

EM316 Thermal-Fluid Sciences I

**United States Naval Academy
Mechanical Engineering Department**

Catalog Description: EM316 Thermo-Fluid Sciences I **Credit:** 3 (3-0-3)
Designation: Required, division core for engineering majors other than ME

A first course in thermal systems that covers incompressible fluid mechanics and heat transfer. Topics in fluid mechanics include properties of fluids, fluid statics, integral conservation equations, differential field analysis, dimensional analysis and similitude, incompressible boundary layers, viscous flow in conduits and flow about immersed bodies. Topics in heat transfer include one-dimensional steady conduction, convection and radiation exchange. Heat transfer emphasis is related to heat exchangers and electronics cooling applications.

Prerequisites: SC112
Corequisites: SM212

Textbooks:
 Required – “Introduction to Thermal and Fluids Engineering” Deborah A. Kaminski and Michael K. Jensen, John Wiley & Sons, Inc., 2005

Course Director: Associate Professor Andrew N. Smith

Course Content:

No.	Topic or Subtopic	hrs.
1	Thermal Systems	2
2	Fundamental Properties	2
3	Properties of Liquid, Solids & Ideal Gases	2
4	Conduction, Convection and Radiation	2
5	Resistor Analogy	2
6	Hydrostatics/Buoyancy	6
7	Open System, Conservation of Mass & Momentum	4
8	Bernoulli’s Equation	2
9	Dimensional Analysis	3
10	Internal Flow, Major and Minor Losses	4
11	Pump Head	2
12	External Flow, Lift and Draft	4
13	Convection Heat Transfer	4
14	Heat Sinks and Extended Surface Heat Transfer	3

Assessment Methods:

		YES	NO
A	Quizzes	X	
B	Homework	X	
C	Exams	X	
D	Laboratory Reports	X	
E	Oral Presentations		X

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F		Design Reports/Notebooks		X
G		Prototypes/Demonstrations		X
H		Projects		X

Course Outcomes¹

Students can effectively;

1. Identify open and closed system; and apply conservation of mass and energy to those systems (A,B,C).
2. Solve hydrostatic problems involving manometers, variation of pressure with depth and hydrostatic forces on planar surfaces (A,B,C).
3. Apply buoyancy to the determination of hydrostatic forces, righting moments and terminal velocity (A,B,C,D).
4. Perform a dimensional analysis using the Buckingham Pi Theorem and use that information to determine the similarity/scaling of experiment results (A,B,C,D).
5. Apply Bernoulli's equation to fluid dynamic problems, and demonstrate an understanding of the applicability Bernoulli's equation (A,B,C).
6. Calculate major and minor losses, and use that information in the steady flow energy equation to calculate pressure or pump head (A,B,C,D).
7. Solve fluid dynamic problems involving external flow. Calculate drag forces on 2D and 3D bodies. Calculate lift and drag forces on foils (A,B,C,D).
8. Solve heat transfer problems that include conduction, convection and radiation. Solve heat transfer problems using the resistor analogy with conduction and convection resistances in Cartesian and cylindrical coordinates (A,B,C).
9. Calculate convection heat transfer coefficients for internal and external flow based on the flow conditions, geometry and fluid properties (A,B,C).
10. Analyze heat sinks for electronic cooling applications (A,B,C,D).

¹ Letters in parenthesis refer to the assessment methods listed in the previous section.

Program Outcomes	Course Outcomes									
	(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
(c)										
(d)										
(e)	x	x	x	x	x	x	x	x	x	x
(f)										
(g)			x	x		x	x			x
(h)				x	x	x	x	x		
(i)				x	x	x	x	x		
(j)										
(k)	x	x	x	x	x	x	x	x	x	x

Date of Latest Revision: 15 MAY 2010, Associate Professor Andrew N. Smith