AE 666
Combustion Diagnostics

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Course Objectives

- To prepare students for Experimental Research in Combustion
  - To develop an understanding of the instruments and measurement techniques pertaining to combustion
  - Understanding the correlation between various parameters
  - Understanding data analysis and error estimates

Course Content

- Error estimates and uncertainty analysis
- Dynamic pressure measurement in combustors
- Temperature measurement in flames using thermocouple
- Pollutant and species measurement using gas sampling
- Non-intrusive optical diagnostics for species
- Temperature and Velocity measurement in flames
- Flow visualization

Course Structure

Introduction • Thermal and flow measurement in reacting flows • Elements of measurement systems • Error estimates and uncertainty analysis	4
Static and dynamic pressure measurement • Pressure transduces, operating principle, time response and application to unsteady combustion systems • Time series analysis and signal processing • Sound pressure level measurements	2
Flow metering and velocity probes • Obstruction and variable area flow meters • Thermal mass flow meters • Pitot static tubes, hot wire anemometers	4

Course Structure (Cont.)

Temperature measurement in flames using thermocouple • Operating principle of a thermocouple • Radiation correction in flames • Unsteady temperature measurement in flames	2
Pollutant and species measurement using gas sampling • Sampling probes • Electrochemical methods • Gas chromatography • Mass spectroscopy	4
Atomic/molecular structure, optical emissions, scattering • Molecular spectroscopy • Optical emissions, fluorescence, chemiluninescence • Mie, Rayleigh and Raman scattering	5

Course Structure (cont.)

Lasers, detectors and optics • Operating principle of laser, types of lasers • Charge couple device (CCD), complementary metal–oxide–semiconductor (CMOS) camera, image intensifiers • Lenses, beam splitters, frequency doubling crystals	2
Velocity field measurement in flames • Particle seeding and flow following • Laser Doppler Velocimetry (LDV) • Particle Image Velocimetry (PIV) • Image processing	6
Species measurement in flames • Spontaneous Raman scattering (SRS) • Absorption spectroscopy • Laser induced fluorescence (LIF) • Laser induced incandescence (LII)	6
Temperature measurement • Rayleigh thermometry (RT) • Coherent anti-stokes Raman spectroscopy (CARS)	3
Other optical techniques • Schlieren, shadowgraph, interferometry	2

Text Books and Reference Material

1. Experimental Combustion: An Introduction, D. P. Mishra, 2014
2. Thermal and Flow Measurements, T. W. Lee, 2008
3. Laser Diagnostics for Combustion Temperature and Species, A. C. Eckbreth, 1996
4. Combustion Measurements, N. Chigier, 1991
5. Measurement Systems, Doeblin, 1984.

Grading Policy

- Mid semester exam: 40%
- End semester exam: 60%