**Additional Related Coursework**

**Combustion:** Graduate Level. Chemical kinetics, thermodynamics, and governing conservation equations of chemically reacting flows. Laminar premixed and diffusion flames, ignition, extinction, flame stabilization, detonation, and droplet and particle combustion were covered.

**Advanced Heat and Mass Transfer:** Graduate Level. Review of the thermophysical properties of matter including nanoscale effects. Exact and computational solutions of heat conduction equations and dimensionless conduction rate approach for steady-state and transient conduction. Species diffusion equations with emphasis on stationary media and partitioning effects. Navier-Stokes equations and exact solutions for special cases.

**Radiation Heat Transfer:** Graduate Level.Fundamentals of radiative emission (black body behavior and Planck’s law), surface properties (emissivity, absorptivity, reflectivity, and transmissivity), electromagnetic theory for prediction of radiative properties, development of solution methods for radiant energy interchange between surfaces and in enclosures with and without absorbing, emitting, and scattering media present.

**Advanced Fluid Dynamics 1** **and 2:** Graduate Level.General equations for conservation of mass, momentum, and energy; and solutions for incompressible Newtonian viscous fluids were presented and analyzed. Kinematics and dynamics of inviscid and incompressible flow including free streamline theory were studied using vector, complex variable, and numerical techniques. Low and high Reynolds number approximations and boundary layer theory. Matching techniques and similarity solutions. Elements of gas dynamics including quasi-one-dimensional flow, shock waves, supersonic expansion, and linearized theory. Non-Newtonian fluids.

**Aerospace Design:** Semester-long course to design an atmospheric miner for Neptune. Mission profile called for mining mission in the atmosphere of Neptune followed by launch to orbit, transfer of payload to another craft, and re-entry into the atmosphere for more mining missions. Design included nuclear-thermal propulsion system, cryogenic cooling and storage system, aerodynamics of the craft, and entry heating analysis. Participated as the lead propulsion system designer on a team of 3 people.

**Flight and Orbital Mechanics:** Aircraft performance, range and endurance, stability and control, take-off and landing, and simple maneuvers. Also included elements of celestial mechanics, orbit transfer, orbit decay due to drag, and lift-off and entry.

**Aerophysics:** Graduate Level. Physical and chemical topics in modern fluid mechanics, plasma dynamics, and combustion sciences, including quantum mechanical analysis of atomic and molecular structure, statistical thermodynamic calculations, chemical and physical equilibrium, reaction kinetics, and adiabatic flame temperature of complex reacting systems and transport phenomena.

**Propulsion:** Performance criteria of engines and air-breathing engine cycle analysis. Rocket flight performance and staging. Introduction to thermochemistry and combustion.

**Aero and Gas Dynamics:** Review of conservation equations and potential flow. Subsonic and supersonic airfoil theory, finite wings, isentropic one-dimensional flow, normal and oblique shock waves, and Prandtl-Meyer expansion waves.

**Aerostructures:** Mechanics of thin-walled aerospace structures including load analysis and shear flow due to shear and twisting loads in open and closed cross-sections. Introduction to structural vibrations and finite element methods. Included application of ALGOR FEA software to various related structures. As part of a team of 5, constructed and successfully test-flew a micro-air vehicle constructed from molded carbon fiber.

**Mechanical Manufacturing:** Focus on graphics and manufacturing processes. Included manual and computer-aided drafting and design, primary and secondary engineering processes, engineering materials, and a hands-on lab applying knowledge obtained in lectures.

**Design of Fluid and Thermal Elements:** Project-based class presenting practical design problems integrating fluid mechanics, thermodynamics, and heat transfer. A series of 6 projects were completed in teams of 3 over the semester.

**Engineering Design:** Semester-long project to design and build a small-scale hover craft in teams of 5.

**Fluid and Thermal Engineering 2:** Heat engines and refrigeration, chemical equilibrium, developing flow, boundary layer theory, hydrodynamic lubrication, heat transfer, and heat exchangers.