ENG ME 516 Statistical Mechanical Concepts in Engineering

2008-2009 Catalog Data:
ENG ME 516 Statistical Mechanical Concepts in Engineering Prereq: graduate standing or consent of instructor. Specific prerequisites vary according to topic, but do not extend beyond what is covered in the core courses in the undergraduate curriculum in mechanical engineering. Elementary introduction to selected fundamental concepts in probability, random processes, signal processing, and statistical mechanics with strong emphasis on their applications to aerospace and mechanical engineering. Examples taken from acoustics, mechanics, thermodynamics, and fluid dynamics. (Formerly ENG AM 506.) 4 cr.

Class/Lab Schedule: 4 lecture hours per week

Status in the Curriculum: Elective

Textbook(s) and/or Other Required Material: *Introduction to Modern Statistical Mechanics* by David Chandler
Statistical Mechanics: Entropy, Order Parameters, and Complexity by James P. Sethna
Fundamentals of Statistical and Thermal Physics by F. Reif.

Coordinator: Kamil Ekinci, Associate Professor, Mechanical Engineering

Prerequisites by topic:
1. Fundamentals of thermodynamics
2. Basic probability theory
3. Basic fluid dynamics
4. Basic heat transfer

Goals:
This course intends to provide a rigorous background in statistical mechanics in order to teach the microscopic probabilistic nature of thermal phenomena. The course is structured to build upon the thermodynamics background and derive the fundamentals starting with basic probability. Subsequently, other interesting problems in statistical physics are presented. Applications of these principles to engineering problems are emphasized.

Course Learning Outcomes:

As an outcome of completing this course, students will:
i. Become proficient in the application of statistical and probabilistic principles to modeling and solution of applied physics and engineering problems. (A, E, K)
ii. Understand the physical basis of how microscopic phenomena are linked to macroscopic phenomena. (A, E, L)
iii. Gain experience in formulating numerical and computer solutions for statistical mechanical systems.(C, M)

iv. Gain experience with presentation of research through a discussion of current problems in statistical mechanics. (B, E, G, L)

Course Learning Outcomes mapped to Program Outcomes:

Program:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Course:	i, iii	i, iv	iii		i, iii		iv	i	i-iv	ii, iv	i-iv	ii,iv	iii	
Emphasis:	5	3	1	0	4	0	4	1	2	4	3	2	2	1

Topics (time spent in weeks):
1. Introduction (1)
2. Thermodynamics Fundamentals, Free Energies and Equilibrium (2)
3. Ensembles, Averages, Correlation Functions and Phase Space Dynamics (2)
4. Noninteracting Systems (2)
5. Phase Transitions (2)
6. Classical Fluids and Transport (2)
7. Introduction to Non-equilibrium Phenomena, Fluctuations and Dissipation (2)
8. In-class Exams (1)

Contribution of Course to Meeting the Professional Component:
Engineering topics: 100%

Status of Continuous Improvement Review of this Course:
Prepared by: Kamil Ekinci **Date**: 6/2/09