United States Naval Academy
Mechanical Engineering Department

EM415 Heat Transfer

Catalog Description: EM415 Heat Transfer **Credit:** 4 (3-2-4)

Study of thermal radiation, steady and transient conduction, laminar and turbulent convection, internal and external flow, boundary layers and empirical correlations. Applications address fins, nuclear reactor cooling, heat exchangers and interactive computing.

Prerequisites: Engineering Thermodynamics, Fluid Dynamics

Textbooks: Incropera, F.P. and DeWitt, D.P., *Introduction to Heat Transfer*, 4th Ed., John Wiley & Sons, *Required*

Course Director: Assoc. Prof. R.J. Volino

Objectives[1]:

1. To give the student an introduction to heat transfer analysis and provide the necessary tools for solving engineering problems involving heat transfer. Included are the fundamentals of conduction, convection and radiation. (a,b,c)
2. To introduce the student to computational heat transfer for solving steady and transient heat transfer problems through numerical methods. (a,b,c)
3. To provide the student with laboratory experience involving heat transfer experimentation and report writing. (a,b,c,d)
4. To provide the student with design experience through open ended problems involving heat transfer. (a,b,c,d)

Course Content:

No.	Topic or Subtopic	hrs.
1	Introduction to Heat Transfer Modes and Problems Solving Methods	3
2	Steady Conduction	9
3	Transient Conduction	3
4	Finite Difference Solutions	3
5	Forced Convection	11
6	Free Convection	2
7	Two-Phase Heat Transfer	1
8	Heat Exchangers	4
9	Radiation	8

Evaluation:

1. Quizzes	_x_ Yes	___ No
2. Homework	_x_ Yes	___ No
3. Exams	_x_ Yes	___ No

4. Laboratory Reports	_x_ Yes	___ No
5. Oral Presentations	___ Yes	_x_ No
6. Design Reports/Notebooks	_x_ Yes	___ No
7. Prototypes/Demonstrations	___ Yes	_x_ No
8. Projects	___ Yes	_x_ No
9. any other evaluation tools used	___ Yes	_x_ No

Acquired Abilities[2]:

1.1 Students will demonstrate the ability to solve 1-D and 2-D steady conduction problems using analytical methods. Included will be rectangular and cylindrical systems and fins. (1,2,3,4,6)
1.2 Students will demonstrate the ability to select the appropriate solution method and solve unsteady conduction problems through lumped capacitance, approximate solutions, and semi-infinite media solutions. (1,2,3,4)
1.3 Students will demonstrate the ability to recognize the physical significance of all terms in the governing equations for convection. (2,3)
1.4 Students will demonstrate the ability to select appropriate empirical correlations for free and forced convection problems and use the correlations to obtain solutions to problems. (1,2,3,4,6)
1.5 Students will demonstrate the ability to construct radiation network solutions and compute the radiation exchange between gray surfaces. (1,2,3)
1.6 Students will demonstrate the ability to analyze heat exchanger performance using the effectiveness and log mean temperature methods. (1,2,3,4)
1.7 Students will demonstrate the ability to identify the various modes of boiling on the boiling curve and qualitatively describe each mode and its implications. (1,2,3)
2.1 Students will demonstrate the ability to construct a finite difference grid to describe a steady or unsteady conduction problem. (1,2,3,4)
2.2 Students will demonstrate the ability to incorporate various conduction and convection boundary conditions into finite difference solutions. (1,2,3,4)
2.3 Students will demonstrate the ability to write finite difference equations and solve the equations. (1,2,3,4)
3.1 Students will demonstrate the ability to report the results of laboratory experiments, including uncertainty estimation. (4)
4.1 Students will demonstrate the ability to apply multiple concepts to solve problems involving multiple heat transfer modes. (1,2,3,4,6)
4.2 Students will demonstrate the ability to perform parametric studies and use them for evaluation of designs. (6)

Date of Latest Revision: 28 OCT 2001

[1] Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering Program.
[2] Numbers in parenthesis refer to the evaluation methods used to assess student performance.