Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2019/2020

Wydział Inżynierii Środowiska i Energetyki

Kierunek studiów: Energetyka

Profil: Ogólnoakademicki

Forma sudiów: stacjonarne

Kod kierunku: 11

Stopień studiów: II

Specjalności: Energy systems and machinery

1 Informacje o przedmiocie

Nazwa przedmiotu	Heat Transfer
Nazwa przedmiotu w języku angielskim	Heat transfer
Kod przedmiotu	WIŚIE EN oIIS C4 19/20
Kategoria przedmiotu	Przedmioty kierunkowe
Liczba punktów ECTS	3.00
Semestry	1

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Cwiczenia	Laboratoria	Laboratoria komputerowe	Projekt	Seminarium
1	15	15	0	0	0	0

3 Cele przedmiotu

Cel 1 Learning the basic mechanisms of heat exchange and the ability to calculate the heat transfer through conduction, convection and radiation. Students also get acquainted with the basic devices used in thermal engineering. Students will be able to calculate and design thermal insulation of buildings. They will also learn how to calculate thermal and hydraulic performance of heat exchangers. They will also learn how to reduce

dynamic errors in the measurement of transient fluid temperatures. They will also learn how to design thermal screens that reduce heat transfer by radiation.

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 Basic knowledge of mathematical analysis and thermodynamics.

5 Efekty kształcenia

EK1 Wiedza He knows the basic mechanisms of heat exchange, including the Fourier law. He knows the equation of steady and transient heat conduction. He knows the correlations for determining heat transfer coefficients at flow in closed ducts and knows the methodology of overall heat transfer coefficient derivation. He knows the theoretical basics of heat transfer through extended surfaces.

EK2 Wiedza He knows the types of heat exchangers and how to calculate them. He knows the basic laws governing the exchange of heat by radiation and knows the purpose of using heat shields.

EK3 Umiejętności It is able to derive steady-state temperature distributions in flat, cylindrical, and spherical walls. He can derive formulas for overall heat transfer coefficients through multilayer planar, cylindrical and spherical walls. It is able to derive a pattern for heat exchange through fins of any shape. He is able to derive a formula for temperature distribution and efficiency of a straight fin of constant thickness. He is able to derive a formula for an effective heat transfer coefficient on the finned surface. It is able to derive a formula for transient temperature response of the body with lumped thermal capacity and to determine a formula for dynamic measurement error with a thermometer when the temperature of the fluid changes stepwise.The student is able to derive a formula for thermal stresses in a plane wall in a quasi-steady state.

EK4 Umiejętności The student is able to determine the basic dimensionless numbers for heat conduction and convection and to use heat transfer corelations for the Nusselt number to calculate the heat transfer coefficient of convection. It is able to derive a formula for the temperature distribution of a fluid and a duct wall (pipeline, chimney). It can derive differential equations describing a steady state heat transfer in heat exchangers of the concentric type and derive a formula for a logarithmic mean temperature difference (LMTD). The student is able to derive a relationship for radiation heat exchange between two surfaces inclined to each other. The student is also able to derive a formula for heat exchange between two plates. The student is able to evaluate an error in measuring the temperature of a high-temperature gas resulting from the radiation of a thermometer on the surrounding surfaces. He can also determine the heat flow rate between two plane surfaces when using heat screens.

6 Treści programowe

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	Fourier's law, derivation of the transient heat conduction equation in the Cartesian coordinate system. Types of boundary conditions and initial condition.	2
W2	Derivation of formulas for steady -state temperature distributions in plane, cylindrical and spherical walls. Derivationed of the formulas for overall heat transfer coefficient in single- and multi-layer walls - plane, cylindrical and spherical geometries.	3

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W3	An equation for the transient temperature of the solid with concentrated thermal capacity. Solution of the heat transfer equation for a step change in temperature of the surrounding fluid. Dynamic error in temperature measurement..	1
W4	Extended heat transfer surfaces: fins and pins. Derivation of a general formula for heat transfer through fins. Derivation of the formula for temperature distribution and efficiency of a straight fin of constant thickness. Derivation of the formula for effective heat transfer coefficient for the finned surface.	2
W5	Discussion of the ways of deriving dimensionless numbers. Correlations to the Nusselt number of fluid flows in closed channels. Determination of a formula for a steady-state temperature distribution of the fluid for its flow through a pipeline or chimney.	2
W6	Classification of heat exchangers, derivation of differential equations describing the steady-state heat transfer in co-current and counter-current concrentic heat exchangers. Derivation of a formula for logarithmic mean of temperature difference (LMTD).	3
W7	Heat transfer by radiation, Lambert's law. Shape factors. Derivation of the formula for heat transfer rate by radiation between two plane surfaces. Thermal shields.	2

Cwiczenia		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
C1	Calculation of steady-state temperature distributions in plane, cylindrical spherical walls.	2
C2	Calculation of equivalent heat transfer coefficient taking into account convection and radiation. Overall heat transfer coefficients of single and multilayer, plane, cylindrical and spherical walls. Critical thickness of thermal insulation.	3
C3	Calculation of the time variations of temperature for heating and cooling of a solid with concentrated thermal capacity. Calculation of dynamic error in fluid temperature measurement.	2
C4	Calculation of the temperature distribution in the fin. Calculation of fin efficiency. Calculation of effective heat transfer coefficient for finned flat surfaces and finned tubes.	3
C5	Determination of the temperature variations of the fluid in the pipeline and chimney, calculation of heat losses during fluid flow.	1
C6	Calculation of the surface area of a concentric heat exchanger. Example of calculation of a cross-current heat exchanger.	3

Cwiczenia		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
C7	Calculation of the heat flow rate between planar surfaces with and without shields. Calculation of a measurement error for the exhaust gas temperature using thermometers without and with thermowell.	1

7 Narzędzia dydaktyczne

N1 Lectures

N2 Exercises

N3 Discussion

8 Obciążenie pracą studenta

Forma aktywności	Średnia liczba godzin na zrealizowanie aktywności
Godziny kontaktowe z nauczycielem akademickim, w tym:	
Godziny wynikające z planu studiów	30
Konsultacje przedmiotowe	3
Egzaminy i zaliczenia w sesji	5
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	27
Opracowanie wyników	10
Przygotowanie raportu, projektu, prezentacji, dyskusji	0
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**75**
Sumaryczna liczba punktów ECTS dla przedmiotu	3.00

9 Sposoby oceny

Ocena formująca

F1 Exercises

F2 Colloquium

F3 Oral answer

Ocena podsumowująca

P1 Written test

P2 Oral examination

Warunki zaliczenia przedmiotu

W1 Student must obtain a positive assessment of all the educational results.

W2 The final grade is the arithmetic mean of the grades obtained in the written and oral examination.

Kryteria oceny

Efekt kształcenia 1	
Na ocenę 2.0	Scope of the knowledge up to 55% required
Na ocenę 3.0	Scope of the knowledge up to 60% required
Na ocenę 3.5	Scope of the knowledge up to 70% required
Na ocenę 4.0	Scope of the knowledge up to 80% required
Na ocenę 4.5	Scope of the knowledge up to 90% required
Na ocenę 5.0	Scope of the knowledge up to 100% required
Efekt kształcenia 2	
Na ocenę 2.0	Scope of the knowledge up to 55% required
Na ocenę 3.0	Scope of the knowledge up to 60% required
Na ocenę 3.5	Scope of the knowledge up to 70% required
Na ocenę 4.0	Scope of the knowledge up to 80% required
Na ocenę 4.5	Scope of the knowledge up to 90% required
Na ocenę 5.0	Scope of the knowledge up to 100% required
Efekt kształcenia 3	
Na ocenę 2.0	Scope of the knowledge up to 55% required
Na ocenę 3.0	Scope of the knowledge up to 60% required
Na ocenę 3.5	Scope of the knowledge up to 70% required
Na ocenę 4.0	Scope of the knowledge up to 80% required
Na ocenę 4.5	Scope of the knowledge up to 90% required
Na ocenę 5.0	Scope of the knowledge up to 100% required

Efekt kształcenia 4	
Na ocenę 2.0	Scope of the knowledge up to 55% required
Na ocenę 3.0	Scope of the knowledge up to 60% required
Na ocenę 3.5	Scope of the knowledge up to 70% required
Na ocenę 4.0	Scope of the knowledge up to 80% required
Na ocenę 4.5	Scope of the knowledge up to 90% required
Na ocenę 5.0	Scope of the knowledge up to 100% required

10 Macierz realizacji przedmiotu

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK1	K2_W03 K2_U01	Cel 1	W1 W2 W3 W4 W5 W6 W7 C1 C2 C3 C4 C5 C6 C7	N1 N2 N3	F1 F2 F3 P1 P2
EK2	K2_W03 K2_W15 K2_U01 K2_U07	Cel 1	W1 W2 W3 W4 W5 W6 W7 C1 C2 C3 C4 C5 C6 C7	N1 N2 N3	F1 F2 F3 P1 P2
EK3	K2_W03 K2_U01 K2_U10 K2_U22 K2_U23	Cel 1	W1 W2 W3 W4 W5 W6 W7 C1 C2 C3 C4 C5 C6 C7	N1 N2 N3	F1 F2 F3 P1 P2
EK4	K2_W03 K2_W08 K2_W20	Cel 1	W1 W2 W3 W4 W5 W6 W7 C1 C2 C3 C4 C5 C6 C7	N1 N2 N3	F1 F2 F3 P1 P2

11 Wykaz literatury

Literatura podstawowa

[1] Taler J., Duda P. — *Rozwiązywanie prostych i odwrotnych zagadnień przewodzenia ciepła*, Warszawa, 2003, WNT

[2] Wiśniewski S., Wiśniewski T. — *Wymiana ciepła*, Warszawa, 2010, WNT

Literatura uzupełniająca

[1] Mills A.F. — *Basic Heat Mass Transfer*, Upper Saddle River, 1999, Prentice Hall

[2] Welty J.R, Wicks Ch.E. Wilson R.E Rorrer G.L. — *Fundamentals of Momentum, Heat, and Mass Transfer*, Hoboken, 2007, John Willey & Sons

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

prof. dr hab. inż. Jan Taler (kontakt: `jan.taler@pk.edu.pl`)

Osoby prowadzące przedmiot

1 prof. dr hab. inż. Jan Taler (kontakt: `taler@mech.pk.edu.pl`)

2 dr inż. Karol Kaczmarski (kontakt: `karol.kaczmarski@mech.pk.edu.pl`)

13 Zatwierdzenie karty przedmiotu do realizacji

(miejscowość, data) (odpowiedzialny za przedmiot) (dziekan)

Przyjmuję do realizacji (data i podpisy osób prowadzących przedmiot)

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