London South Bank University

FESBE - Department of Engineering Systems

UNIT GUIDE: 2007/2008

Thermofluids 1

DTF-1-101

Unit Title	Thermofluids 1
Unit Reference Number	DTF-1-101
Level	1
Credit Value	1
Subject Area	Environmental, Energy and Building Services Eng.
Student Study Hours	150
Teaching Contact Hours	36
Pre-requisites	None
Assessment Method	70% written exam and 30% coursework
Unit coordinator	Prof J.F. Missenden x7676
Teaching Team	Prof J.F. Missenden x7676 Dr F. Ampofo x7013
Courses	HND, BSc, BEng (Hons) in Building Services Engineering, and BEng (Hons), MEng in Mechanical Engineering and Mechatronics

INTRODUCTION

This is a basic and fundamental course, which introduces the concepts and governing principles in Thermodynamics and Fluid Mechanics. An introduction to aspects of Heat Transfer is also provided.

AIMS

To convey the principles of material properties from the standpoint of equilibrium thermodynamics, introducing thermodynamic laws for ideal and real substances and systems. To teach the fundamental concepts of fluid flow and introduce the basic aspects of heat transfer.

LEARNING OUTCOMES

The student should be able to:

Apply the laws of Thermodynamics and Fluid Mechanics to engineering systems and make calculations and evaluate systems' performance.

Analyse from first principles the performance of a thermodynamic system or a fluid flow situation.

Make realistic calculations and analyse the contribution of the various heat transfer mechanisms in a given physical situation.

KEY AND COGNITIVE SKILLS

The student shall develop the following:

An appreciation of heat and work, and their relationship in various thermal processes.

An understanding of basic laws governing energy and its conservation, and the production of power.

An understanding of basic laws governing fluid flow and heat transfer.

The use of basic skills to carry out calculations with simple thermo-fluids and heat transfer systems.

THE PROGRAMME OF TEACHING LEARNING AND ASSESSMENT

This unit will be taught over two semesters, using a mixture of formal lectures, handouts, tutorial sheets and directed reading.

Syllabus

The syllabus for this unit is for the most part common for both Ing and CEng courses. Any differences on content or emphasis are indicated.

Thermodynamics

Dimensions and units. Definitions of and properties of a fluid. Work and heat. Thermodynamic state, intensive and extensive properties and the two property rule. Closed and open thermodynamic systems, paths and cycles. The zeroth law.

State equations for ideal gases from Boyle's and Charles' laws. Specific gas constant, universal gas constant and corrections for real gases. Specific heat capacities. Pressure/volume relationships for isentropic and real processes. Work done by/on a fluid.

Phases of real substances. Diagrams with pressure, volume, temperature and enthalpy. triple and critical point. Enthalpy of phase change.

Energy, its thermodynamic form and the first law for a non-flow process. Non-steady and steady flow energy equation and applications.

Reversibility and irreversibility of natural processes. Entropy as a property and the second law. Thermo-dvnamic cycles and that due to Carnot.

Gaseous mixtures, Gibbs-Dalton Law and Avogadro's Hypothesis. Basic Psychrometry.

Fluid Mechanics

Fluid properties: pressure, absolute, potential, static and dynamic pressures. Viscosity and Newton's Law. Compressibility and surface tension. Fluid Statics.

Equations for mass and energy continuity, Bernoulli's Equation and friction losses. Relationship with the steady flow energy equation. Analysis of systems and hydraulic gradients.

Methods of measurement of fluid flow and velocity, Pitot tube, Pitot-static tube Orifice and Venturi meters, manometric calculations.

Flow of fluid within a tube or duct, flow regimes, and the Reynolds number.

Application to air and water flow systems and simple pipe and duct pressure loss prediction. Darcy's formula and friction factor variation. Abrupt contraction/enlargement, Entry and exit losses and losses in bends and fittings.

Basic Heat Transfer

Fourier equation and application in steady one-dimensional cases. Composite structures, Resistance and overall heat transfer coefficient.

Convection. Heat transfer by convection, simple convective coefficient, equation and resistance contribution. Relative magnitudes of convection rates in practical cases.

Electromagnetic radiation, the black body and the Stefan-Boltzmann constant. Emissivity, absorptivity, transmissivity, reflectivity and the grey body. Simple shape factors.

Composite problems involving several modes of heat transfer.

WEEKLY TEACHING AND LEARNING PROGRAMME

Week 1	Introduction to Thermofluids. Basic concepts. Thermodynamic system, state and processes.
Week 2	Dimensions and units, definitions and properties of a fluid.
Week 3	Heat, work, zeroth law.
Week 4	Pressure, absolute, gauge, potential, static and dynamic. Fluid statics.
Week 5	State equations, relevant parameters for ideal gases, real gases.
Week 6	Dimensional analysis.
Week 7	Energy, its thermodynamic forms, and first law for non-flow processes.
Week 8	Model testing.
Week 9	Ideal and real processes, work done on/by fluids.
Week 10	Continuity, Bemoulli's Equation and frictional losses.
Week 11	Phases of real substances. Use of diagrams and tables for calculations of single and two-phase properties.
Week 12	Methods of fluid flow and velocity measurement.
Week 13	First law applied to a flow process. Applications of unsteady and steady flow energy equations.
Week 14	Flow in a tube or duct, flow regimes and the Reynolds number.
Week 15	Thermodynamic systems, heat engines, refrigerators, concepts of irreversibility, efficiency. Camot gas and vapour cycles.
Week 16	Air and water flow systems and simple pipe and duct pressure loss prediction.
Week 17	Second Law, Kelvin-Plank Statement, Clausius and Corollaries.
Week 18	The basic momentum equation.
Week 19	Entropy, T-ds relations, isentropic efficiency and applications.
Week 20	Introduction to modes of heat transfer. Conductive heat transfer.
Week 21	Mixtures of ideal gases.
Week 22	Convective heat transfer.
Week 23	Introduction to psychrometry.
Week 24	Radiative heat transfer.
Week 25	Review and revision.

ASSESSMENT PROGRAMME

Assignments will be set and weighted at 30%.

A three-hour examination will be set for 70% of the assessment.

In order to pass the unit a student must achieve a minimum mark of 30% in the coursework and examination and an overall aggregate, after weighting, of 40%.

LEARNER SUPPORT MATERIAL

Core

Eastop, T. D. and McConkey, A., Applied Thermodynamics for Engineering Technologists, Longman, 1995.

McGoven, J.A., The Essence of Engineering Thermodynamics, Prentice Hall, 1996.

Massey, B.S. Mechanics of Fluids, 7th ed. Stanley Thornes Ltd, 1998.

Rogers, G. and Mayhew, Y. Thermodynamics and Transport Properties of Fluids, 5th ed. Blackwell, 1995.

Optional

Marquand, C. and Croft, Thermofluids, 1994.

Rogers, G. and Mayhew, Y., Engineering Thermodynamics, Work and Heat Transfer, 4th ed. Longman, 1992.

Henderson, R. Schmidt, F. and Wolgemuth, C., Introduction to Thermal Sciences, 2nd ed. Wiley, 1993.

Vennard, J.K. and Street, R.L., Elementary Fluid Mechanics, Wiley, 1982.