynamics,* by K. Ogata, 4th Edition, Prentice Hall, 2004

Course Objectives:

This course is designed to expose students to the properties of linear systems and the use of various modeling tools. Laplace transformation representations of dynamic systems and MATLAB-Simulink programming packages are used. Linear system stability is discussed using Routh stability criterion and Root locus techniques. Frequency response concept is addressed.

Topics:

- Ordinary differential equations
- Laplace domain representation of dynamics
- Mathematical modeling of dynamic systems
- Block diagram algebra
- Time domain analysis of system response
- Stability of linear systems
- Frequency domain analysis

Design Projects:

Not applicable

Computer Use:

Various simulation and modeling software (such as MATLAB, Simulink and Maple) are available for use by the students. In addition to analytical software, students are required to use available word processing software to complete homework projects.

Evaluation Methods:

Homework, Quiz, Midterm Exam, Final Exam

Contribution to Professional Component:

This course builds upon the fundamentals of statics, dynamics and differential equations. The course provides the necessary building blocks for Measurement Techniques (ME 260W) and the Senior Design capstone course (ME 272P/273P).

Relationship of Course Objectives to Program Educational Objectives:

As a junior level course in Mechanical Engineering, ME 253 emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving

problems using mathematical, scientific and engineering principles and tools," and Program Educational Objective #3: "our alumni continue to expand their professional and personal skills and engage in life-long learning."

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
In this course students start with the linear ordinary differential equation solutions, Laplace transformations, and transfer function representations of dynamics, and continue with the broader understanding of dynamic responses. Using programming tools such as MATLAB and Simulink, students gain expertise in debugging numerical outcomes using engineering insight and mathematical functions.

b) an ability to design and conduct experiments, as well as analyze and interpret data:
Through the use of modeling and simulation tools students are exposed to design alternatives and corresponding system response. Students learn to draw conclusions based on the response properties obtained.

c) an ability to design a system, component, or process to meet desired needs:
Students are required to complete an open-ended design project using modeling, simulation and animation tools.

d) an ability to function on multi-disciplinary teams: *not applicable*

e) an ability to identify, formulate, and solve engineering problems:
Students gain an understanding that every linear system can be broken into first and second order dynamics, and that these are the building blocks of more complex systems. Students learn how to assess the systems response to a set of conventional driving functions (such as step, impulse, ramp and sine functions). Based on this, students can troubleshoot and interpret the simulation results obtained through MATLAB/Simulink.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively: *not applicable*

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context: *not applicable*

i) a recognition of the need for, and an ability to engage in life-long learning:
The need for life-long learning is reinforced by exposure to new developments in modeling and simulation tools, as emphasized by the changing popularity of the various commercial packages.

j) a knowledge of contemporary issues: *not applicable*

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students learn to work with the underlying analytical tools which give them greater decision making abilities. Advanced modeling and simulation tools, such as MATLAB/Simulink are used in this course.

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to apply Laplace transforms in linear system modeling.
2) Students will be able to solve ordinary differential equations (ODE) using Laplace transformations.
3) Students will be able to model mechanical dynamic systems.
4) Students will be able to model hydraulic dynamic systems.
5) Students will be able to model thermal dynamic systems.
6) Students will assess the fundamental characteristics of first order systems.
7) Students will assess the fundamental characteristics of second order systems.
8) Students will assess the fundamental characteristics of higher order systems.
9) Students will be able to model systems using MATLAB/Simulink tools.
10) Students will be able to perform parametric analysis of system properties using MATLAB.
11) Students will be able to examine the output signatures of a linear system in response to a step input.
12) Students will be able to examine the output signatures of a linear system in response to an impulse input.
13) Students will be able to form transfer functions to represent input-output relations for dynamic systems.

ME 3253 departmental syllabus page 3/3

14) Students will be informed about the connection between the system behavior and characteristic root distribution.
15) Students will be able to extract the root distribution of the linear systems using Routh-Hurwitz method.
16) Students will know how to assess the frequency response of a linear system.

Approval Block:

Prepared by: J. Tang and N. Olgac, September 2006
Reviewed by: K. Kazerounian, October 2006
Revised by: J. Tang and N. Olgac, October 2006
C&C Approval: N. Olgac, January 2007
Department Head Approval: January 31, 2007

ME 3253 sample instructor syllabus

LINEAR SYSTEMS THEORY ME 3253

Textbook: Katsuhiko Ogata System Dynamics (Fourth Edition)
Prentice Hall, 2004 ISBN 0-13-142462-6

<u>Syllabus</u>

- Introduction and review/overview 1 wk
- Laplace domain representation of dynamic systems (Chapter 2) 1½ wks
- Mathematical modeling of dynamic systems (Chapters 3, 4, 6, and 7) 3½ wks
  - c) Differential equations representing systems, transfer function
  - d) Linearization of nonlinear functions
  - e) Modeling of mechanical systems, electrical systems, and fluid systems and thermal systems
- Time domain analysis of systems (Chapters 8 and 10) 5 wks
  - d) Transient responses
  - e) Stability
  - f) Root locus
- Frequency response of systems (i.e., the frequency domain) (Chapters 9 and 11)
  - d) Magnitude and phase
  - e) Bode and Nyquist plots 2 wks

<u>Fluid Mechanics Examination</u>

Exam format: closed-book, one equation sheet is allowed (one piece of paper letter size, front and back pages OK), calculator not allowed.

Faculty point-of-contact: Professor Zhao

Topics are typically covered in ME 3250. The departmental syllabus of ME 3250 and a sample instructor's syllabus are attached.

ME 3250 departmental syllabus page 1/3

ME 250 – Fluid Dynamics I

Catalog Description:

Laws of conservation of mass, momentum, and energy in fluid systems, fluid statics, dimensional analysis, incompressible, inviscid and viscous flows, steady and unsteady flows, internal and external flows.

Prerequisites:

- ME 233 – Thermodynamic Principles

Texts:

- Required Text: *Fundamentals of Fluid Mechanics,* 5th edition, by B.R. Munson, D.F. Young, and T.H. Okiishi, Wiley, 2006

Course Objectives:

This course is designed to teach juniors the fundamentals of fluid mechanics using integral and differential calculus, physics and thermodynamics. The concept of pressure is introduced through the study of hydrostatics. Students apply the control volume approach for mass, momentum and energy to the analysis and design of fluid systems. The use of differential flow analysis is applied to inviscid and viscous flow. Furthermore, students begin to utilize engineering approximations applicable to fluid flow and to make use of dimensional analysis and similarity principles. Boundary layer theory and the concepts of lift and drag are introduced.

Topics:

- Hydrostatics
- Bernoulli's equation
- Kinematics
- Control volume equations
- Differential equations and dimensional analysis
- External flow
- Potential flow
- Internal flow
- Boundary layers

Design Projects: Not applicable.

Computer Use:

Students will use available software for simulating fluid flow problems, and homework assignments will incorporate specific problems requiring computer applications.

Evaluation Methods:

Homework, Semester Exams and Quizzes, Final Exam

Contribution to Professional Component:

This course is designed to teach the fundamentals of fluid mechanics to students who have had instruction in integral and differential calculus, physics and thermodynamics.

Relationship of Course Objectives to Program Educational Objectives:

The course emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving problems using mathematical, scientific and engineering principles and tools," Program Educational Objective #2: "our alumni approach engineering decisions with an informed consideration of global and societal contexts and consequences," and Program Educational Objective #3: "our alumni continue to expand their professional and personal skills and engage in life-long learning."

ME 3250 departmental syllabus page 2/3

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
Students use advanced mathematical concepts and control volume analysis to solve fluid flow problems. Emphasis is placed on the simplification of complex mathematical problems to yield engineering solutions.

b) an ability to design and conduct experiments, as well as analyze and interpret data: *not applicable*

c) an ability to design a system, component, or process to meet desired needs:
Students acquire the ability to design systems, components or processes to meet desired needs utilizing control volume analysis, dimensional analysis and empirical data on fluid flow induced forces.

d) an ability to function on multi-disciplinary teams: *not applicable*

e) an ability to identify, formulate, and solve engineering problems:
Students learn to identify the basic principles involved, formulate and solve fluid flow related engineering problems.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively: *not applicable*

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context: *not applicable*

i) a recognition of the need for, and an ability to engage in life-long learning:
Fluid Dynamics I is an introductory course for a sophisticated and mature field. As such, it highlights the need for additional study and education to master the concepts taught.

j) a knowledge of contemporary issues:
Students are exposed to current issues in engineering through class lectures on state of the art technology.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students learn to use techniques associated with control volume analysis and computational fluid dynamics to solve fluid mechanics problems.

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to determine hydrostatic forces and moments on submerged objects.
2) Students will be able to understand the concept of viscosity and a Newtonian fluid.
3) Students will be able to understand and apply the principles of mass and momentum conservation using an integral control volume approach.
4) Students will be able to understand the principles of mass and momentum conservation for Newtonian fluids based upon analysis of a differential control volume.
5) Students will be able to utilize and design moving and accelerating objects using a control volume approach.
6) Students will be able to understand the origin of the Navier-Stokes equation, Euler's equation and the Bernoulli equation and the limitations of each.
7) Students will be able to understand the difference between laminar and turbulent flows and the implications of each on forces and stresses in fluid systems.
8) Students will be able to solve problems using Bernoulli equations and simplified forms and solution of Euler's and the Navier-Stokes equations.
9) Students will be able to understand and use dimensional analysis and similarity principles for design purposes.
10) Students will be able to design and analyze piping and pumping systems including major and minor losses.
11) Students will be able to understand the various velocity and pressure measurement devices that were introduced in ME 262 Introductory Thermal-Fluids Laboratory.
12) Students will be able to understand the boundary layer concept, the origin of lift and drag forces, and the limitations of inviscid flow analysis.

ME 3250 departmental syllabus page 3/3

Approval Block:

Prepared by: M. Renfro and T.-H. Fan, September 2006
Reviewed by: L. Langston, October 2006
Revised by: M. Renfro and T.-H. Fan, September 2006
C&C Approval: N. Olgac, January 2007
Department Head Approval: January 31, 2007

ME 3250 sample instructor syllabus

ME3250 - COURSE SYLLABUS - Spring 2011

Reading is from Munson, Young, Okiishi, and Huebsch, "Fundamentals of Fluid Mechanics," edition 6.

Week	Lecture	Day	Date	Subject	Reading
1	1	W	19-Jan	Introduction to Fluid Mechanics, Fluid Properties	1.1-1.5
	2	F	21-Jan	Viscosity, Pre-quiz	1.6-1.8
2	3	M	24-Jan	Surface Tension	1.9-1.11
	4	W	26-Jan	Fluid Statics, Manometers	2.1-2.7
	5	F	28-Jan	Submerged Surfaces	2.8-2.10
3	6	M	31-Jan	Buoyancy	2.11-2.13
	7	W	2-Feb	Bernoulli Equation	3.1-3.4
	8	F	4-Feb	Stagnation Pressure, Pitot-Static Tubes, Jets	3.5-3.7
4	9	M	7-Feb	Pressure Head	3.8-3.9
	10	W	9-Feb	Bernoulli Examples, Velocity Fields	4.1
	11	F	11-Feb	Acceleration Fields	4.2-4.3
5	12	M	14-Feb	Control Volumes, Reynolds Transport Theorem	4.4-4.5
	13	W	16-Feb	Conservation of Mass	5.1
	14	F	18-Feb	Linear Momentum Equation	5.2
6	15	M	21-Feb	Review / Make-up	Ch1-4
		W	23-Feb	**Midterm 1**	Ch 1-4, HW 1-4
	16	F	25-Feb	Angular Momentum	5.2
7	17	M	28-Feb	Energy Conservation	5.3-5.5
	18	W	2-Mar	Chapter 5 Examples	Ch 5
	19	F	4-Mar	Fluid Elements, Mass Conservation	6.1-6.2
8		M	7-Mar	NO CLASS - Spring Break	
		W	9-Mar	NO CLASS - Spring Break	
		F	11-Mar	NO CLASS - Spring Break	
9	20	M	14-Mar	Stream Function, Differential Momentum	6.3
	21	W	16-Mar	Inviscid Flow	6.4
	22	F	18-Mar	Simple Potential Flows	6.5
10	23	M	21-Mar	Superposition	6.6
	24	W	23-Mar	Viscous Flows	6.7-6.9
	25	F	25-Mar	Couette and Poiseuille Flow	6.9-6.11
11	26	M	28-Mar	Review / Make-up	Ch. 5 & 6
		W	30-Mar	**Midterm 2**	Ch 5 & 6, HW 5-8
	27	F	1-Apr	Dimensional Analysis	7.1-7.5
12	29	M	4-Apr	Reynolds Number	7.6-7.7
	30	W	6-Apr	Computational Fluid Dynamics	7.8
	31	F	8-Apr	Similarity and Modeling	7.9-7.11
13	32	M	11-Apr	Laminar Pipe Flow	8.1-8.2
	33	W	13-Apr	Turbulent Pipe Flow	8.3
	34	F	15-Apr	Moody Chart	8.4
14	35	M	18-Apr	Pipe Losses	8.4-8.7
	36	W	20-Apr	Boundary Layers	9.1-9.2
	37	F	22-Apr	Momentum Thickness, Skin Friction	9.2
15	38	M	25-Apr	Drag	9.3
	39	W	27-Apr	Lift	9.4
	40	F	29-Apr	Review / Make-up	

FINAL EXAM **Section 01, Monday May 2, 8:00-10:00 am**

<u>Thermodynamics Examination</u>

Exam format: closed-book, one equation sheet is allowed (one piece of paper letter size, front and back pages OK), calculator is allowed.

Faculty point-of-contact: Professor Sung

Topics are typically covered in ME 2233 and ME 2234. The textbook involved is: *Fundamentals of Engineering Thermodynamics*, Seventh Edition by M.J. Moran, H.N. Shapiro, D.D. Boettner, and M.B. Bailey, John Wiley & Sons, Inc., 2011.

The departmental syllabus of ME 2233 and a sample instructor's syllabus, the departmental syllabus of ME 2234 and a sample instructor's syllabus are attached.

ME 2233 departmental syllabus page 1/3

ME 233 - Thermodynamic Principles

Catalog Description:

Introduction to the First and Second Laws of Thermodynamics. Thermodynamic properties of pure substances and ideal gases. Analysis of ideal and real processes—including turbines, pumps, heat exchangers, and compressors.

Prerequisites:

- CHEM 127Q - General Chemistry
- PHYS 151Q - Physics for Engineers I
- MATH 210Q - Multivariable Calculus (or Concurrent enrollment)

Texts:

- Required Text: *Thermodynamics: An Engineering Approach*, 5th edition, by Y.A. Cengel and M.A. Boles, WCB McGraw-Hill, 2005

Course Objectives:

The fundamental principles of classical thermodynamics are covered in this sophomore level course. At the completion of this course students will have the ability to: determine the properties of pure substances using the thermodynamic tables, use the ideal gas approximation and other equations of state, apply the conservation of energy to steady and unsteady flows, and to apply the second law of thermodynamics to steady and unsteady flows.

Topics:

- Introductory concepts and definitions
- Energy and the first law of thermodynamics
- Properties of pure simple compressible substances
- Closed system energy analysis
- Open system energy analysis
- Second law of thermodynamics
- Entropy

Design Project:

A team "best practices" project on a thermodynamics topic.

Computer Use:

None required.

Evaluation Methods:

Homework, Essay, Project, Exams, Final Exam

Contribution to Professional Component:

This course covers basic thermodynamics and problem solving skills which are the foundation for the applied thermodynamics course (ME 234), the thermal-fluids laboratory (ME 262), fluid mechanics (ME250), and heat transfer (ME 242).

Relationship of Course Objectives to Program Educational Objectives:

Since Thermodynamic Principles is a fundamental course in engineering, it emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving problems using mathematical, scientific and engineering principles and tools," Program Educational Objective #2: "our alumni approach engineering decisions with an informed consideration of global and

ME 2233 departmental syllabus page 2/3

societal contexts and consequences," and Program Educational Objective #3: "our alumni continue to expand their professional and personal skills and engage in life-long learning."

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
Students acquire the ability to utilize the laws of thermodynamics along with mathematical tools to analyze and solve complex engineering problems.

b) an ability to design and conduct experiments, as well as analyze and interpret data: *not applicable*

c) an ability to design a system, component, or process to meet desired needs:
Students begin to acquire the ability to design thermal systems, components and processes to meet a desired need.

d) an ability to function on multi-disciplinary teams:
Students work in teams on a project.

e) an ability to identify, formulate, and solve engineering problems:
Students learn to identify, formulate and solve basic engineering problems through assignments that involve the analysis of real thermal systems. Students are expected to identify the thermodynamic principles involved and to implement them to determine values of engineering interest.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively:
Teams complete a project progress report and a project final report.

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context:
Through an understanding and application of the first law of thermodynamics (concerning conservation of energy) and the second law of thermodynamics (concerning loss mechanisms) students learn about energy-related decisions pertinent to society.

i) a recognition of the need for, and an ability to engage in life-long learning
The class provides students with the recognition that subsequent courses and material will build upon the fundamental principles presented.

j) a knowledge of contemporary issues:
Students gain knowledge of contemporary issues as related to the second law of thermodynamics and its application of energy conservation and power utilization.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students begin to acquire the ability to use the techniques and skills associated with the application of the laws of thermodynamics, systems, and control volume concepts.

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to use both SI and English units.
2) Students will be able to recognize the structure of a thermodynamic system and its surroundings.
3) Students will be able to recognize the concept and utility of a control volume.
4) Students will be able to understand energy.
5) Students will be able to understand the concept and utility of work and heat.
6) Students will be able to manipulate phase changes involving a pure substance.
7) Students will be able to recognize an ideal gas and the limitations to its use.
8) Students will know the zeroth law of thermodynamics.
9) Students will be able to use various temperature scales and what an absolute temperature is.
10) Students will be able to draw a P-V diagram for a pure substance such as water and identify different phase regions (liquid vapor, solid) in the diagram.
11) Students will know and understand the first law of thermodynamics.

ME 2233 departmental syllabus page 3/3

12) Students will know and understand the second law of thermodynamics.
13) Students will know what enthalpy and entropy are.
14) Students will know how to analyze problems involving heat engines and refrigerators.
15) Students will know what a Carnot engine is and the importance of its efficiency.

Approval Block:

Prepared by: R. Bass and N. Sammes, September 2006
Reviewed by: U. Pasaogullari, October 2006
Revised by: R. Bass and N. Sammes, October 2006
C&C Approval: N. Olgac, January 2007
Department Head Approval: January 31, 2007

ME 2233 sample instructor syllabus

ME 2233 – THERMODYNAMIC PRINCIPLES – Fall 2011 – Prof. Renfro

Lecture	Day	Date	Topic	Reading (Section)	Homework Problems
1	Tu	30-Aug	Introduction, Energy Conservation, Systems, Units	1.1-1.5, 2.5	
2	Th	1-Sep	Properties, Pressure, Temperature	1.6-1.7	
		5-Sep	**NO OFFICE HOURS - LABOR DAY**		
3	Tu	6-Sep	Problem Solving, Kinetic and Potential Energy, Quasistatic Processes	1.8-1.9, 2.1-2.2	
4	Th	8-Sep	***Pre-Req Quiz***, Boundary Work, Energy Transfer by Heat and Work	2.3-2.4	
5	Tu	13-Sep	Energy Balance for Closed Systems	2.5	
6	Th	15-Sep	Energy Balance for Cycles	2.6-2.7	
7	Tu	20-Sep	p-v-T Properties of Pure Substances, thermodynamic tables	3.1-3.5	
8	Th	22-Sep	p-v-T Property Evaluation for Real Fluids	3.6-3.7	
9	Tu	27-Sep	***EXAM 1 (Lectures 1-8)***		
10	Th	29-Sep	Real fluid examples, Incompressible Substances	3.8-3.10	
11	Tu	4-Oct	p-v-T Relation for Real and Ideal Gases	3.11-3.12	
12	Th	6-Oct	Ideal Gas Model and Properties	3.13-3.15	
		10-Oct	**NO OFFICE HOURS - CONFERENCE**		
13	Tu	11-Oct	Mass Conservation for Open Systems	4.1-4.3	
		12-Oct	**NO OFFICE HOURS - CONFERENCE**		
14	Th	13-Oct	Energy Conservation for Open Systems, Nozzles,Valves	4.4-4.6	
15	Tu	18-Oct	Heat Exchangers, Turbines, Throttling	4.7-4.10	
16	Th	20-Oct	System integration/problem solving, Examples	4.11	
17	Tu	25-Oct	Introduction to 2nd Law of Thermodynamics	5.1-5.2	
18	Th	27-Oct	***EXAM 2 (Lectures 1-17)***		
19	Tu	1-Nov	Reversibility, Cycle limitations	5.3-5.7	
20	Th	3-Nov	Absolute T	5.8-5.9	
21	Tu	8-Nov	Carnot cycle, Clausius Inequality	5.10-5.11	
22	Th	10-Nov	Entropy Evaluation	6.1-6.5	
23	Tu	15-Nov	Closed System Entropy Balance	6.6-6.8	
24	Th	17-Nov	Open System Entropy Balance	6.9-6.11	
	Tu	22-Nov	**NO CLASS - THANKSGIVING, NO OFFICE HOURS THIS WEEK**		
	Th	24-Nov	**NO CLASS - THANKSGIVING, NO OFFICE HOURS THIS WEEK**		
25	Tu	29-Nov	Isentropic Efficiencies	6.12-6.13	
26	Th	1-Dec	***EXAM 3 (Lectures 1-25)***		
27	Tu	6-Dec	Power and Refrigeration Cycles	8.1-8.2, 10.1-10.2	
28	Th	8-Dec	Course Review, ***Instructor Evaluation***		
	T	13-Dec	***Final Exam, 1-3 PM***		

ME 2234 departmental syllabus page 1/3

ME 234 – Applied Thermodynamics

Catalog Description:

Thermodynamic first and second law analysis of vapor and gas cycles, property relations for simple pure substances, properties of ideal gas mixtures, psychrometry, fundamentals of combustion thermodynamics, application of thermodynamics in the design of thermal engineering systems.

Prerequisites:

- ME 233 – Thermodynamic Principles or CHEG 211 – Chemical Engineering Thermodynamics

Texts:

- Required Text: *Thermodynamics: An Engineering Approach,* 5th edition by Y.A. Cengel and M.A. Boles, McGraw-Hill, 2005
- Suggested Reference: *Fundamentals of Engineering Thermodynamics,* 4th edition, by M.J. Moran and H.N. Shapiro, Wiley, 1999

Course Objectives:

This course is designed to teach junior mechanical engineering students the application of thermodynamic principles to the design and optimization of engineering systems. Specifically, students will have the ability to apply the first and second law of thermodynamics to (1) vapor power and refrigeration systems, (2) gas power systems, (3) applications concerning humidification, dehumidification, evaporative cooling, and (4) thermodynamics of combustion systems such as furnaces, flow reactors etc.

Topics:

- Vapor power systems: Rankine cycle
- Vapor power systems: superheat and reheat
- Refrigeration and heat pump systems
- Gas power systems
- Thermodynamic relations for simple compressible substances
- Non-reacting gas mixtures
- Psychrometry
- Reacting gas mixtures and combustion

Design Project:

Design problems assigned either individually or in teams of 2 or 3 students.

Computer Use:

The use of computational tools is required in all written communications and engineering drawings. Students are expected to make use of computational engineering and mathematics software packages for solving the problem. In addition, spreadsheets or other computational tools must be used to conduct design optimization.

Evaluation Methods:

Homework, Design Project, Semester Exams, Final Exam

Contribution to Professional Component:

This course serves as the foundation for the analysis of thermal engineering systems in terms of the application of basic energy conservation principles and considerations of the second law of thermodynamics.

ME 2234 departmental syllabus page 2/3

Relationship of Course Objectives to Program Educational Objectives:

The course emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving problems using mathematical, scientific and engineering principles and tools," and Program Educational Objective #2: "our alumni approach engineering decisions with an informed consideration of global and societal contexts and consequences."

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
Students acquire the skills to apply the laws of thermodynamics in mathematical form for the solution and optimization of thermal engineering systems.

b) an ability to design and conduct experiments, as well as analyze and interpret data: *not applicable*

c) an ability to design a system, component, or process to meet desired needs:
Students gain design skills through assigned Design Project work.

d) an ability to function on multi-disciplinary teams:
Students gain team experience working in their Design Project groups.

e) an ability to identify, formulate, and solve engineering problems:
Students learn to identify, formulate, and solve engineering problems using the basic principles of thermodynamics.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively:
Students gain experience in written communication through the Design Project report.

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context:
Students learn about the importance of efficient energy utilization from a perspective of limited energy resources (optimization of system efficiency) as well as the pollution prevention aspect (combustion and air pollution).

i) a recognition of the need for, and an ability to engage in life-long learning: *not applicable*

j) a knowledge of contemporary issues:
Students obtain a knowledge of contemporary issues through the design of internal combustion engines (with consideration of pollution aspects), aircraft engines, and land based gas turbine engines.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students learn to use analysis techniques and methods to solve problems in thermodynamics (and where applicable the integration of different subjects) in the design and optimization of thermal systems.

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to analyze a vapor power cycle given a set of operational parameters and constraints, determine cycle efficiency, its power output, and required heat input.
2) Students will be able to make modifications to improve the overall cycle efficiency for the steam power cycle.
3) Students will be able to analyze and optimize a vapor refrigeration system given the requirements and constraints of a refrigeration system.
4) Students will be able to understand the second law limitation of thermodynamic efficiencies and will be able to sort out realistic and unrealistic thermodynamic system claims.
5) Students will be able to analyze and determine cycle efficiency, work output and required heat input for a spark-ignition IC engine with a given set of operating parameters.
6) Students will be able to analyze and determine cycle efficiency, work output and required heat input for a diesel engine with a given set of operating parameters.
7) Students will be able to analyze and determine cycle efficiency, work output, and required heat input for a gas turbine cycle, and determine thrust of a turbojet, for a given set of operating parameters.

ME 2234 departmental syllabus page 3/3

8) Students will be able to determine the moisture content in air and perform calculations for humidification and dehumidification.
9) Students will be able to design a thermodynamic system such as a combined cycle power system based on given constraints and availability of components and optimize its overall efficiency.
10) Students will be able to understand the design and operation of thermal engineering systems including engines, power generation systems, and refrigeration systems and apply this knowledge to the design of similar systems.
11) Students will be able to understand and apply thermodynamic laws of air conditioning and humidification/ dehumidification systems.
12) Students will be able to understand combustion and chemical reactions as they relate to power generation systems.

Approval Block:

Prepared by: R. Bass, J. Bennett and M. Renfro, February 2007
Reviewed by: B. Cetegen, February 2007
Revised by: R. Bass, J. Bennett and M. Renfro, February 2007
C&C Approval: N. Olgac, June 2007
Department Head Approval: B. Cetegen, June 2007

ME 2234 sample instructor syllabus

ME 2234-02 – COURSE SYLLABUS

Week	Lecture	Day	Date	Subject	Reading (Sonntag)	Reading (Moran)	Notes
1	1	T	18-Jan	Review- Concepts and Definitions	Ch.1 & 2	Ch.1	Please turn in a few paragraphs on what your expections are for this class.
	2	Th	20-Jan	Review - Properties. **Pre-req Quiz**	Ch. 3	Ch. 3	
	3	T	25-Jan	1st law for a Control Mass	Ch. 5	Ch.2	HW 1 due
	4	Th	27-Jan	1st Law for a Contro Volume	Ch. 6	Ch.4	
3	5	T	1-Feb	2nd Law	Ch. 7	Ch. 5	HW 2 due. **Monday is the last day to add or drop courses without additional signatures**
	6	Th	3-Feb	Entropy	Ch. 8	6.1-6-10	
4	7	T	8-Feb	Isentropic Process	Ch. 9	6.11- 6-13	HW 3 due
	8	Th	10-Feb	Exergy	10.1-10.3	7.1-7.3	
5	9	T	15-Feb	Exergy Examples	10.4	7.4-7.6	HW 4 due
	10	Th	17-Feb	Review / Make-up	Ch. 1- 10	Ch. 1- 7	
6		T	22-Feb	**Midterm 1: Ch.1-10 (S) Ch. 1-7 (M) (HW 1-4)**			No HW due
	11	Th	24-Feb	Rankine Cycle	11.1-11.4	8.1- 8.3	
7	12	T	1-Mar	Regenative and Cogenative Cycles	11.5-11.7	8.4-8.6	HW 5 due
	13	Th	3-Mar	Air-Standard Power Cycles- Brayton	12.1-12.5	9.1, 9.5-9.11	
8		T	8-Mar	NO CLASS - Spring Break			
		Th	10-Mar	NO CLASS - Spring Break			
9	14	T	15-Mar	Air-Standard Power Cycles- Otto	12.7-12.8	9.2	HW 6 due
	15	Th	17-Mar	Air-Standard Power Cycles- Diesel	12.9-12.10	9.3- 9.4	
10	16	T	22-Mar	Vapor Refrigeration Cycle	11.8-11.13	10.1-10.4	HW 7 due. **Monday is the last day to drop a**
	17	Th	24-Mar	Heat Pumps & Gas Refrigeration	12.6, 12.12	10.5-10.7	Designed Project Assigned.
11	18	T	29-Mar	Equations of State	14.1-14.6	11.1-11.4	HW 8 due.
	19	Th	31-Mar	Review / Make-up/ Project Discussion	Ch. 11-12	Ch. 8-10	
12		T	5-Apr	**Midterm 2: Ch.11-12 (S), CH. 8-10 (M) (HW 5-8)**			No HW due
	20	Th	7-Apr	Additional Thermodynamic Relations	14.7-14.11	11.5-11.7	
13	21	T	12-Apr	Ideal Gas Mixtures	13.1-13.3	12.1-12.3	HW 9 due
	22	Th	14-Apr	Analyzing Mixture Systems	13.4, 13.5, 14.9, 14.10	12.4-12.9, 11.8, 11.9	
14	23	T	19-Apr	Combustion	15.1-15.5	13.1- 13.2	HW 10 due
	24	Th	21-Apr	Adiabetic Flame Temperature, Absolute entropy	15.6-15.10	13.3-13.5	**Project due**
15	25	T	1-Mar	Chemical and Phase Equilibrium	Ch 16	Ch. 14	HW 11 due
	26	Th	28-Apr	Review / Make-up	Ch. 1-16	Ch. 1-14	
FINAL EXAM			**Thursday May 5th, 10:30am-12:30pm**				

<u>Heat Transfer Examination</u>

Exam format: closed-notes, open-book (see next page for specification), calculator will be used.

Faculty point-of-contact: Professor Pasaogullari

Topics are typically covered in ME 3242. The specific exam guideline and the departmental syllabus of ME 3242 are attached.

Heat Transfer qualifying exam: guideline

- There are six problems on this examination. You must solve 5 of the 6 problems. Each of the 5 problems is worth 20 points, for a maximum total of 100 points.
- This is an open book examination. You are allowed to bring one book. You may bring a copy of Incropera, DeWitt, Bergman, Lavine, or Bergman, Lavine, Incropera, DeWitt.
- You must use a calculator on this exam. However, your calculator may not have communication or wireless capability.
- One 8.5 inch × 11 inch (or A4) sheet of notes is allowed. Your notes may be written on both sides of the sheet.
- Begin the solution of each problem on a new page of paper.
- Do not write on the backs of pages.
- Hand in your exam in order.
- Put your ID on each paper of paper you turn in.
- Turn in your sheet of handwritten notes. Put your ID on the sheet.

Performance

Problem 1 _____

Problem 2 _____

Problem 3 _____

Problem 4 _____

Problem 5 _____

Problem 6 _____

TOTAL: _____

ME 3242 departmental syllabus page 1/3

ME 242 – Heat Transfer

Catalog Description:

Fundamentals of conduction, convection and radiation heat transfer. Application of the general laws of heat transfer, and heat exchange to a wide variety of practical problems. The analytical, numerical, and graphical solution of one, two, and three dimensional problems.

Prerequisites:

- ME 233 – Thermodynamic Principles
- ME 250 – Fluid Dynamics I

Texts:

- Required Text: *Fundamentals of Heat and Mass Transfer*, by F.P Incropera, D.P DeWitt, T.L. Bergman and A.S. Lavine, 6th Edition, John Wiley & Sons, 2007.

Course Objectives:

This course aims to provide Mechanical Engineering students in their senior year with the fundamentals of thermal transport phenomena. The emphasis is on understanding the physical principles and applying them to solve simplified engineering problems involving thermal transport. Open-ended projects provide students with experience in formulating a problem, numerically solving the governing equations, and eliciting design solutions through systematic parametric analysis.

Topics:

- Introduction to the three modes of heat transfer
- Conduction Heat Transfer—one-dimensional, multi-dimensional, and transient
- Introduction to finite difference techniques
- Convection heat transfer
- Radiation heat transfer
- Heat exchangers

Design Project:

Two homework sets will involve open-ended design problems. Written reports will be submitted.

Computer Use:

Students use computational techniques and resources including the latest word processing tools, scientific document preparation tools and scientific analysis tools. Students may choose from a variety of analytical tools, such as Maple, Mathematica, MATLAB and the IHT software provided with the text, in the solution of the various assignments.

Evaluation Methods:

Homework = 5%
2 Design Projects (10% each) = 20%
5 Exams (10% each) = 50%
Final Exam = 25%

Contribution to Professional Component:

The course builds upon the concepts learned in Thermodynamic Principles (ME 233), Applied Thermodynamics (ME 234), Fluid Mechanics (ME 250) and Thermo-Fluids Lab (ME 262). The principles taught in ME 242 are used by some students in the capstone senior design projects course.

Relationship of Course Objectives to Program Educational Objectives:

As an intermediate course, Heat Transfer emphasizes abilities and skills leading to the fulfillment of Program Educational Objective #1: "our alumni practice mechanical engineering by designing systems and solving problems using mathematical, scientific and engineering principles and tools," Program Educational Objective #2: "our alumni approach engineering decisions with an informed consideration of global and societal contexts and consequences," and Program Educational Objective #3: "our alumni continue to expand their professional and personal skills and engage in life-long learning."

Relationship of Course Objectives to ABET 3a-k:

a) an ability to apply knowledge of mathematics, science, and engineering:
This course continually requires the students to apply their knowledge of mathematics, science and engineering. The problem formulation and solution calls for techniques learned in Calculus and Differential Equations courses.

b) an ability to design and conduct experiments, as well as analyze and interpret data:
The computational design project involves conducting parametric studies, and analyzing and interpreting the numerical results.

c) an ability to design a system, component, or process to meet desired needs:
The course projects emphasize designing a process or a component based on specified considerations that are influenced by the temperature field. The course emphasizes the use of a science-based approach to design using the fundamental principles learned in class.

d) an ability to function on multi-disciplinary teams:
The projects are assigned to a team of 2-3 students, and foster effective communication and working in a team environment. These team assignments, although not multi-departmental, still require the students to understand and utilize team dynamics.

e) an ability to identify, formulate, and solve engineering problems:
This is the essential thrust of the course. Throughout the semester the students are taught, through examples and homework, a systematic approach to problem identification, simplification, formulation, and analytical solution of engineering problems involving heat transfer.

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively:
This ability is developed through the written and oral presentations associated with the design projects and constitutes 10% of the overall grade.

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context: *not applicable*

i) a recognition of the need for, and an ability to engage in life-long learning:
The need for life-long learning is introduced through the use of new applications and problems relevant to current and emerging technologies (such as nanotechnology, biotechnology, and information technology).

j) a knowledge of contemporary issues:
Knowledge of contemporary issues is introduced through the newer applications and problems relevant to current and emerging technologies.

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:
Students use modern computational techniques and resources, latest word processing and scientific document preparation tools, and scientific analysis tools. Students may choose from a variety of tools, such as Maple, Mathematica, and MATLAB in the solution of the various assignments.

ME 3242 departmental syllabus page 3/3

Relationship of Course Objectives to Course Outcomes:

1) Students will be able to explain the physical origins of the three modes of heat transfer.
2) Students will understand the conduction process and its mathematical description.
3) Students will be able to find analytical solutions to one-dimensional conduction problems.
4) Students will be able to find numerical solutions to multi-dimensional conduction problems.
5) Students will be able to find solutions to transient problems based upon the lumped capacitance approach.
6) Students will use existing analytical solutions to determine temperature distributions in objects that undergo transient heating or cooling processes.
7) Students will find temperature distributions within and heat transfer rates to/from extended surfaces such as fins.
8) Students will be able to explain what a boundary layer is and how it is important in convection heat transfer.
9) Students will be able to explain how laminar and turbulent flow differ and explain the impact of laminar and turbulent flow on convective heat transfer rates.
10) Students will find analytical solutions (for fluid temperature distributions and surface convective heat transfer rates) to selected problems involving convective heat transfer.
11) Students will interpret the meaning of dimensionless parameters used in convection heat transfer studies.
12) Students will use appropriate correlations to determine convective heat transfer coefficients for single phase external and internal flows during forced convection.
13) Students will be able to explain the physical origins of boiling and condensation processes.
14) Students will be able to use the appropriate correlations to determine heat transfer coefficients for boiling and condensation processes.
15) Students will use the effectiveness-NTU method to predict the performance of standard heat exchanger configurations.
16) Students will be able to explain the physical origins of radiation heat transfer and recognize the difference between diffuse and specular surfaces, as well as gray and spectral surfaces.
17) Students will be able to use and explain the consequences of the Planck distribution for blackbody behavior.
18) Students will be able to determine net radiation heat transfer rates for diffuse-gray surfaces within enclosures.
19) Students will be able to analyze multimode heat transfer problems to determine overall heat transfer rates as well as temperature distributions.
20) Students will apply the preceding principles to the analysis and design of heat transfer problems and/or systems which arise in ME 272P and ME 273P (Senior Design I and II).

Approval Block:

Prepared by: T. Bergman, September 2006
Reviewed by: R. Pitchumani, October 2006
Revised by: T. Bergman, October 2006
C&C Approval: N. Olgac, January 2007
Department Head Approval: Baki Cetegen January 31, 2007