Fire University of Warsaw, Poland
Faculty of Security Engineering and Civil Protection
Syllabus 2018 -

Introduction to fire modeling

profile	general academics
degree	first degree
programme	ERASMUS
semester	1
part time / full time	full time
ECTS	5
coordinator	mł. bryg. dr inż. Piotr Tofiło

form of the activity: exercise

hours	30
prerequisites	General mathematical and calculational skills
objectives	Learning how to solve fire modelling problems using approaches of varying complexity, focusing mostly on efficient use of fire engineering correlations
methods	Working with the teacher towards the solution of a problem on a blackboard.
own work	Solving homework problems. Analysing the textbook problems.
basic literature	Karlsson and Quintiere - Enclosure Fire Dynamics
supplementary literature	

contents	hours
Learning to solve problems involving elements of fire dynamics, smoke control, fire suppression, structural fire protection, fire chemistry, heat transfer. Other skills trained are: selecting design fire scenarios in the context of fuel controlled fires and ventilation controlled fires. Learning to use zone modelling and CFD modelling.	30

form of the activity: exercise

hours	30
prerequisites	Achieving learning outcomes in the following areas: basic laws of physics, elements of combustion physicochemistry, and thermodynamics and fluid mechanics.
objectives	The aim of the subject is to familiarize students with the basics of the dynamics of fire development in a room and building, taking into account elements of hazard (fire) modeling.

methods	Informative lecture with multimedia presentation (films illustrating selected issues, slides, computer simulations).
own work	Study of the subject literature, detailed familiarization with the problems presented during the lecture, preparation for exercises and the examination.
basic literature	1. Drysdale D.: An Introduction to Fire Dynamics, Wyd. Wiley, 1986 i wyd. późniejsze. 2. Karlsson B, Quintiere J.G., Enclosure Fire Dynamics, CRC Press, 2000.
supplementary literature	1. SFPE Handbook of Fire Protection Engineering, NFPA, Massachusetts.

contents	hours
Fire theory in fire safety engineering. Definitions of such concepts as: low- and high-temperature fire environment, fire characteristics of materials, fire state parameters. Heat exchange mechanisms in an internal fire environment - conduction, radiation, convection, determination of heat fluxes and temperature distribution. Bernoulli's principle. Movement of gases in fire conditions in a building. Determination of hydrostatic pressure differences and gas velocities. Basic mechanisms of smoke spread in a building - chimney drafts, wind impact.	5
Fire parameters (characteristics) of materials. Mass burning rate and specific mass burning rate. Dependence of specific mass burning rate on time for fire in a room and in an open space. Influence of mass burning rate on the rate of wood charring. Basic equation of flame spread over materials. Thermal inertia of materials and fire dynamics. Fire surface and combustion surface. Fire power (heat release rate, HRR) and fire power density. Methods for determining HRR. Examples of fire power course over time - furniture. Fire classification according to ISO. Fire "t2". Influence of extinguishing actions on fire intensity.	5
Structure of fire in a room. Definitions of fire zones. Fire hazard factors related to fire zones. Combustion zone - average flame height, flame deflection under the ceiling of the room. Characteristics of the axisymmetric convective column of fire. Interaction of the convective column with the boundaries of the room - parameters of the ceiling stream. Time to activate the thermal detector. Zone of thermal radiation influence - model of the radiation stream from the flame. Smoke zone. Changes in the range of visibility during the fire.	5
Changes in gas concentrations (oxygen, carbon monoxide, hydrogen cyanide) during a room fire. Gas exchange in a room with two small holes and a door opening - determining the flows of gases flowing out and air flowing into the room. Gas exchange in the room during a fire until extinguished.	5
Basic conditions for the transition of combustion to the fire development phase (phase I). The course of fire development in a room. Fire phases. Characteristics of combustion rate and heat generation during a fire. Fuel-controlled fire, ventilation-controlled fire. Influence of various factors on fire dynamics. Heat release rate in phase I, phase II of a fire and in the ventilation opening of a room. Emissions of combustion products. Principles of conservation of mass, component and energy.	4
Nonlinear phenomena of an internal fire – flashover and backdraft. Symptoms, mechanisms and threats from flashover and backdraft. Examples of real fires with these effects – analysis of the course. Influence of changes in ventilation and extinguishing on the power of poorly ventilated fires. Methods of preventing flashover and backdraft and also avoiding the effects of these effects. Similarities and differences between both effects.	3
Scientific theory and modelling. Division of fire models, definitions and modelling objectives. Physical and mathematical models. Deterministic modelling – zone and field. Assumptions and examples of analytical fire models. Fundamentals of fire zone modeling - assumptions, model equation system. Computer programs based on zone models (ASET, CFAST). Examples of modeling applications for calculating fire parameters.	3