Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2020/2021

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 Exchangers
Nazwa przedmiotu w języku angielskim	Heat Exchangers
Kod przedmiotu	WIŚIE EN oIIS D2 20/21
Kategoria przedmiotu	Przedmioty specjalnościowe
Liczba punktów ECTS	4.00
Semestry	1

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Cwiczenia	Laboratoria	Laboratoria komputerowe	Projekt	Seminarium
1	15	0	15	0	30	0

3 Cele przedmiotu

Cel 1 Objective 1 The student is acquainted with the construction of heat exchangers and with the "mean logarithmic temperature difference" method for thermal design of heat exchangers.

Cel 2 Objective 2 The student is familiar the "NTU" method for the thermal design of heat exchangers.

Cel 3 Objective 3 To be able to select the right type of exchanger for the right technical applications.

Cel 4 Objective 4 Ability to design the basic elements of heat exchangers

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 Requirement 1 Knowledge of the basics of thermodynamics

2 Requirement 2 Thermodynamics and heat transfer

3 Wymaganie 3 CAD Basis Skills

5 Efekty kształcenia

EK1 Umiejętności The student will learn to calculate heat exchangers using the "mean logarithmic temperature diffrence " and "NTU" methods.

EK2 Umiejętności Student potrafi: projektować wymienniki ciepła i wykonać dokumentacje techniczną.

EK3 Umiejętności The student is able to: design heat exchangers and prepare technical documentation.

EK4 Umiejętności The student knows the types of heat exchangers and design issues occurring in their design process.

6 Treści programowe

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P1	Designing a heat exchanger to heat a phase change material and maintain it at constant temperature.	8
P2	Designing a heat exchanger to heat a phase change material and maintain it at constant temperature.strength calculations	8
P3	Preparation of the technical drawing of the designed exchanger	14

Laboratoria		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
L1	Test of a tube-in-tube heat exchanger for two cases: paraller flow and counter flow.	3
L2	Calculation of the necessary length of the exchanger by one of the methods discussed in the lecture	5
L3	Creating a numerical model of the heat exchanger and carrying out a computer simulation of the flow.	5
L4	Analysis and comparison of experimental results, analytical calculations and numerical results.	2

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	Heat transfer: convection, conduction, radiation	2
W2	First principle of thermodynamics for heat exchangers	1
W3	logarithmic mean temperature difference LMTD	3
W4	NTU method for calculating heat exchangers	3
W5	Shell-and-tube heat exchangers	2
W6	Plate heat exchangers	2
W7	Compact heat exchangers	2

7 Narzędzia dydaktyczne

N1 Lectures

N2 Laboratory exercises

N3 Design exercises

N4 Consultation

N5 Whiteboard calculation task activities

8 Obciążenie pracą studenta

Forma aktywności	Średnia liczba godzin na zrealizowanie aktywności
Godziny kontaktowe z nauczycielem akademickim, w tym:	
Godziny wynikające z planu studiów	60
Konsultacje przedmiotowe	3
Egzaminy i zaliczenia w sesji	3
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	4
Opracowanie wyników	15
Przygotowanie raportu, projektu, prezentacji, dyskusji	20
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**105**
Sumaryczna liczba punktów ECTS dla przedmiotu	4.00

9 Sposoby oceny

Ocena formująca

F1 Individual project

F2 Report of the laboratorytests

F3 Oral answer

Ocena podsumowująca

P1 Project

Warunki zaliczenia przedmiotu

W1 The final note is the arithmetic mean of all the grades. In order to obtain a positive note in a course, the student must have at least sufficient(3.0) note for all learning outcomes.

W2 Ocena 2

Kryteria oceny

Efekt kształcenia 1	
Na ocenę 2.0	The student does not know he rules of calculating the exchangers according to the "MLTD" methods and "NTU."

Na ocenę 3.0	The student knows the rules of calculating the exchangers according to the "MLTD" methods and "NTU." The student knows the basic designs for designing heat exchangers.
Na ocenę 3.5	Student knows the basics of design calculations concerning exchangers according to the methods of "logarithmic mean" and "NTNU". Student knows the basic formulas for designing heat exchangers. Student can correctly calculate the overall heat transfer coefficient for the specific exchanger.
Na ocenę 4.0	Student knows the basics of design calculations concerning exchangers according to the methods of "logarithmic mean" and "NTNU". Student knows the basic formulas for designing heat exchangers. Student can correctly calculate the overall heat transfer coefficient for the specific exchanger. Student knows how to include thermal resistance from contaminants in calculations.
Na ocenę 4.5	Student knows the basics of design calculations concerning exchangers according to the methods of "logarithmic mean" and "NTNU". Student knows the basic formulas for designing heat exchangers. Student can correctly calculate the overall heat transfer coefficient for the specific exchanger. Student knows how to include thermal resistance from contaminants in calculations. The student is able to correctly determine the efficiency of heat exchangers.
Na ocenę 5.0	Student knows the basics of design calculations concerning exchangers according to the methods of "logarithmic mean" and "NTNU". Student knows the basic formulas for designing heat exchangers. Student can correctly calculate the overall heat transfer coefficient for the specific exchanger. Student knows how to include thermal resistance from contaminants in calculations. The student is able to correctly determine the efficiency of heat exchangers. He can correctly calculate the temperatures at the outlets of the analyzed exchangers.
Efekt kształcenia 2	
Na ocenę 2.0	The student does not know the basic designs for designing heat and strength exchangers.
Na ocenę 3.0	The student knows the basic designs for designing heat and strength exchangers. Student is able to draw the exchanger in 2D and correctly dimension the drawing.
Na ocenę 3.5	The student knows the basic designs for designing heat and strength exchangers. Student is able to draw the exchanger in 2D and correctly dimension the drawing. Student can correctly select materials for the designed exchanger.
Na ocenę 4.0	The student knows the basic designs for designing heat and strength exchangers. Student is able to draw the exchanger in 2D and correctly dimension the drawing. Student can correctly select materials for the designed exchanger. He is able to select an armature and design a connection to armature.
Na ocenę 4.5	The student knows the basic designs for designing heat and strength exchangers. Student is able to draw the exchanger in 2D and correctly dimension the drawing. Student can correctly select materials for the designed exchanger. He is able to select an armature and design a connection to armature. The student correctly makes a technical drawing with dimensions and description. Minor drawing errors are acceptable.

Na ocenę 5.0	The student knows the basic designs for designing heat and strength exchangers. Student is able to draw the exchanger in 2D and correctly dimension the drawing. Student can correctly select materials for the designed exchanger. He is able to select an armature and design a connection to armature. The student correctly makes a technical drawing with dimensions and description.
Efekt kształcenia 3	
Na ocenę 2.0	The student does not know the physical phenomena occurring in the exchangers.
Na ocenę 3.0	The student knows the physical phenomena occurring in the exchangers.
Na ocenę 3.5	The student knows the physical phenomena occurring in the exchangers and the fundamentals of heat transfer and fluid mechanics. Can explain phenomena occurring for condensers, evaporators, parallel-flow, counter-flow and cross-flow exchangers.
Na ocenę 4.0	The student knows the physical phenomena occurring in the exchangers and the fundamentals of heat transfer and fluid mechanics. Can explain phenomena occurring for condensers, evaporators, parallel-flow, counter-flow and cross-flow exchangers. Student is able to calculate flow resistance and select pump power for media in exchangers.
Na ocenę 4.5	The student knows the physical phenomena occurring in the exchangers and the fundamentals of heat transfer and fluid mechanics. Can explain phenomena occurring for condensers, evaporators, parallel-flow, counter-flow and cross-flow exchangers. Student is able to calculate flow resistance and select pump power for media in exchangers. Students is be able to derive formulas for the logarithmic mean temperature difference.
Na ocenę 5.0	The student knows the physical phenomena occurring in the exchangers and the fundamentals of heat transfer and fluid mechanics. Can explain phenomena occurring for condensers, evaporators, parallel-flow, counter-flow and cross-flow exchangers. Student is able to calculate flow resistance and select pump power for media in exchangers. The student can correctly calculate the mass of the exchanger, and the cross-sectional area due to the speed limit.Students is be able to derive formulas for the logarithmic mean temperature difference.
Efekt kształcenia 4	
Na ocenę 2.0	The student does not know the basic types of heat exchangers used in industry.
Na ocenę 3.0	The student knows the basic types of heat exchangers that are used in industry.
Na ocenę 3.5	He knows the basic types of heat exchangers used in industry. Student can select the type of exchanger, due to media, phase changes, weight limit and others.
Na ocenę 4.0	He knows the basic types of heat exchangers used in industry. Student can select the type of exchanger, due to media, phase changes, weight limit and others. Students are able to select/calculate an exchanger with respect to size and cost.

Na ocenę 4.5	He knows the basic types of heat exchangers used in industry. Student can select the type of exchanger, due to media, phase changes, weight limit and others. Students are able to select/calculate an exchanger with respect to size and cost. Student can correctly select materials for exchanger due to strength aspects, factors in exchangers and cost.
Na ocenę 5.0	He knows the basic types of heat exchangers used in industry. Student can select the type of exchanger, due to media, phase changes, weight limit and others. Students are able to select/calculate an exchanger with respect to size and cost. Students will be able to correctly select materials for the exchanger due to strength aspects, media and operating costs.

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	Cel 1 Cel 2	W1 W2 W3 W4	N1 N2 N5	F2 F3
EK2	K2_U18 K2_U24	Cel 1 Cel 2	W1 W2 W3 W4	N1 N2 N5	F2 F3
EK3	K2_U23 K2_U24	Cel 3 Cel 4	P1 P2 L1 L2 L3 L4 W1 W2 W3 W4 W5 W6 W7	N1 N2 N3	F2 F3
EK4	K2_W14	Cel 4	P1 P2 P3 L1 L2 L3 L4 W1 W2 W3 W4 W5 W6 W7	N3 N4	P1

11 Wykaz literatury

Literatura podstawowa

[1] Kakac S. — *Heat Exchangers: Selection, Rating, and Thermal Design*, NY, 1995, CRC Press

Literatura uzupełniająca

[1] W.S. Janna — *Engineering heat transfer,*, Boca Raton, 2009, CRC Press

[2] T. Hobler — *Heatflow and heat exchangers,*, Warszawa, 1979, WNT

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

dr hab. inż. Atrur Cebula (kontakt: acebula@pk.edu.pl)

Osoby prowadzące przedmiot

1 dr hab. inż. Artur Cebula (kontakt: acebula@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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