Catalog Data:
AE 6440: Turbine Engine Aerothermodynamics. Credit (3-0-3). Analysis and design of gas turbine engine components including axial flow compressors, turbines, inlets and nozzles. Heat transfer and turbine blade cooling.

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Textbook *(Tentative)*::
Mechanics and Thermodynamics of Propulsion *Hill and Petersen* Addison-Wesley, 1992.

References:
Course Notes and Handouts

Course Objectives:
This course is meant for graduate students with a propulsion research interest, whether system design, experimental, or CFD oriented. There are three main objectives for this course:

1) Teach the graduate student the elements of aerodynamic and thermodynamic design of gas turbine engines. Emphasis will be placed on turbomachinery component design, which will primarily consists of aerodynamic design of axial flow compressor blading as well as axial flow turbine blading. (e.g., how to design for adequate stall margin with high pressure ratio).
2) Teach fundamental heat transfer concepts as they relate to gas turbine engines, primarily, turbine cooling design.
3) Expose students to new research in the area of turbomachinery component design (e.g. active/passive stall margin control, cooling flow delivery techniques, inlet/nozzle flow control).

In addition, the student will learn about subsonic and supersonic inlet and nozzle design.

Pre-requisites:
Undergraduate level exposure to thermodynamics, fluid mechanics, compressible flow and tubine engine propulsion.

Topics:
1. Introduction (2 hours)
   a. Historical Perspective
   b. Definitions
   c. Classifications of Propulsion Systems
2. Real and Ideal Brayton Cycles (2 hours)
   a. Review of Brayton Cycle
   b. Component efficiency trades

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3. Turbomachinery Flows I - Axial Flow Compressors (9 hours)
a. Radial Equilibrium
b. Cascade Theory
c. Blade Design
d. Secondary Flows
e. Loss Sources
f. Compressor Stall/Surge
g. Active/Passive Flow Control
h. Bleed Flow Design

4. Turbomachinery Flows II - Axial Flow Turbines (8 hours)
a. Loss Sources
b. Secondary Flows
c. Shock/Blade Interaction
d. Blade Reaction
e. Turbine/Compressor Matching

5. Heat Transfer Fundamentals (5 hours)
a. Conduction
b. Convection
c. 1-D Analysis

6. Turbine Cooling Design (8 hours)
a. Turbine Blade Cooling Requirements
b. Coolant Delivery System
c. Internal Blade Cooling
d. Film Cooling
e. Turbine Gas Path Cooling
f. Combustor Cooling

7. Inlets and Nozzles (4 hours)
a. Subsonic / Supersonic Inlet Design
b. Subsonic / Supersonic Nozzle Design
c. Active Flow Control Concepts

8. Advanced Concepts (5 hours)
a. Turbine Based Combined Cycle
b. Augmentor / Ramjet Concepts
c. Fuel Injection for Scramjet Engines