Catalog Description: AE 6414 Multiphase Combustion. Fundamentals of dispersed-phase dynamics of liquid-gas and soot and aerosol flows. Fluid-particle-wall interactions. Numerical and experimental methods. Advances in spray combustion.

Text: *Fluid Dynamics and Transport of Droplets and Sprays*, W. Sirignano, Cambridge University Press, 2001.

Course Coordinator: Dr. Suresh Menon

Learning Objectives: Introduce students to the issues related to flow with more than one phase and the implication to the physics due to interaction between various phases. . Provide an in-depth study of the models that have been developed with a focus on practical applications. Also introduce students to the new developments in this field.

Expected Outcomes: Students will be able to: a) understand fundamental physics of multi-phase flows; b) develop approaches useful for modeling multiphase combustion flows; c) interpret results and plan measurements using common experimental methods for multiphase combustion flows.

Prerequisites: Graduate level exposure to thermodynamics, combustion, fluid dynamics and turbulent flows.

Topics:

1. **Fundamentals of the dispersed phase (3 hours):** Volume/Void Fraction, response time, Stokes Number, one-way and two-way coupling, dilute and dense flows, droplet cloud combustion
2. **Dynamics of liquid-gas flows (6 hours):** Instabilities in multiphase flows: effect of swirl and shear, liquid jet and spray breakup, droplet formation, size distribution, effect of turbulence, breakup, coalescence, shattering, and internal circulation
3. **Aerosol dynamics (3 hours):** binary nucleation, coagulation, and condensation, solid and metal combustion, nano-energetics
4. **Fluid-Particle-Wall Interactions (9 hours):** Evaporation, condensation and combustion, Drag effects, radiation and convective heat transfer, wall collisions and filming
5. **Formulation of two-phase flow equations (9 hours):** Eulerian-Lagrangian, Eulerian-Eulerian and Lagrangian-Lagrangian models, approaches for dense regime, soot and aerosol dynamic models
6. **Numerical methods (6 hours):** RANS models for spray combustion, RANS models for aerosol/soot formation, Direct and Large-Eddy simulations of sprays, aerosols
7. **Experimental methods (6 hours):** Liquid injector designs and constraints, atomization process, sampling methods, PDPA, in-situ measurements and accuracy, error analysis
8. **New areas of research (3 hours):** Examples: supercritical sprays, inception of