Introduction to Engineering Math and Physics through Fire Dynamics

September 9 – December 16 (Eight Lectures, bi-weekly)

Course Description

This course 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.

Course Content

Kinematics - Vectors, vector algebra, coordinate systems

Steady vs. Transient solutions *(essentially an intro to calculus for those w/o background)*

Energy/Temperature

Thermodynamics/Thermochemistry

- Balancing Equations
- Reaction Properties (endo- vs. exothermic reactions, h_{vap}, h_{fusion}, Δh_c, C_p, P_{vap})

Fluid Mechanics, Basic Concepts of

Heat and Mass Transfer (material thermal properties)

Ignition Phenomena

Fire Spread

Forest Fires

Schedule

Week 1 – Course intro, Understanding the Physics and Math behind the Fire Problem and Recent Advanced Projects

Week 2 – Upward Flame Spread | Scalars vs. Vectors and Derivatives

Week 3 – Candle Flame lab | Intro to Flame Chemistry/Balancing Equations

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

Week 5 – How is Heat Transferred/Released by Fires? Three Modes of Heat Transfer. FEM /Basic Modeling Concepts

Week 6 – Fluid Flow and Water Based Suppression – Thermal Response and Sprinkler Spray Characterization | Design a Sprinkler Characterization Lab

Week 7 – Flame Spread Lab | Understanding the limitations of models

Week 8 – Forest Fires | Student presentations/final projects

Learning Outcomes

Upon completion of this course, 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

Three laboratories will be conducted during this course; 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

Review problems/assignments suggested following each lecture
In class presentations (recaps or reviews) of previous lecture topics/related material
Participation in classroom problem sessions and discussions
Final Project

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.

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 class will be necessary to succeed.)

Students are expected to come prepared, interested, and ready to work for each class/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 course.

The University has a very strict policy on Academic Dishonesty (Cheating, Fabrication, Plagiarism, or Facilitating academic dishonesty). These rules will be enforced for this class. 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.