Our Mission

To provide the next generation of combustion researchers with a comprehensive knowledge in the technical areas of combustion theory, chemistry, experiment, computation and applications.

The 2019 Session

The 2019 **Princeton-Combustion Institute** Summer School on Combustion, scheduled for **June 23 to June 28, 2019,** will offer the following courses: (1) Combustion Dynamics; (2) Combustion Chemistry and Modeling; (3) Numerical Combustion, Part I: Computational Methods for Soot Formation; Part II: Numerical Combustion from Fundamentals to Engine Applications; (4) Laser Diagnostics in Turbulent Combustion Research; (5) Combustion Fundamentals of Fire Safety - Promise and Progress.

Application Materials

Submit application at https://cefrc.princeton.edu/combustion-summer-school by March 15, 2019. Acceptance will be communicated by April 5, 2019.

Program Dates

Arrival & Welcome Dinner: Sunday, June 23, 2019; dinner at 6:30pm
Class Schedule: Monday, June 24, 2019 to Friday, June 28, 2019
Celebration & Farewell Banquet: Thursday, June 27, 2019
Departure/Check Out: Friday, June 28, 2019

Course Description

Combustion Dynamics (M-F) Lecturer: **Prof. Sébastien M. Candel**, CentraleSupélec, U. Paris-Saclay, France

This course provides an introduction to the analysis of combustion dynamics problems. It includes a tutorial on acoustics and on early combustion instability models and deals with perturbed flame dynamics, flame transfer functions, nonlinear flame dynamics, flame describing function methods, swirling flames, spray flames, azimuthal coupling in annular combustors, passive and active control of instabilities. Applications of Computational Flame Dynamics (CFD) will be reviewed. Concepts will be illustrated with experimental data and large eddy simulations.

Combustion Chemistry and Modeling (M-F) Lecturer: **Prof. Henry J. Curran**, National University of Ireland, Galway, Ireland

This course provides an introduction to the development of detailed chemical kinetic mechanisms to describe the oxidation of hydrocarbon and oxygenated hydrocarbon fuels. It includes a tutorial on the importance of thermochemistry and the use of group additivity to estimate/calculate thermodynamic parameters for species using the THERM program. There will be a detailed discussion on the important general classes of reactions associated with fuel oxidation and the calculation/estimation of the important rate constants associated with these reactions. The importance of good experimental data which are used as validation targets will also be discussed.

Numerical Combustion

Part I: Computational Methods for Soot Formation (M-W) Lecturer: **Prof. Angela Violi**, University of Michigan, USA

Various chemical and physical processes occur between the oxidation and pyrolysis of fuel and the formation of combustion by-products. This course will review our current understanding of the models that describe the formation of gas-phase species, including polycyclic aromatic hydrocarbons and their transition to nanoparticles and further grow into soot. Special emphasis will be given to atomistic simulations, such as molecular dynamics, highlighting their use and potential for combustion applications.

Further inquiries on the academic program and logistics of participation may be made by contacting Prof. Chung K. Law, program organizer, cklaw@princeton.edu, or Dr. Ran Sui, program coordinator, rsui@princeton.edu, Tel 609 258 4083.
Visit us online at https://cefrc.princeton.edu/combustion-summer-school.

Course Description (continued...)

Part II: Numerical Combustion from Fundamentals to Engine Applications (Th-F) Lecturer: **Dr. Jacqueline H. Chen**, Sandia National Laboratories, Livermore, USA

This course provides an overview of numerical combustion methodology applied to fundamentals of fluids-chemistry interactions relevant to practical engines for power generation and transportation. Computational methods discussed include direct numerical simulation (DNS), large-eddy simulation and RANS along with DNS-based model validation. To achieve more realistic aero-thermo-chemical conditions future exascale computation on heterogeneous machine architectures using asynchronous programming paradigms will be discussed including incorporating in situ anomaly detection of intermittent combustion events and chemical explosive mode analysis. Finally, the application of DNS to understand flame stabilization, autoignition, and flame propagation processes will be illustrated through several examples.

Laser Diagnostics in Turbulent Combustion Research (M-F) Lecturer: **Prof. Jeffrey A. Sutton**, Ohio State University, USA

The course provides an overview of several laser-based measurement techniques, building up from working principles to application. Velocimetry techniques, as well as scalar measurements for species concentrations and temperature will be discussed. Both particle-based and gas-phase measurements will be treated, focusing on the underlying light-matter interaction, spectroscopy, and signal interpretation. A primary area of discussion will target the challenges for quantitative measurements in turbulent combustion environments. Several high-fidelity measurement examples from laboratory-scale flames/reactors will be presented to showcase new insights to turbulent combustion physics. New and emerging laser-based approaches will be discussed which target a fully four-dimensional description of realistic combustion environments.

Combustion Fundamentals of Fire Safety (M-F) Lecturer: **Prof. José L. Torero**, University College London, UK

This course will address the combustion processes that define a fire safety strategy. Applications covered will be from forest to building fires. Fundamental processes such as pyrolysis, ignition and flame spread will be linked to material flammability. The structure of a buoyant diffusion flame will be developed to characterize mechanisms of heat transfer in forest fires as well as the degradation of structural strength. Diffusion flame theory and buoyancy driven flows will be used to describe heat release rates and the evolution of a fire within a compartment. The generation of heat and products of combustion will be used to evaluate the performance of different fire protection measures such as sprinklers, smoke detectors and smoke management systems.

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