Module Title: Fire Dynamics

Module Code:	FIRD CC801
Credits:	10
Credit Level:	8
Prerequisite Modules:	None

Timetabled Hours per Week	
Lectures	**4**
Tutorials	
Lab/Studio/Practicals	**2**
Independent Learning	**7**
Total	**13**

Description:

This module will provide the learner with the essential theoretical scientific concepts of fire dynamics. The objective will be to further develop the learners' understanding of fire, its development spread and impact. The learner will be provided with detailed tools to assist in the practical applications of fire safety to building construction. Additionally the learner will be provided with the essential theoretical scientific concepts of fire science via the application of practical experiments. Finally the learner will gain valuable insight and practical experience of various fire parameters.

Module Learning Outcomes:

On successful completion of this module the learner will be able to:

1. Apply concepts and knowledge to the solution of technical issues related to fire.
2. Undertake quantitative analyses of compartment and building fires.
3. Assess the factors influencing enclosure fire development, spread and resulting severity.
4. Analyse the yields, toxicity and thus the impact of combustion products.
5. Explain how a fire initiates, develops and impacts on elements within an enclosure.
6. Appraise qualitatively the limitations of the applied equations.
7. Evaluate the impact of enclosure characteristics on the resulting fire intensity. Undertake practical materials fire tests.
8. Analyse the results from practical fire tests and examine qualitatively limitations of practical fire testing.
9. Evaluate qualitatively and quantitatively the underling theoretical principles, basic features and applicability of the materials fire tests undertaken

Indicative Content:

1. **Compartment Fires:**
   Combustion: laminar and turbulent. Stages of fire development, Fire induced flows, Compartment flow dynamics, Single room fire analysis. Growth period, Growth rates, Conditions for flashover, Growth factors Smoke temperature, Burning regimes. Practical applications including limitations (Qualitative). Pressure Profiles and Vent Flows.

2. **Flame Spread:**
   Review of Pilot and auto-ignition, Flame Spread on solid & liquid surfaces(including surface orientation and direction of propagation. Geometry of sample & environmental effects. Qualitative and Quantitative examples.

3. **Energy Release Rates:**
   Definitions & Theory, including steady burning of liquid and solid fuels, Energy Release Rates, Fire Growth Rates. Design fires, Practical examples. Qualitative description of limitations of approaches.

4. **Fire Plumes:**
   Overview of relevant theory including: Turbulent Fire Plumes, Flame Height, Fire Plume theories. Quantification methods and practical applications including limitations. Special cases. Ceiling and wall jets. Radial flame extensions.

5. **Gas Temperatures:**
   Review of the definitions & concepts. Measurement. Pre-flashover and post flashover design approaches. MQH correlation including variations. Energy release rates for flashover. Quantitative post flashover techniques.

6. **Heat Transfer:**
   Review of the definitions & concepts, forms of heat transfer, application of equations for steady state and transient conduction problems, convection (free & forced) & radiation (incl. shape & view factors). Quantitative examples.

7. **Pressure flows and vent profiles:**
   Terminology and simple examples. Pressure profiles of room with a vent. Well mixed case.

8. **Combustion Products:**
   Fuel Chemistry, Conservation equations for species, Estimating yields, Predicting species concentrations in compartment fires. Toxicity.

10. Laboratory Practicals:

A series of laboratory experiments will be carried out to provide practical experience and assessment of various fires, hot gas & smoke parameters. These practicals will be conducted under the following general headings:-

- Plume Theories.
- Ignition & combustion: Including small-scale ISO experiments, piloted & spontaneous ignition, non-combustibility.
- Fire growth: Including flame spread, impingement, heat release, fire severity/compartment fires (small scale), burning rates, flame heights.
- Fire spread:
- Combustion products: Combustion gas analysis, Stoichiometric efficiency, oxygen index
- Toxicity and corrosivity.
- Smoke analysis: including optical density.

The practical experiments will be coordinated so as to coincide with the concurrent theoretical elements of the module for optimum benefit.

Module Assessment:

Coursework	40 %
End of Semester Final Exam	60 %

Learning Outcome	Addressed by	
	Coursework	**End of Semester Final Exam**
1	x	x
2	x	x
3	x	x
4	x	x
5	x	x
6	x	x
7	x	
8	x	
9	x	

End of Semester Final Examination

Final Written Examination: The final written examination will be 3 hours in duration. It will comprise 7 questions of which the learner should attempt 5 questions.

Continuous Assessment:

The learner will be normally required to submit six laboratory reports, all with equal weighting.

The learner will be required to submit one additional assignment.

The continuous assessment shall have the following weightings:

Assignment Number and Topic	Weighting
Laboratory reports	35%
Assignment 1	5 %

Details of the nature of assessment and submission dates are contained in the annual Programme Assessment Schedule.

Resources:

Note: Learning resources will also be available on Blackboard.

Essential Reading				
Author	**Year**	**Title**	**Publisher**	**ISBN**
Buchanan, A H	2001	*Structural Design for Fire Safety**	John Wiley & Sons, LTD	0 471 89060 X
Karlsson, B & Quintiere, J G	1999	*Enclosure Fire Dynamics**	CRC Press	0 8493 1300 7
Supplementary Reading:				
Cengel, Y A	2007	*An Introduction to Thermodynamics 2nd Ed**	McGraw-Hill	0073380172
Drysdale, D	2011	*An Introduction to Fire Dynamics* 3rd Ed	John Wiley & Sons, LTD	978-0470319031
BSI	1970 - Present	*BS 476. Fire Tests on Building Materials & Strictures Part 1 – 33*	BSI	N/A
International Organisation for Standardisation	1973 - Present	*ISO Fire (Resistance) Tests .e.g. 834, 1182,1716, 3008, 3009, 5657, 5925, 6944:*	International Organisation for Standardisation	N/A
Society of Fire	2016	*SFPE Handbook of Fire*	Society of Fire	978-1493925643

Protection Engineers/NFPA		*Protection Engineering 5th Ed*	Protection Engineers/NFPA	
Friedman, R	1998	*Principles of Fire Protection Chemistry and Physics 3ed Ed**	NFPA	0 87765 440 9
Charted Institution of Building Service Engineers	2010/ 2012	*Fire Engineering Guide E 3rd Ed (With 2012 corrections)*	Charted Institution of Building Service Engineers	0 978 1 906846 13 8
Quintiere, J G	1998	*Principles of Fire Behaviour**	Delmar	0 8273 77320

*preferred text

Other Resources

www nist.gov

LYIT Engineering Database