

## Introduction to Engineering Math and Physics through Fire Dynamics

(Eight Lectures, bi-weekly)

### Program Description

This program is designed to introduce students to, and spark their interest in, developing their knowledge of the fundamental concepts in mathematics, physics, and chemistry needed to understand and solve engineering problems. Concepts will be studied with direct applications to various fire protection engineering applications through a series of lectures and related laboratory experiments.

### Program Content

Kinematics - Vectors, vector algebra, coordinate systems

Steady vs. Transient solutions

Energy/Temperature

Thermodynamics/Thermochemistry

    Balancing Equations

    Reaction Properties (endo- vs. exothermic reactions,  $h_{\text{vap}}$ ,  $h_{\text{fusion}}$ ,  $\Delta h_c$ ,  $C_p$ ,  $P_{\text{vap}}$ )

Fluid Mechanics, Basic Concepts

Heat and Mass Transfer (material thermal properties)

Ignition Phenomena

Fire Spread

Forest Fires

### Schedule

Week 1 – Program intro, Understanding the Physics and Math behind the Fire Problem and Recent Advanced Projects | Flame Spread Lab | Derivatives

Week 2 – Upward Flame Spread | Scalars vs. Vectors

Week 3 – Fire Kinematics | Candle Flame lab

Week 4 – Flame Temperature, Color, and Fuel Controlled Fire Behaviors | Intro to Radiation/Spectral Emission | Flame Colors Lab

Week 5 – Intro to Flame Chemistry/Balancing Equations

Week 6 – Adiabatic Flame Temperature Calculations

Week 7 – Final Assessment | Final project experiments/Labwork

Week 8 – Forest Fires | Student presentations/final projects

## Learning Outcomes

Upon completion of this program, the student should:

- Understand when calculus is needed to solve a problem/understand the limitations of non-transient solutions to problems
- Understand the effects/limitations of engineering assumptions in problem solving, experimental design and physical equations
- Have a working/basic knowledge of experimental design – what to look for when designing an experiment, finding flaws in testing approach/methodology and presentation of results
- Display a working knowledge of software used to evaluate, manipulate, and present experimental measurements (e.g. Excel, MATLAB)
- Develop a basic knowledge of fundamental fire dynamics
- Utilize and convert between standard SI Units (e.g. know the scaling relationships between prefixes- nano, micro, milli, kilo, mega)
- Be able to convert between, understand, and be able to express problem solutions in terms of the correct units – N, m, J, Pa, W...

## Grading

Your grade in this program will be determined based on your performance in five areas:

- Labwork
  - Three laboratories will be conducted during this program; accompanying lab reports will be assigned for each. If reports are turned in after their assigned due date, they will be penalized by 10% for each day late. Reports turned in more than five days late will not be accepted. Lab reports will be graded based on:
    - Data collection and lab performance
    - Technical presentation of results (data manipulation; accurate/clear figures)
    - Results and analysis (understanding of topic)
    - Clarity and precision of writing
- Homework - Review problems/assignments suggested following each lecture
- Participation in lecture problem sessions and discussions
  - In session presentations (recaps or reviews) of previous lecture topics
- Adiabatic Flame Temperature Calculations - Problem solving competition
- Final Project progress reports and presentation

## **Student Expectations**

Attendance and participation in every lecture and laboratory session is required. Extenuating circumstances (religious/personal reasons) will be taken into account but require at least a one week warning.

Email will be the primary means of communication for this program. You are expected to keep up with all announcements and assignments sent out by email.

All assignments (reading and written) should be completed and submitted individually (unless otherwise stated), on time, and to the best of each student's ability.

Students are expected to enrich their knowledge of lecture topics with additional sources of information not directly discussed during lectures. (i.e. additional reading/work outside of lecture sessions will be necessary to succeed.)

Students are expected to come prepared, interested, and ready to work for each discussion/lab session. This is not a high school course- students are not forced to be here and will be asked to leave if their behavior is detrimental to the program.

The University has a very strict policy on Academic Dishonesty (Cheating, Fabrication, Plagiarism, or Facilitating academic dishonesty). These rules will be enforced for this program. All students are expected to be aware of University policies – violations will not be tolerated, regardless of excuses. Students found in violation of this honor code will be dismissed from the program with an XF grade.