

AE/ME 6766 Combustion

Catalog Description: AE/ME 6766: Combustion. 3-0-3

Introductory chemical kinetics, detonations and deflagrations, laminar flame propagation in premixed gases, ignition and quenching, laminar diffusion flames and droplet burning, turbulent reacting flows.

Coordinator: Jerry M. Seitzman, Assistant Professor

Text at the level of:

An Introduction to Combustion: Concepts and Applications, Stephen R. Turns, McGraw-Hill, 1996.

Learning Objectives:

1. Modeling of chemical reaction rates and development of reaction mechanisms.
2. Development of conservation equations including reaction rates and mass diffusion.
3. Propagation of laminar premixed combustion waves.
4. Physical and chemical effects on flame speed and thickness.
5. Structure of laminar diffusion flames and burning droplets.
6. Structure and propagation of premixed turbulent flames.
7. Structure and modeling of nonpremixed turbulent combustion.

Prerequisites:

Chemical thermodynamics and gas kinetic theory (AE 6765).

Lecture Topics:

Combustion Overview and Review (1 lectures)

Chemical Kinetics (10 lectures)

- Introduction to reaction kinetics
- Reaction rates and bimolecular collision models
- Reaction mechanisms and chain reactions
- Partial equilibrium and steady-state approximations
- NO_x kinetics
- H₂-O₂ explosions
- Global kinetic models for hydrocarbon oxidation

Coupled Chemical and Thermal Analysis (2 lectures)

- Plug flow and well-stirred reactors

Conservation Equations (2 lectures)

- Mass transport
- Schvab-Zeldovich formulation

Laminar Premixed Combustion (12 lectures)

- Rankine-Hugoniot analysis of detonations and deflagrations
- Structure of plane detonations
- Chapman-Jouget detonations
- Laminar flame structure
- Laminar flame speed and flame thickness
- Propagation limits: quenching, flammability limits, flame stabilization
- Ignition: spark and thermal ignition

Laminar Nonpremixed Combustion (9 lectures)

- Laminar jet mixing
- Laminar jet diffusion flames
- Soot formation and destruction

- Laminar counterflow diffusion flames
- Droplet evaporation
- Droplet burning

Introduction to Turbulence (1 lecture)

- Characteristics of turbulent flows
- Length and time scales
- Reacting flow regimes

Premixed Turbulent Flames (3 lectures)

- Length and velocity ratios
- Wrinkled and corrugated flames, flamelets in eddies
- Turbulent flame speed
- Modeling

Nonpremixed Turbulent Flames (3 lectures)

- Fast (equilibrium) chemistry
- Finite rate chemistry and flamelet models
- Jet flames