Course Code, Course Title: **ENFP625, Advanced Fire Modeling**

Credits: **Three (3)**

Contact hours: **1 online meeting per week, one hour long (this is an online course offered with an asynchronous format)**

Instructor, term: **A. Trouvé, Spring 2027**

Textbook: **Karlsson B., Quintiere J.G., *Enclosure Fire Dynamics*, CRC Press LLC, 2000 (1st Ed.) or 2022 (2nd Ed.).**

Other supplemental materials: ***SFPE Handbook of Fire Protection Engineering*, 5th Ed., M.J. Hurley (Ed.), New York: Springer, 2016; *SFPE Handbook of Fire Protection Engineering*, 6th Ed., Society of Fire Protection Engineers (Ed.), New York: Springer, 2026.**

CFAST: https://pages.nist.gov/cfast/; Peacock, R.D., Reneke, P.A., Forney G.P. (2026) "*CFAST - Consolidated Model of Fire Growth and Smoke Transport (Version 7) – Volume 2: User's Guide*", NIST Technical Note 1889v2.

FDS: https://pages.nist.gov/fds-smv/; McGrattan, K., Hostikka, S., Floyd, J., McDermott, R., Vanella, M., Mueller, E., Paul, C., "*Fire Dynamics Simulator – User's Guide,*" NIST Special Publication 1019, Sixth Ed., National Institute of Standards and Technology, Gaithersburg, MD, USA, 2026; McGrattan, K., Hostikka, S., Floyd, J., McDermott, R., Vanella, M., Mueller, E., Paul, C., "*Fire Dynamics Simulator – Technical Reference Guide, Volume 1: Mathematical Model; Volume 2: Verification; Volume 3: Validation; Volume 4: Configuration Management*" NIST Special Publication 1018, Sixth Ed., National Institute of Standards and Technology, Gaithersburg, MD, USA, 2026.

PyroSim: https://www.thunderheadeng.com/pyrosim/; "*PyroSim User Manual*," Thunderhead Engineering, MD, USA, 2026. (https://www.thunderheadeng.com/docs/2026-2/pyrosim/)

Catalog description: **Validity, utility, reliability of current computer models. Applications of models in risk assessment, underwriting, loss prediction, hazard analysis. Development and validation of specific application models.**

Prerequisites and Corequisites: **Prerequisite: ENFP312**

Specific outcomes of instruction: **Upon completion of this course, students should be able to:**

- **Demonstrate an understanding of current fire models and their role in the practice of fire protection engineering.**

- **Identify the different approaches used in current fire models: CFD modeling versus zone modeling.**
- **Apply current fire models (FDS, PyroSim, CFAST) to the simulation of representative fire configurations.**
- **Demonstrate an understanding of the main stages in the development of compartment fires.**
- **Identify the different combustion regimes found in compartment fires: fuel-limited versus oxygen-limited combustion.**
- **Estimate the mass flow rate of smoke produced by a fire.**

Student outcomes assessed (ABET SOs if applicable): **Not applicable**

Brief list of topics covered:

- **Introduction to computer-based fire modeling and comparison between the zone modeling and CFD modeling approaches.**
- **Introduction to zone modeling software used by professional fire engineers (CFAST).**
- **Introduction to CFD modeling software used by professional fire engineers (FDS and PyroSim).**
- **Compartment fire dynamics:**
    - **Fire growth: formation of a smoke layer and transition to flashover.**
    - **Mass and energy conservation statements and application to zone modeling.**
    - **Pyrolysis: the description of fuel sources in fires and the concept of a design fire.**
    - **Combustion: fuel-limited versus oxygen-limited combustion regimes, heat release rate and species yields.**
    - **Ventilation: vent flows, natural ventilation theory, smoke production and transport in buildings.**
    - **Heat transfer: radiation heat transfer between gray surfaces in enclosures, radiation heat transfer from the fire smoke, wall heat losses.**