AGH University of Science and Technology

Module name:	Numerical modeling of heat transfer
Academic year:	2019/2020
Code:	ZSDA-3-0018-s
ECTS credits:	3
Faculty of:	Szkoła Doktorska AGH
Field of study:	Szkoła Doktorska AGH
Specialty:	—
Study level:	Third-cycle studies
Form and type of study:	Full-time studies
Lecture language:	English
Profile of education:	Academic (A)
Semester:	0
Course homepage:	http://www.metal.agh.edu.pl
Responsible teacher:	prof. dr hab. inż. Malinowski Zbigniew (malinows@agh.edu.pl)

Module summary

Description of the finite element method implementations to numerical solution of heat transfer problems. Implementation of heat transfer boundary conditions into finite element solver. Numerical simulations of a selected heat transfer problem using finite element solver.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	Student is prepared to solve heat transfer problems in engineering and science.	SDA3A_K01, SDA3A_K03, SDA3A_K02	Presentation
Skills: he can			
M_U001	Student is able to perform simulation of a selected heat transfer problem using finite element method.	SDA3A_U03, SDA3A_U02, SDA3A_U01	Presentation
Knowledge: he knows and understands			
M_W001	Student is able to define a complex heat transfer boundary conditions for selected heat transfer problems.	SDA3A_W02, SDA3A_W04, SDA3A_W01	Presentation
M_W002	Student is able to analyze simulation results of a selected heat transfer problem	SDA3A_W03, SDA3A_W02, SDA3A_W01	Presentation

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	15	0	0	0	0	15	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	Student is prepared to solve heat transfer problems in engineering and science.	+	-	-	-	-	+	-	-	-	-	-
Skills: he can												
M_U001	Student is able to perform simulation of a selected heat transfer problem using finite element method.	+	-	-	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Student is able to define a complex heat transfer boundary conditions for selected heat transfer problems.	+	-	-	-	-	+	-	-	-	-	-
M_W002	Student is able to analyze simulation results of a selected heat transfer problem	+	-	-	-	-	+	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	15 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	30 h
Realization of independently performed tasks	15 h
Summary student workload	90 h
Module ECTS credits	3 ECTS

Additional information

Module content

Lectures

1.Transient and steady-state heat transfer equations.
2.Finite element method solution to heat transfer problems
3.Methods of boundary condition implementation into finite element solver
4.Modeling of internal heat sources
5.Heat balance implementations and stability of numerical solutions.
6.Heat convection in turbulent and laminar flows
7.Examples of numerical simulations of selected heat transfer problems

Seminar classes

1.Selection of the heat transfer problem
2.Specification of the heat transfer mechanisms
3.Definition of object geometry and boundary conditions
4.Simulation of the heat transfer problem using finite element solver
5.Analysis of numerical results
6.Oral presentation of results
7.Discussion of simulation results

Teaching methods and techniques:

Lectures: Multimedia presentation of lectures. Oral description of problems.
Seminar classes: Solving of heat transfer problems using dedicated finite element solver.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

Oral presentatio of a problem and discusion of results

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:
– Attendance is mandatory: Yes
– Participation rules in classes: Students take part in lectures and get knowledge according to syllabus. Discussion of problems is allowed during lecture classes. Audiovisual registration requires permission.

Seminar classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Student selects boundary condition, defines geometry and properties of an object and performs simulations with minimum integration of lecturer.

Method of calculating the final grade

Average from seminar(weight 0.5) and oral presentation of a selected problem (weigh 0.5)

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

consulting and self solution of a specified problem of heat transfer.

Prerequisites and additional requirements

Basis of heat transfer, fluid flow and numerical methods

Recommended literature and teaching resources

1.Yunus A. Cengel: Heat and Mass Transfer, McGraw-Hill, London 2007
2.O.C. Zienkiewicz, R.L.Taylor, The Finite Element Method Volume 1: The Basis, fifth ed., Butterworth-Heinemann, Linacre House, Jordan Hill, Oxford OX2 8DP, 2000.

Scientific publications of module course instructors related to the topic of the module

1.T. Telejko, Z. Malinowski, Application of an inverse solution to the thermal conductivity identification using the finite element method, Journal of Materials Processing Technology, 146 (2004), s. 145–155.
2.Z. Malinowski, J.G. Lenard, M.E. Davies, A study of the heat transfer coefficient as function of temperature and pressure, Journal of Materials Processing Technology, 41 (1994), s. 125–142.
3.Malinowski Z., Telejko T., Hadała B., Cebo-Rudnicka A., Szajding A.: Dedicated three dimensional numerical models for the inverse determination of the heat flux and heat transfer coefficient distributions over the metal plate surface cooled by water, International Journal of Heat and Mass Transfer, vol. 75, 2014, 347-361
4.Malinowski Z., Cebo-Rudnicka A., Telejko T., Hadała B., Szajding A.: Inverse method implementation to heat transfer coefficient determination over the plate cooled by water spray, Inverse Problems in Science and Engineering, 23 no. 3, 2015, 518-556
5.Cebo-Rudnicka, Z. Malinowski, A. Buczek, The influence of selected parameters of spray cooling and thermal conductivity on heat transfer coefficient, Int. J. Thermal Sciences 110 (2016) 52-64.
6.Z. Malinowski, A. Cebo-Rudnicka, B. Hadała, A. Szajding, T. Telejko, Implementation of one and three dimensional models for heat transfer coefficient identification over the plate cooled by the circular water jets, Heat and Mass Transfer 58 (2018) 2195-2213.

Additional information

None