

**FIRE 72 Course Outline as of Fall 2019****CATALOG INFORMATION**

Dept and Nbr: FIRE 72

Title: FIRE BEHAVIOR/COMBUST

Full Title: Fire Behavior and Combustion

Last Reviewed: 9/10/2018

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	3.00	Lecture Scheduled	3.00	17.5	Lecture Scheduled	52.50
Minimum	3.00	Lab Scheduled	0	17	Lab Scheduled	0
		Contact DHR	0		Contact DHR	0
		Contact Total	3.00		Contact Total	52.50
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 105.00

Total Student Learning Hours: 157.50

Title 5 Category: AA Degree Applicable

Grading: Grade Only

Repeatability: 00 - Two Repeats if Grade was D, F, NC, or NP

Also Listed As:

Formerly: FIRE 60A

**Catalog Description:**

Theory and fundamentals of fire ignition, extension, behavior and control. An in-depth study of fire chemistry, fire characteristics of materials, extinguishing and fire control techniques.

**Prerequisites/Corequisites:****Recommended Preparation:**

Eligibility for ENGL 100 or ESL 100

**Limits on Enrollment:****Schedule of Classes Information:**

Description: Theory and fundamentals of fire ignition, extension, behavior and control. An in-depth study of fire chemistry, fire characteristics of materials, extinguishing and fire control techniques. (Grade Only)

Prerequisites/Corequisites:

Recommended: Eligibility for ENGL 100 or ESL 100

Limits on Enrollment:

Transfer Credit: CSU;

Repeatability: Two Repeats if Grade was D, F, NC, or NP

## **ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:**

<b>AS Degree:</b>	<b>Area</b>			Effective:	Inactive:
<b>CSU GE:</b>	<b>Transfer Area</b>			Effective:	Inactive:
<b>IGETC:</b>	<b>Transfer Area</b>			Effective:	Inactive:
<b>CSU Transfer:</b>	Transferable	Effective:	Fall 1981	Inactive:	
<b>UC Transfer:</b>		Effective:		Inactive:	

**CID:**

**Certificate/Major Applicable:**

Both Certificate and Major Applicable

## **COURSE CONTENT**

### **Student Learning Outcomes:**

At the conclusion of this course, the student should be able to:

1. Define basic terms and concepts related to chemistry and fire behavior.
2. Describe the different states of matter, their influence on fire behavior and the chemical processes associated with combustion
3. Describe the properties of fire suppression agents and the techniques used to suppress fires

### **Objectives:**

At the conclusion of this course, the student should be able to:

1. Describe the impact of fire in the United States and the need for fire research agencies
2. Identify the systems of measurement used in the study of fire behavior
3. Describe the different states of matter and their physical and chemical properties
4. Summarize the laws of heat transfer and their hazards
5. Describe the properties of gaseous combustibles
6. Describe the properties of liquid combustibles
7. Describe the properties of solid combustibles
8. Describe the combustion process and their associated products
9. Describe the hazards of smoke, heat and the combustion process
10. Describe how fire gases develop and move in the open and confined spaces
11. Describe the agents used to extinguish fires and the properties that make them effective
12. Describe the principles of wildland fire behavior and the factors that influence their ignition and development
13. Define explosive fire behavior and distinguish between the different types of explosions

### **Topics and Scope:**

- I. Introduction to Fire History
  - A. History of fire
  - B. Natural causes of fire

- C. Fire's impact on society
- D. Fire research
- II. Fire Measurement and the SI Systems of Units
  - A. Length, area and volume
  - B. Mass and density
  - C. Time units
  - D. Force and pressure units
  - E. Energy and enthalpy units
  - F. Power units
  - G. Temperature units
  - H. Conversion factors
- III. States of Matter and Physical and Chemical Changes
  - A. States of matter
    - 1. Characterization of phases
    - 2. Properties of gases
    - 3. Properties of liquids
    - 4. Properties of solids
  - B. Physical and chemical changes
    - 1. Physical changes
    - 2. Chemical changes
      - a. Energetics of chemical change
      - b. Chemical equilibrium and chemical kinetics
- IV. Heat Transfer
  - A. Temperature and heat
  - B. Modes of heat transfer
    - 1. Conductive heat transfer
    - 2. Convective heat transfer
    - 3. Radiative heat transfer
  - C. Hazards from heat transfer
    - 1. Life safety
    - 2. Endurance of structures
- V. Gaseous Combustibles
  - A. Categorization of flames
    - 1. Premixed versus diffusion flames
    - 2. Laminar versus turbulent flames
  - B. Ignition of gases
  - C. Flammability limits and propagation rates of premixed flames
    - 1. Flammability limits
    - 2. Burning velocity
    - 3. Explosions deflagrations and detonations
  - D. Chemical mechanisms of the combustion of gases
    - 1. Elementary chemistry
    - 2. Hydrogen oxidation
    - 3. Pre-mixed methane-oxygen flame chemistry
    - 4. Combustion of larger hydrocarbon fuels
  - E. Specific hazardous classes
    - 1. Hydrogen
    - 2. Acetylene
    - 3. Methane
    - 4. Ethylene
    - 5. Ammonia
- VI. Liquid Combustibles

- A. Ignition of liquids
  - 1. Flash point
  - 2. Fire point
  - 3. Auto-ignition temperature
- B. Burning rates of liquid pools
- C. Flame spread rates over liquid surfaces
- D. Hazards of liquid fuel fires
- VII. Solid Combustibles
  - A. Fire stages and metrics
    - 1. Solids versus gases and liquids
    - 2. Materials and products
    - 3. Pyrolysis
    - 4. Ignition to flaming combustion
    - 5. Ignition to non-flaming combustion
    - 6. Char formation and melting
    - 7. Mass burning and flame spread
  - B. Combustible solids
    - 1. Cellulosic and other natural materials
    - 2. Synthetic polymer materials
    - 3. Fire retardants
    - 4. Composite materials and furnishings
    - 5. Acid-base pairs
    - 6. Metals
    - 7. Exothermic materials
- VIII. Combustion Products
  - A. Smoke aerosols
  - B. Chemical combustion
  - C. Soot formation
  - D. Aerosol soot formation
  - E. Measurement of aerosol yields
  - F. Quantity of smoke particles produced
  - G. Visibility through smoke
  - H. Gaseous combustion products
    - 1. Carbon dioxide and water
    - 2. Carbon monoxide
    - 3. Partially oxidized organic materials
    - 4. Hydrogen halides
    - 5. Hydrogen cyanide
    - 6. Nitrogen oxides
    - 7. Other combustion gases
  - I. Smoke alarms
- IX. Smoke and Heat Hazards
  - A. Hazards of smoke exposure
  - B. Toxicity of prominent gases
    - 1. Carbon monoxide
    - 2. Carbon dioxide
    - 3. Hydrogen cyanide
  - C. Hydrogen Chloride and hydrogen bromide
  - D. Nitrogen oxides
  - E. Organic irritants
  - F. Other toxic species
- X. Movement of Fire Gases

- A. Structure of a fire plum in the open
  - B. Fire plume under a ceiling
  - C. Filling of a fire compartment with smoke
  - D. Smoke flow from a compartment opening
  - E. Smoke movement in a building
- XI. Fire Extinguishing Agents
- A. Categories of fire suppressing agents
  - B. Aqueous agents
    - 1. Water
    - 2. Enhanced water
    - 3. Aqueous foams
  - C. Non-aqueous agents
    - 1. Inert gases
    - 2. Active halogenated agents
    - 3. Dry chemical agents
  - D. Special considerations for fire extinguishment
    - 1. Extinguishment of flowing gas flames
    - 2. Extinguishment of shallow liquid fuel fires
    - 3. Extinguishment of deep liquid fuel fires
    - 4. Ultrafast extinguishment of fires
- XII. Wildland Fire Behavior
- A. The wildland fire triangle
  - B. Modes of heat transfer
  - C. Environmental factors
  - D. Fuel types and factors
  - E. Topography
  - F. Fire weather
- XIII. Explosive Fire Behavior
- A. Causes and types of explosions
  - B. Explosive reaction
  - C. Strength of explosives

### **Assignment:**

- 1. Reading 20 to 30 pages per week
- 2. Research paper
- 3. Classroom group or chat room activities
- 4. Glossary/definition assignment
- 5. One to two group or individual research project(s) and oral or power point presentation(s)
- 6. Quizzes (8 - 10)
- 7. Final exam

### **Methods of Evaluation/Basis of Grade:**

**Writing:** Assessment tools that demonstrate writing skills and/or require students to select, organize and explain ideas in writing.

Research paper, glossary/definition assignment
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Writing 10 - 20%
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**Problem Solving:** Assessment tools, other than exams, that demonstrate competence in computational or non-computational problem solving skills.

Research paper, group presentation

Problem solving  
10 - 20%

**Skill Demonstrations:** All skill-based and physical demonstrations used for assessment purposes including skill performance exams.

Group presentation, group evaluations

Skill Demonstrations  
10 - 20%

**Exams:** All forms of formal testing, other than skill performance exams.

Quizzes, final exam

Exams  
50 - 60%

**Other:** Includes any assessment tools that do not logically fit into the above categories.

Attendance and participation

Other Category  
5 - 10%

### **Representative Textbooks and Materials:**

Principles of Fire Behavior and Combustion. 4th ed. Gann, Richard and Friedman, Raymond. Jones and Bartlett. 2015

Principles of Fire Behavior. 3rd ed, Quintiere, James. Delmar Publishers 2014 (classic)