

**United States Naval Academy  
Mechanical Engineering Department**

**Catalog Description:** EM415 Heat Transfer

**Credit:** 4 (3-2-4)

**Designation:** Required, engineering sciences and design

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:** EM319 - Engineering Thermodynamics, EM324 - Fluid Dynamics

**Corequisites:** None

**Textbooks:** Incropera, DeWitt, Bergman and Lavine, Introduction to Heat Transfer, 5<sup>th</sup> Ed., John Wiley & Sons, Required

**Course Director:** Prof. K.A. Flack

**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

**Assessment Methods:**

		YES	NO
A	Quizzes	X	
B	Homework	X	
C	Exams	X	
D	Laboratory Reports	X	
E	Oral Presentations		X
F	Design Reports/Notebooks		X
G	Prototypes/Demonstrations		X
H	Projects	X	
I	Other		X

**Course Outcomes :**

1. Students will demonstrate the ability to solve 1-D steady conduction problems using analytical methods. Included will be rectangular, spherical and cylindrical systems. (A,B,C,D)
2. Students will demonstrate the ability to solve 2D steady conduction problems using the finite difference method. (A,B,C,D)
3. Students will demonstrate the ability to solve unsteady conduction problems through lumped capacitance (A,B,C)
4. Students will demonstrate the ability to solve unsteady conduction problems using the finite difference method. (A,B,C,D)
5. 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. (A,B,C,D)
6. Students will demonstrate the ability to identify the various modes of boiling on the boiling curve and qualitatively describe each mode and its implications. (A,B,C)
7. Students will demonstrate the ability to analyze heat exchanger performance using the effectiveness NTU methods. (A,B,C,D)
8. Students will demonstrate the ability to construct radiation network solutions and compute the radiation exchange between gray surfaces. (A,B,C)
9. Students will demonstrate the ability to report the results of laboratory experiments, including uncertainty estimation. (D)
10. Students will demonstrate the ability to perform parametric studies and use them for evaluation of thermal designs. (H)

<sup>1</sup> Letters in parenthesis refer to the assessment methods listed in the previous section.

	<b>Course Outcomes</b>									
<b>Program Outcomes</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a)	X	X	X	X	X	X	X	X	X	X
(b)	X	X		X	X		X		X	X
(c)										X
(d)										
(e)	X	X	X	X	X	X	X	X		X
(f)										
(g)									X	
(h)										
(i)										
(j)										
(k)									X	X

**Date of Latest Revision:** 20 APR 2010, Prof. K.A. Flack