Masters of Science/Masters of Engineering in Fire Protection Engineering Technology Model Curriculum Content

Society of Fire Protection Engineers

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Recommended Curriculum Content for an MS/ME in Fire Protection Engineering
January 1, 2018

Society of Fire Protection Engineers (SFPE)

INTRODUCTION

This document is intended to provide recommendations for the development of a model curriculum content for a master of science (MS), master of engineering (ME), or equivalent degree in fire protection engineering (FPE). Given current interest in the development of new MS programs in FPE, as well as the desire to maintain existing programs that are state of the art, SFPE offers this document as a helpful guideline. The document is written in a broad fashion in an attempt to offer the most versatility. While there are key core topics that should be required, this document is not intended to imply that there is only one specific or narrow approach to the development of such programs. Multiple topics may be covered within an individual course or series of courses.

OBJECTIVES

Technical skills

Students should have the technical knowledge and skills needed to practice fire protection engineering locally, nationally, and internationally in a variety of modern professional settings utilizing fire safety codes and regulatory standards. Students should be able to analyze flammability characteristics of materials, understand and utilize fire dynamics, predict human behavior in fire conditions, conduct a performance-based design, and should be able to assist in the design of egress, fire detection, suppression, smoke control, and alarm systems. It is important to also be aware of emerging trends and issues that impact any of the above listed areas.

Critical thinking

Students should have the capacity to apply the existing body of knowledge through critical analysis of specific problems and issues in the field of fire protection engineering. Students should be able to identify relevant fire safety codes, standards, and regulations; comprehend the fire safety performance objectives and criteria associated with these documents; and apply these fire safety objectives and criteria to a broad range of applications. Students should be able to use critical thinking to perform comprehensive fire and life safety evaluations of buildings and other structures through application of the knowledge, skills, and tools acquired in the program, including performance-based design analysis for buildings or structures that do not fit into traditional codes.

Communication (Written and Verbal)
Students should have the ability to understand and communicate societal, environmental, economic, and safety implications of fire protection engineering decisions on the local and global communities. Students should be able to clearly communicate scientific ideas, analyses, and conclusions, both orally and in writing, to a range of audiences using a variety of forms. Students should respond effectively to cultural communication differences. Students should understand the preparation and presentation competencies necessary for oral communication in a variety of contexts, as both a speaker and a listener, and be able to synthesize and analyze written text. Students should have proficiency in utilizing standard forms of writing and grammar for a variety of audiences that interact with fire protection engineers.

Teamwork and Interdisciplinary Collaboration
Students should have the ability to conduct inter-professional learning and be prepared for deliberatively working together with the common goal of completing activities in the fire protection engineering field. Graduating students should be able to work with members from many professions, collaborating and communicating closely to solve problems and complete designs in the fire protection engineering field.

Ethics
Students should appreciate the need to practice ethically and to practice engineering with integrity and responsibility. Students should demonstrate understanding of the ethical principles in general, in application of specialized knowledge, in results of research, in creative expression, and in design processes. Students should be able to identify and analyze ethical issues in real-world fire protection engineering situations and practices, be able to articulate what makes a particular course of action ethically defensible, be able to assess their own ethical values, and be able to identify/evaluate ethical concerns in research and intellectual contexts.

Lifelong Learning
Students should appreciate the need to maintain continual professional competency, recognize the complexity and breadth of engineering knowledge required in professional practice, and thus appreciate the need for engagement in life-long learning. Students should demonstrate the ability to incorporate self-regulated learning in maintaining their skills. Students should recognize how autonomy and self-management occur in the fire protection engineering workplace where there is a constant need to learn and stay abreast of current developments in the field.

COURSE OVERVIEW
Potential students for an MS program in FPE include students with a BS in FPE as well as students with a BS in another engineering or science discipline. In either case, students should be required to have general core engineering courses as outlined in Reference No. 1 before they are admitted into the program, or concurrent be enrolled in other program courses that are required as a prerequisite.

Certain key core courses should be required unless previously taken at the undergraduate level. Options should also be available that include both broad and focused courses to allow a variety of course selection and prevent repetition of previous courses taken, particularly for those students whose prior education included a BS in FPE. Graduate students, such as those trying to advance themselves in an existing career, may desire to select specific courses to allow for a focused specialization. Course selection should be such that the core topics in Table 1 are covered, with the option for specialization in areas such as those outlined in Table 2.

While various specializations may be offered based on the expertise of the program and faculty, it is recommended that students be exposed to coursework that includes basics through applications into project-based courses that assimilate this learning.
Thus, courses may be broken down as follows:

a. **Core courses**. Table 1 provides a list of core topics that each student should be required to complete. These topics may be covered in two to four courses as determined by the program.
b. **Application courses**. Table 2 includes a list of additional topics that will allow a more focused study of some of the key items that are introduced in the core courses. Importantly, these courses will require students to ***apply*** basic engineering concepts to more detailed FPE problems.
c. **Design courses.** The topics listed in Table 2 may also be combined to develop a design-centric course or series of courses where all of the application knowledge is further assimilated through a detailed design solution in a project-based course or through thesis credit for an academic master's project.

DEGREE REQUIREMENTS

This guideline is intended to cover a full master's degree program and not a professional development program. It assumes the student successfully completes a minimum of 30 credit hours of required coursework. A credit hour is the basic unit of measure for college credit used to measure the relative weight of a given course toward the fulfillment of a degree. Each credit hour is usually represented by 14 contact hours. A contact hour is usually represented by one hour of class per week, per semester. Additional time — including that for homework, projects, research, or other studies — would amount to 120 and 180 hours per course.

Courses that have classroom and laboratory requirements often receive additional credit.

Depending on the requirements of the individual college or university, a project or master's thesis may be:

1. Required or
2. Allowed to be substituted for an equivalent number of credit hours of coursework in either a capstone design course or series of design courses (e.g., degree project in FPE in Table 2).

Crediting methods will vary from one academic system to another, so appropriate adjustments should be made considering the above. Although individual course titles may vary, all core topics should be collectively covered within them. Course content may vary for the same general subject depending on the area of specialization and target career path.

Individual colleges and universities may allow the following depending on their individual requirements:

1. One or more elective courses outside the fire protection curriculum may be chosen if it relates to the student's area of study. These courses may be useful in providing more detailed scientific understanding of principles, theories, or techniques that can be incorporated into FPE applications and designs.
2. Some course requirements should be in core areas and others may be in specialized areas.

REFERENCES

1. *"Recommendations for a Model Curriculum for a BS Degree in Fire Protection Engineering (FPE),"* SFPE, December 15, 2017. Can be found at: http://www.sfpe.org/Portals/sfpepub/100415%20SFPE%20BS%20Model%20Curriculum%20-%20Final%20Draft.pdf.
2. "A Proposal for a Model Curriculum in Fire Safety Engineering," *Fire Safety Journal,* March, 1995.
3. "*Modular Approach to the Subject of Fire Safety Engineering,*" D.J. Rasbash, University of Edinburgh Dept. of Fire Safety Engineering.
4. "*Survey of Fire Protection Engineering Education Activities,*" John M. Watts, Jr., Ph D, Fire Safety Institute, December, 1985.
5. "The Path Forward: The Future of Graduate Education in the United States," Educational Testing Service, April 2010.

Table 1 – Core FPE Topics

Topic	Subject Information
Fire Dynamics and Fire Chemistry	The objective is to understand the various stages of fire, provide a knowledge base concerning the different methods and techniques applied in the analysis of a fire sequence, and develop ability to critically examine those methods in terms of practical application. Fire chemistry may be taught within a fire dynamics course to provide further background knowledge regarding combustion reactions and heat transport. Collectively, information should increase FPE-related skills.
Fire Risk/Hazard Analysis	The objective is to provide knowledge in the areas of probability and statistics; the concepts, tools, and methods of hazard assessment and risk analysis; and the use and application of these in fire-related scenarios. A general understanding of how fire impacts people (including egress and human behavior), property, and society as a whole should be provided.
Design Methodology	The objective is to provide knowledge regarding development of fire safety engineering solutions using both prescriptive- and performance-based design methodologies from first principles to achievement of fire performance objectives. Requires skills developed from previous fundamental fire safety engineering coursework. Various levels of design and consequences should be discussed as well as the specification of all key parameters that are the basis for the performance-based design.
Building Fire Safety	The objective is to provide a general understanding of building fire protection, code, and standard concerns and may include fundamental concepts of equivalencies and/or performance -based design.
Fire Protection Systems	The objective is to provide a general understanding of fire mitigation, including water- and non-water-based suppression, detection systems, fire modeling, fire testing, and code and standard concerns.

Table 2 – Additional "Application" Focused Topics or Courses

Topics	Objectives
Fire Modeling	The objective is to provide knowledge of zone and field (CFD) models, including the technical basis for enclosure fire model elements, the limitations of computer-based fire models, and the use of current computer-based fire models for practical FPE problems.
Fire Testing	The objective is to provide knowledge of test apparatus, methodologies, processes, and data analysis related to fire hazards and flammability assessment methods for engineering and research.
Water-Based Suppression	The objective is to provide knowledge of fundamental principles, design criteria and installation requirements for water-based fire suppression systems, including classification of occupancy hazards to establish the proper sprinkler design criteria, the design of sprinkler and mist systems for the specific construction features and occupancy involved, and the effects of various forms of heat transfer and oxygen displacement characteristics relating to water-based suppression.
Special Hazards Non-Water-Based Suppression	The objective is to provide knowledge of fundamental principles, design criteria, and installation requirements for non-water-based fire suppression (including clean agent, halon, carbon dioxide, inert gas, dry chemical, and foam fire-suppression agents) used in total flooding, direct application, and explosion suppression.
Detection, Alarm, and Smoke Control	The objective is to provide knowledge of fundamental principles, design criteria, and installation requirements for fire detection, occupant notification and smoke control systems, including how to analyze, evaluate, and specify these systems. Computer-based analysis of detection systems/techniques.
Explosion Prevention and Protection	The objective is to provide knowledge related to deflagrations and detonations and methods used to prevent ignition and limit the effects of deflagrations, including explosion suppression systems, pressure-resistant and pressure-relieving construction, and BLEVE theory and prevention.
Structural Fire Protection	The objective is to provide knowledge regarding the impact of fire exposure on materials used in construction assemblies, the role various construction features play in the fire resistance of the assembly, the application of mechanics and heat transfer engineering principles, and the use of computer-based analysis of structures exposed to fire.
Fire Investigation	The objective is to provide knowledge of fire investigation with regard to gathering and interpreting fire scene evidence; utilizing laboratory forensic testing; researching related codes, standards, and technical reports and re-construction of the fire scenario with physical and numerical models.
Fire Protection Related Codes and Standards	The objective is to provide knowledge of the use and application of building codes and related reference standards, including for both active and passive fire protection. This topic may be covered within another separate course.

Egress and Life Safety Analysis	The objective is to provide knowledge of human behavior in fire, including physiological and psychological response, decision-making and movement, and approaches, tools, and methods to integrate this knowledge with knowledge gained from other courses to evaluate life-safety issues in the event of fire. While a basic knowledge may be provided within several other separate courses, focused applications-level course work is helpful for those students who will design egress systems, including special situations using performance-based designs with complicated occupancies that potentially modify human behavior.
Storage and Transportation of Hazardous Materials	The objective is to provide knowledge of the handling, transportation, and storage of hazardous materials including limitations of amounts stored, determination of needed separation distances, and proper identification. Such information may be of particular interest to those who would work in public service or are responsible for public transportation of such materials.
Fire Risk Management	The objective is to provide knowledge of risk management concepts (avoid, accept, mitigate, transfer) and associated strategies and of the application of these concepts and strategies during facility design and operation so that processes, equipment, and storage can be located and managed so as to minimize risk of unacceptable loss.
Management of Wildland-Urban Interface fires	The objective is to provide knowledge regarding technological, economic, social, and political issues affecting fire management in the interface of wildlands and urban areas. Includes related codes and standards, fire risk analysis, evacuation, and incident-response planning.
Industrial Fire Safety	The objective of this course is to use principles of fire dynamics, heat transfer, and thermodynamics combined with a general knowledge of automatic detection and suppression systems to analyze fire protection requirements for generic industrial hazards. Topics covered include safe separation distances, plant layout, hazard isolation, smoke control, warehouse storage, and flammable liquid processing and storage. Historic industrial fires influencing current practice on these topics can also be discussed.
Consequence Analysis	The course will provide an introduction to the field of consequence estimations within the FPE operational field. It will also form a valuable complement to the fire risk analysis course insofar as the consequences of undesirable leakages of gases and liquids are concerned.
Risk-Based Land Use Planning	The course will provide the FPE with sufficient knowledge to allow him/her to collaborate at an early, strategic stage in the planning process so that risk analyses can be included and used to create a base where the objective is a robust and sustainable society.
Degree Project in Fire Safety/ Fire Protection Engineering	The aim of the degree project is to allow the student to develop and demonstrate the knowledge and skills required to work independently as a fire engineer by acquiring new knowledge, applying this and the knowledge previously acquired to a problem in fire protection engineering, and resolving it independently and in a manner conducive to good engineering practice.