ES4D9-15 Heat Transfer Theory and Design

23/24

Department
School of Engineering
Level
Undergraduate Level 4
Module leader
Evgeny Rebrov
Credit value
15
Module duration
10 weeks
Assessment
40% coursework, 60% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES4D9-15 Heat Transfer Theory and Design

Module web page

Module aims

To provide a knowledge of heat transfer that is of vital importance in many industrial sectors from process industries, through vehicles, etc., power plant, to building technology.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

The theoretical background to heat and mass transfer by conduction, convection, radiation, condensation and boiling is given. The design applications developed concentrate on more realistic mixed mode or complex heat transfer, e.g. fins (heat sinks for electronic components, compact heat exchangers), flat plate solar collectors, heat exchangers.

Introduction: Problems in heat transfer.

Convection: Continuity, momentum, energy equations as applied to boundary layers. Laminar and turbulent flow. Dimensional analysis. Forced convection heat transfer and pressure drops: in tubes, across tube banks, on flat plates. Natural convection.

Conduction: Steady state conduction. 2-D and 3- D conduction with heat generation. 1- , 2 and 3-D transient conduction.
Mixed conduction and convection - fin effectiveness.

Radiation heat transfer.

Condensation, boiling and sublimation heat transfer.

Applications:
Heat exchangers. Heat exchanger types. LMTD and E-NTU design methods. Heat exchanger design optimisation.
Mixed radiation and convection - flat plate solar collector. Heat pipes. Building heat transfer.

CAD methods in heat transfer design - introduction about the role of numerical modelling techniques in heat transfer design and overview of some frequently used commercial software packages.

Learning outcomes

By the end of the module, students should be able to:

- Apply comprehensive knowledge of the basic heat transfer processes.
- Critically examine the roles of numerical techniques in conceptualizing heat transfer designs, and interpret the usefulness of frequently used commercial software packages
- Autonomously evaluate heat transfer rates using correlations of non-dimensional groups, complex analytical techniques or numerical techniques.
- Autonomously model real-life processes for the purposes of approximate calculation.
- Evaluate the compromises between effectiveness and cost inherent in the design optimisation of heat transfer equipment.

Indicative reading list

1. Introduction to Heat Transfer by Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, John Wiley & Sons; 6th Edition (14 April 2011)
2. Heat Transfer by Jack P. Holman, McGraw-Hill Higher Education; 10th edition (1 May 2009).
3. Heat Exchangers. Selection, Rating, and Thermal Design, by Sadik Kakac, Hongtan Liu, and Anchasa Pramuanjaroenkij, CRC Press, 3rd Edition (1 March 2012)
4. Foundations of Heat Transfer: International Student Version by Frank P. Incropera, David P. DeWitt, Theodore L. Bergman and Adrienne S. Lavine, John Wiley & Sons; 6th Edition International Student Version edition (27 April 2012).
5. The Engineering Databook, Engineering Student Office, School of Engineering, University of Warwick.
6. Thermodynamic and Transport Properties of Fluids: S. I. Units, by G. F. C. Rogers and Yon

R. Mayhew, Wiley-Blackwell; 5th Edition (27 Nov 1994, reprinted: 2004).

Subject specific skills

Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality
Ability to seek to achieve sustainable solutions to problems and have strategies for being creative and innovative

Transferable skills

Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions
Overcome difficulties by employing skills, knowledge and understanding in a flexible manner
Apply problem solving skills, information retrieval, and the effective use of general IT facilities

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Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Supervised practical classes	2 sessions of 1 hour (1%)
Private study	118 hours (79%)
Total	150 hours

Private study description

118 hours private study

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D9

	Weighting	Study time
Coursework assignment	40%	

The coursework assigment includes a set of theoretical questions to be answered via an on-line computer quiz (10%), a set of practical problems (20%) and a design problem (10%).

Online Examination	60%	

2 * 1 hour QMP online tests to be scheduled in the same time slot with short break in between

~Platforms - AEP,QMP

- Online examination: No Answerbook required
- Students may use a calculator
- Engineering Data Book 8th Edition

Feedback on assessment

- Feedback via written and verbal comments on the assignment;
- The publication of solutions to past examination papers;
- Worked examples in examples classes;
- Student support through advice and feedback hours;
- Cohort level feedback on examinations.

Past exam papers for ES4D9

Availability

Pre-requisites

N/A

Courses

This module is Core for:

- Year 1 of TESA-H341 Postgraduate Taught Advanced Mechanical Engineering

This module is Optional for:

- Year 4 of UESA-H116 MEng Engineering with Exchange Year
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year
- RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics
  - Year 1 of H6P9 Wide Bandgap Power Electronics (EngD)
  - Year 2 of H6P9 Wide Bandgap Power Electronics (EngD)

- Year 1 of TESA-H642 Postgraduate Taught Energy and Power Engineering
- TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies
  - Year 1 of H1A0 Sustainable Energy Technologies
  - Year 2 of H1A0 Sustainable Energy Technologies

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering
- UESA-H311 MEng Mechanical Engineering
  - Year 4 of H311 Mechanical Engineering
  - Year 4 of H30L Mechanical Engineering with Automotive Engineering
  - Year 4 of H30G Mechanical Engineering with Business Management
  - Year 4 of H30P Mechanical Engineering with Fluid Dynamics
  - Year 4 of H30K Mechanical Engineering with Instrumentation
  - Year 4 of H30M Mechanical Engineering with Robotics
  - Year 4 of H30H Mechanical Engineering with Sustainability
  - Year 4 of H30N Mechanical Engineering with Systems Engineering
- Year 4 of UESA-H316 MEng Mechanical Engineering
- Year 4 of UESA-H318 MEng Mechanical Engineering with Exchange Year
- Year 5 of UESA-H317 MEng Mechanical Engineering with Intercalated Year
- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering
- Year 1 of TESA-H642 Postgraduate Taught Energy and Power Engineering