Name:	***Fire Dynamics***
Course Description:	This course examines fire dynamics within the context of firefighting and its applications to fire situations, including combustion, flame spread, flashover, and smoke movement, as well as applications to building codes, large-loss fires, and fire modeling.
Objectives:	**Unit 1: Introduction**
	After completing this unit, you should be able to: • define fire dynamics; • describe typical compartment fire phenomenology from ignition through fully developed burning; • explain the concept of zones as applied to stratification of gases in a compartment fire; • read and use simple x-y, semi-log, and log-log plots; • identify and evaluate a variable in a correlation; • determine dimensional consistency in equations; and • use and understand mathematical functions.
	Unit 2: Chemistry, Physical Processes, and Fluid Dynamics
	After completing this unit, you should be able to: • balance a chemical equation; • define stoichiometry; • define buoyancy, pressure, and flow; • perform simple radiation, conduction, convection, and heat transfer calculations; • describe the mechanisms of radiation, conduction, and convection in heat transfer; • define what is meant by an energy balance; • calculate the minimum amount of air necessary to burn a given amount of fuel; and • define heat of combustion.
	Unit 3: Fire and Combustion
	After completing this unit, you should be able to: • describe the structure of a gaseous, laminar diffusion flame; • define laminar, turbulent, premixed, and diffusion flames; • define flammability limits, and explain each in the context of the structure of a flame; • define heat of combustion, heat of vaporization, and adiabatic flame temperature; • define rate of heat release; • calculate the burning rate of a liquid fuel; • describe the mechanism of solid burning; • describe the burning behavior of upholstered furniture as it relates to furniture calorimeter results; and • describe how a cone calorimeter test relates to burning behavior of a solid fuel.

Objectives:	**Unit 4: Explosions**
	After completing this unit, you should be able to: • differentiate between deflagrations and detonations on the basis of physical mechanism and damage; • define the term "explosion"; • describe three types of explosions; • calculate the TNT equivalent of a given amount of material; • relate TNT equivalence to overpressure; • relate overpressure to damage; and • differentiate between a BLEVE and an UVCE.
	Unit 5: Ignition and Flame Spread
	After completing this unit, you should be able to: • differentiate between piloted and nonpiloted ignition; • define spontaneous ignition; • describe the process of flame spread over liquid fuels; • describe the phenomenology of flame spread over a solid fuel; • list five variables that affect flame spread rate; • define concurrent and counterflow flame spread; and · explain the importance of thermal inertia in ignition and flame spread.
	Unit 6: Flames and Flame Spread
	After completing this unit, you should be able to: • calculate the height of a buoyant diffusion flame; • describe the structure of turbulent, buoyant, and diffusion flames; • calculate the thermal radiation from a flame; • define the structure of a buoyant plume and ceiling jet; • list three reasons why plumes are important in fire safety; • explain the impact of walls and corners on flames and plumes; • calculate the temperature and velocity of a fire plume; and • describe the interaction between fires and heat detectors.
	Unit 7: Preflashover Compartment Fires
	After completing this unit, you should be able to: • list five stages in the fire development process; • define the relationship between fuel burning rate and compartment temperature; • calculate the fire gas temperature in a room; • list four heat loss mechanisms in a growing fire; • list five factors affecting the time to flashover in a room; • define a t^2 fire growth rate; and · list five control volumes used to define fire growth in a compartment fire model.

Objectives:	**Unit 8: Postflashover Fires**
	After completing this unit, you should be able to: • list and describe five energy-loss terms important in postflashover fire temperature determination; • define fuel surface and ventilation-limited fires; • calculate the ventilation-limited burning rate and heat-release rate in a postflashover fire; • estimate the postflashover time-temperature curve for a compartment fire; and · define the concept of excess pyrolyzate.
	Unit 9: Smoke Movement
	After completing this unit, you should be able to: • define smoke; • explain how toxic gas production can be determined from a cone calorimeter; • relate visibility to smoke density; • describe five forces which act to move smoke in buildings; • estimate the mechanical ventilation required to maintain a given smoke layer height in an open structure; • describe four smoke control strategies; and • describe the process of smoke spread in a corridor.
	Unit 10: Fire Suppression
	After completing this unit, you should be able to: • define physical and chemical suppression concepts; • explain the fire suppression mechanisms of water, CO_2, and Halon 1301; • list five variables that affect the amount of water required to suppress a fire; • explain the importance of surface tension in the suppression process of AFFF on liquid pool fires; • describe three interactions between a water spray and a burning fuel; • define inerting; • describe the relationship between fire size, sprinkler actuation time, and suppression; • define QRS and ESFR in the context of automatic sprinklers; and • calculate the heat absorption of water in terms of flow rate and heat output of a fire.
	Unit 11: Fire Dynamics Applications to Building Codes and Large Loss Fires
	After completing this unit, you should be able to: • describe three fire growth processes important in the DuPont Plaza Hotel fire; • describe the relationship between burning rate, ventilation, and fire spread in the DuPont Plaza and First Interstate Bank fires; • explain the relationship between building code treatment of fire resistance and postflashover fire behavior;

Objectives:	**Unit 11: Fire Dynamics Applications to Building Codes and Large Loss Fires (cont'd)**
	• describe the importance of flashover in the First Interstate Bank and DuPont Plaza Hotel fires; and • identify shortcomings in the use of occupancy classification as a measure of fire hazard of a building.
	Unit 12: Fire Dynamics and Special Hazards
	After completing this unit, you should be able to: • list four variables which affect spontaneous heating and ignition; • explain why flames in oxygen-enriched atmospheres are hotter than those in air; • list two effects of oxygen-enriched atmospheres on fire behavior; • explain why postflashover fire temperatures in the compartment of origin are lower in ships than in buildings **and** why adjacent spaces reach higher temperatures in ships; • list the factors that affect the pressure rise caused by a compartment fire in a ship compartment; • describe five variables which affect the behavior of wildland fires; • explain how flame arresters work; and • describe the predominant fire spread mechanisms in the King's Cross Underground Fire.
	Unit 13: Fire Modeling and Trends in Fire Dynamics
	After completing this unit, you should be able to: • define physical and mathematical fire models; • list and describe five advantages and limitations of mathematical fire modeling; • explain the differences between zone and field mathematical models; • list three zone-type mathematical fire models; • list three active areas of research in fire dynamics; • describe two trends in mathematical modeling; and • describe five applications of mathematical modeling.
Required Texts:	*Principles of Fire Protection Chemistry*, Raymond Friedman, NFPA. *Fire Dynamics Course Guide;* National Fire Academy, Degrees at a Distance Program.
Supporting References/ Research for Faculty and Students	**U. S. Fire Administration** Publications: http://www.usfa.fema.gov/applications/publications/pubs_main.cfm See Fire Protection, Fire Administration, Fire Service Operations, Wildfire Applied Research: http://www.usfa.fema.gov/dhtml/inside-usfa/research.cfm Research Reports: http://www.usfa.fema.gov/dhtml/inside-usfa/r_reports.cfm Technical Reports: http://www.usfa.fema.gov/applications/publications/techreps.cfm

	Topical Fire Research Series: http://www.usfa.fema.gov/dhtml/inside-usfa/tfrs.cfm Learning Resource Center: http://www.usfa.fema.gov/dhtml/inside-usfa/lrc.cfm **National Institute for Standards and Technology** http://www.fire.nist.gov: Fire Tests/Data, Software/Models, Publications, FIREDOC (under Publications) **References** Society of Fire Protection Engineers: http://www.pentoncmg.com/sfpe/index.html **Current Events/News** http://www.firehouse.com/ http://www.fireengineering.com/ http://www.withthecommand.com/	
Assessment:	Students will be evaluated for mastery of learning objectives by methods of evaluation to be determined by the instructor.	
NFPA Standards Addressed:	**Unit(s)**	**Description**
1033-3-6.5(a)	13	Analytical methods and procedures
Chief Fire Officer Designation Competencies Addressed:	www.cfainet.org This course provides partial fulfillment of CFOD: Competency #11 Life Safety Competency #14 Training Competency #15 Fire Suppression	
Point of Contact:	Edward Kaplan, United States Fire Administration (301) 447-1127, ed.kaplan@fema.gov	