COURSE DESCRIPTION CARD - SYLLABUS

Course name
Heat and Mass Transfer [N2IŚrod2-ZwCKiOP>WC]

Course

Field of study
Environmental Engineering

Year/Semester
1/1

Area of study (specialization)
Heating, Air Conditioning and Air Protection

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
16

Other (e.g. online)
0

Tutorials
16

Projects/seminars
0

Number of credit points

6,00

Coordinators

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Lecturers

Prerequisites

1.Knowledge: Mathermatics: differential and integral equations and their solutions. Physics: thermodynamics, fluid mechanics at level 6 PRK. 2.Skills: Application of differential and integral equations for description of physical phenomena, solution of differential equations. Thermodynamicsand fluid mechanics: analysis of thermodynamic and fluid flow problems problems, performing of measurements and investigations. 3.Social competencies: Awareness of the need of permanent updating and supplementing knowledge and engineering skills.

Course objective

Extension of knowledge and skills of heat and mass transfer calculations and measurement of heat fluxes appearing in build and natural environmental engineering

Course-related learning outcomes

Knowledge:

1. Student has a wider knowledge and calculation skill concerning heat and mass transfer and heat measurements needed for solving advanced thermal problems in environmental engineering appearing in build and natural environment.
2. Student knows basic methods needed for theoretical and design solution of thermal problems appearing in environmental engineering.
3. Student has a knowledge concerning detailed ruls of methods and calculations of heat and mass transfer and heat exchanders appearing in environmental engineering.
4. Student has an advanced knowledge concerning development tendencies and new achievements in heat equipment and processes in environmental engineering.

Skills:
1. Student can find and estimate information gained from literature and internet concerning heat engineering equipment appearing in environmental engineering.
2. Student can find adequate relationships describing analysed heat processes and how determine thermodynamic properties needed for heat and mass transfer calculations.
3. Student can recognize and solve advanced design and operation heat and mass transfer problems occurred in heat equipment and can critically estimate a design solution and recognize a danger hazard in erected and operated heat equipment.
4. Student can plan and realize operating tests and prototype investigations of equipment appearing in environmental engineering.
5. Student can determine an accuracy and analyse obtained results of calculation and measurements and can critically analyse obtained results of calculations and measurements and develop conclusions.

Social competences:
1. Student understand and appreciate a team cooperation in solving theoretical and practical problems.
2. Student is aware of the range and limits of the used calculation methods and relationships as well as importance of possessed a theoretical and practical knowledge.
3. Student understands a need of examination and verification of results of used calculation and experimental methods.
4. Student is aware of need of innovation thinking and action.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures:
The final exam consists of two parts:
Part 1: Test of competence dealing with solving of heat and mass transfer engineering problems (2 problems).
Part 2: Test of understanding of fundamentals of heat and mass transfer (4 questions).
In some cases an oral examination is used. Also an activity of students during lectures and tutorials is taken into account.
To pass each of the two parts of the exam (as well as to pass the tutorials) there is necessary to obtain at least 50% of the maximum points (max=20 points). The exam is passed if both part 1 and part 2 are passed. Corrected (Improved) is only this part which was failed.
Grading system:
0-9 points = 2,0 (failed)
10-12 points = 3,0 (sufficient)
13-14 points = 3,5 (sufficient plus)
15-16 points = 4,0 (good)
17-18 points = 4,5 (good plus)
19-20 points = 5,0 (very good)
Tutorials:
60-minute written test at the end of semester (solution 2 or 3 problems). Continuous assessment of student activity (reward of activity)
Laboratory training (exercise):
Short 15 minute entrance test before each laboratory training and final assessment of the written raport and eventual oral presentation of the results.

Programme content

The module program covers the following topics:
1. steady state heat conduction and transfer,
2. heat convection,
3. thermal radiation,
4. transient heat flow - heating and cooling,
5. heat exchangers,
6. thermal radiation,
7. solar radiation,
8. heat transfer during condensation,
9. heat transfer at boiling,
10. mass transfer.

Course topics

The lecture program covers the following topics:
1. general equation of steady state and transient heat conduction, Fourier's law,
2. steady state heat transfer through flat and cylindrical single- and multi-layer walls,
3. heat convection, Newton's law, dimensionless numbers Nu, Gr, Pr, Re, Ra,
4. heat transfer in transient conditions, dimensionless numbers Bi and Fo, lumped capacity model for Bi < 0.1,
5. heating and cooling of solid bodies Bi > 0.1, graphic method,
6. heating and cooling of solid bodies Bi > 0.1, numerical method,
7. heat exchangers, derivation of equations,
8. heat exchangers, thermo-hydraulic calculations,
9. heat transfer by radiation, basic laws: Planck, Kirchhoff, Wien, Stefan-Boltzmann, Lambert, thermal screen,
10. solar radiation - mathematical model equations,
11. heat transfer during condensation pure vapor, Nusselt solution,
12. heat transfer during condensation in real conditions.
13. heat transfer at boiling, boiling crisis, Nukiyama curve,
14. mass transfer, mass diffusion, mass convection, dimensionless numbers Sh, Sc

The tutorials cover the following topics:
1. calculating the insulation thickness of flat and cylindrical walls,
2. determining the temperature distribution in flat and cylindrical walls,
3. calculating the values of heat transfer coefficients in internal and external flows,
4. calculating the heating and cooling time of solids,
5. thermal and flow calculations of heat exchangers,
6. calculation of solar radiation density on any oriented surface,
7. calculation of radiative heat flux density,
8. calculation of heat flux density during boiling and condensation,

The laboratory program covers the following topics:
1. measurement of the transient temperature field in a solid body,
2. measurement of temperature distribution in the fin and fin efficiency,
3. measurement of thermal conductivity of insulating materials,
4. measurement of thermal conductivity of building materials,
5. tests of heat exchangers.

Teaching methods

Classical lecture with elements of conversation
Tutorials: solving problems method
Laboratory exercises: teaching by experimentation

Bibliography

Basic:
1. Wiśniewski St., Wiśniewski T.S., Wymiana ciepła. WNT, Warszawa 2000
2. Kostowski E., Przepływ ciepła. Wyd. Polit. Śląskiej, Gliwice, 1986
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7. Pomiary cieplne, T. 1 i T. 2, Praca zb. (red. T.R. Fodemski), WNT, Warszawa 2001
8. Hobler T., Ruch ciepła i wymienniki. WNT, Warszawa 1979
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10. Zbiór zadań z przepływu ciepła. Pod red. E. Kostowskiego, Wyd. Polit. Śląskiej, Gliwice 2001
11. Oleśkowicz-Popiel C., Czujniki strumieni ciepła. Wyd. Politechniki Poznańskiej, Poznań 1986
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14. Taler J., Duda P., Rozwiązywanie prostych i odwrotnych zagadnień przewodzenia ciepła. WNY, Warszawa, 2003
15. Zarzycki R., Wymiana ciepła i ruch masy w inżynierii środowiska. WNT, Warszawa 2005

Additional:
1. Incropera F.P., De Witt D.P., Bergman T.L., Lavine A.S., Introduction to Heat and Mass Transfer. 5th Ed., John Wiley and Sons, 2007
2. Incropera F.P., De Witt D.P., Bergman T.L., Lavine A.S., Fundamentals of Heat and Mass Transfer. 6th Ed., John Wiley and Sons, 2006
3. Bejan A., Kraus A.D., Heat Transfer Handbook, John Willey sons Sons, Inc., 2003
4. Eckert E.R.G., Drake R.M., Analysis of Heat and Mass Transfer. McGraw-Hill Book Co., 1972
5. Holman J.P., Heat Transfer, McGraw Hill, Metric Edition, 2010
6. Kakac S., Liu H., Heat exchangers: Selection, Rating, and Design. CRC Press, 1998
7. Howell J.R., Siegel R., Menguc M.P., Thermal Radiation Heat Transfer. CRC Press and Taylor and Francis Group, New York 2011

Breakdown of average student's workload

	Hours	ECTS
Total workload	150	6,00
Classes requiring direct contact with the teacher	52	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	98	4,00