

## **AE 4080 Aerothermodynamics 3 Credit Hours**

**Course Overview:** AE4080 is an ungraduated level options course which provides an introduction to hypersonic flow. The course content includes inviscid hypersonic flow theory, introduction to viscous hypersonic flow, aerothermodynamic heating, the fundamentals of heat transfer and the design of thermal protection systems. Throughout the course, comparisons are made between the perfect gas assumption and the effects of a high temperature, chemically reacting gas.

**Instructor:** Dr. John A. Dec, Professor of the Practice

**Textbooks:** Required: Bertin, John J., *Hypersonic Aerothermodynamics*, AIAA Education Series, 1994.

Reference: Anderson, John D., *Hypersonic and High Temperature Gas Dynamics*, 3<sup>rd</sup> Edition, AIAA Education Series, 2019.

### **Learning Objectives:**

1. Governing Equations for Hypersonic Flows.
2. Hypersonic Pressure Distribution, Aerodynamic Force Coefficients.
3. Fundamentals of Heat Transfer
4. Thermal Protection System Design.

### **Prerequisites:**

1. AE 3030 Aerodynamics

### **Hypersonic Flow Characterization (3 hrs)**

- Introduction to Hypersonic Flow
- Characteristics of Hypersonic Flow

### **Inviscid Hypersonic Flow (12 hrs)**

- Review of Perfect Gas Shock Relations
- Shock Relations for a High Temperature Chemically Reacting Gas
- Newtonian and Modified Newtonian Flow
- Tangent Cone and Tangent Wedge Approximations
- Aerodynamic Force and Moment Coefficients

### **Viscous Hypersonic Flow (6 hrs)**

- Introduction to Boundary Layers
- Introduction to High Temperature Equilibrium Flow
- Governing Equations
  - Continuity Equation
  - Momentum Equation
  - Energy Equation

### **Aerothermodynamic Heating (6 hrs)**

- Stagnation Point Convective Heating
- Non-Stagnation Region Convective Heating and Skin Friction

### **Fundamentals of Heat Transfer (6 hrs)**

- Conduction
- Convection
- Radiation

### **Thermal Protection System Design (6 hrs)**

- Reusable, Non-Ablative Thermal Protection Systems
- Ablative Thermal Protection Systems
- Inflatable Thermal Protection Systems