

1. EM317 Thermofluid Sciences II

2. Credit Hours (3)/Contact Hours (4)

3. Course Director – Cody J. Brownell

4. USNA Thermal-Fluid Sciences, 1st Ed., by Warzoha, Smith, and Brownell (e-book)

5. Specific course information

- a. A basic thermodynamics course in which the first and second laws of thermodynamics are studied primarily from the classical macroscopic viewpoint and applied to both closed and open systems. Working substances include perfect gases, real gases and vapors in addition to solids and liquids. Thermodynamic cycles are covered with specific reference to internal combustion engines, gas turbine engines, steam power plants and refrigeration. Methods for improving the performance of thermodynamic cycles are discussed including regeneration.
- b. Prerequisites: EM316 or EM324
- c. Required for Naval Architecture, Weapons and Robotics, Electrical, Computer, and General Engineering majors.

6. Educational objectives for the course

- a. Apply conservation of mass and the 1st law of thermodynamics to the analysis of closed systems including the determination of boundary work.
- b. Apply conservation of mass and the 1st law of thermodynamics to the analysis of open systems including nozzles, diffusers, pumps, turbines, compressors, throttling valves, mixing chambers, and heat exchangers.
- c. Determine thermodynamic property information for ideal gases, water, R134a, and R12 utilizing property tables, property diagrams, ideal gas law, and constant specific heats.
- d. Apply the effectiveness NTU method to the analysis of heat exchangers.
- e. Understand the 2nd law of thermodynamics and how it relates to the performance and design of heat engines.
- f. Incorporate isentropic efficiencies in the analysis of systems that utilize turbines, pumps, compressors, and nozzles.
- g. Analyze internal combustion engines using the Otto and Diesel Cycles.
- h. Analyze gas turbine engines using the Brayton cycle, including regeneration, split shaft gas turbines, and aircraft engines.
- i. Analyze steam power cycles using the Rankine cycle, including cycle modifications such as reheat, regeneration, and nuclear power use.
- j. Analyze heat pumps and refrigeration systems using the vapor-compression refrigeration cycle.

7. Specific program outcomes addressed by this course

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Reinforced	X				X	X	X
Mastered							

8. Brief list of topics to be covered

- a. Thermodynamic Systems
- b. Units and Properties
- c. 1<sup>st</sup> Law of Thermodynamics for Closed Systems
- d. Properties of Ideal Gases and Pure Substances
- e. Boundary Work
- f. 1<sup>st</sup> Law of Thermodynamics for Closed Systems
  - i. Conservation of Mass
  - ii. Conservation of Energy
- g. Open System Devices
  - i. Nozzles/Diffusers
  - ii. Compressors
  - iii. Pumps
  - iv. Turbines
  - v. Throttles
  - vi. Heat Exchangers
- h. Heat Exchangers (Effectiveness-NTU)
- i. 2<sup>nd</sup> Law of Thermodynamics
  - i. Carnot Cycles
  - ii. Entropy
  - iii. Isentropic Efficiency
- j. Combustion
- k. Otto/Diesel Cycles
- l. Brayton Cycle
- m. Gas Turbines
- n. Rankine Cycle
- o. Refrigeration/Heat Pumps
- p. Nuclear Power