Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2020/2021

Wydział Mechaniczny

Kierunek studiów: Mechanika i Budowa Maszyn — Profil: Ogólnoakademicki

Forma sudiów: stacjonarne — Kod kierunku: M

Stopień studiów: I

Specjalności: Machine design (Konstrukcja maszyn- w języku angielskim)

1 Informacje o przedmiocie

Nazwa przedmiotu	Fluid-flow machinery
Nazwa przedmiotu w języku angielskim	
Kod przedmiotu	WM MIBM oIS C5 20/21
Kategoria przedmiotu	Przedmioty specjalnościowe
Liczba punktów ECTS	7.00
Semestry	6 7

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Ćwiczenia	Laboratorium	Laboratorium komputerowe	Projekt	Seminarium
6	15	0	0	0	0	0
7	15	0	0	0	30	0

3 Cele przedmiotu

Cel 1 Acquaintance with the basic laws and equations governing the movement of fluids in a way that allows independent modeling of flow problems that are important for the engineer.

Cel 2 Acquiring basic theoretical knowledge necessary for modeling fluid movement and designing complex flow phenomena occurring in flow machinery and equipment.

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 Knowledge of integral and differential calculus.

2 Basic knowledge of physics.

5 Efekty kształcenia

EK1 Wiedza Knows and understands mathematical methods and numerical methods for solving simple problems in the field of mechanics, material strength, fundamentals of machine construction, fluid mechanics, thermodynamics at the engineering level. In particular, he knows: a) arithmetic and algebra, including matrix calculus, analytical geometry on the plane and in space, b) important elements of mathematical analysis including: differential and integral calculus, linear ordinary differential equations, trigonometric series, elements of variation calculus c) complex numbers

EK2 Wiedza Knows and understands mathematical models of physical phenomena and a description of physical phenomena occurring in engineering problems; fundamentals of physics, including material point mechanics, optics, electricity and magnetism, as well as solid state physics and atom structure; issues in the field of statics, kinematics and dynamics of a point and arrangement of material points, dynamics of a solid and arrangement of solids, dynamics of spherical motion of solids; basics of thermodynamics and fluid mechanics.

EK3 Umiejętności Is able to analyze the operation of a system or process and the possibility of its optimization, through the introduction of modern technical solutions, select basic analytical, program and physical tools to solve a simple engineering task characteristic of the studied direction.

EK4 Umiejętności Is able to use basic forms of communication in the field of mechanical engineering, including technical drawings with the use of CAD, programming and mathematical description.

6 Treści programowe

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	Modelling in engineering. Introduction to CFD methods. Analysis of flow phenomena occurring in selected industrial equipment. Capabilities of CFD packages and their using for simulation of performance of industrial equipment and apparatuses.	5
W2	Base of numerical modelling of momentum, heat and mass transport processes. Main principles of numerical model preparation model geometry composition, mesh generation. Mesh quality criterions. Boundary conditions. User Defined Functions (UDF).	5
W3	Methods of discretization. Methods of numerical simulations. The finite-volume method. Continuity and motion equations. Energy transport the balance of kinetic energy, the balance for thermal energy. .	5

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W4	Simulations of flow. Characteristic of laminar and turbulent flow. Description of multiphase flow. Simulations of turbulent flow in selected industrial devices. Direct numerical Simulations (DNS), Large Eddy Simulation (LES) and Reynolds Averaging Numerical Simulations (RANS) methods. Similarities and differences. Using the proper method for simulation of performance of selected industrial equipment.	5
W5	Simulations of multiphase flow. Numerical analysis of liquid liquid, solid liquid and polluted gasses flow. Euler-Lagrange and Euler Euler models for modelling of multiphase flow. Population balance in processes of break-up drops and bubbles. Simulations of heat and mass transfer. Numerical modelling of chemical reactions.	5
W6	Possibilities of presentation of results obtained from CFD simulations. Vector and contour maps of velocity components distribution. Distributions of static and dynamic pressures. Analysis of turbulence parameters for liquid flow: kinetic turbulence energy (KTE), dissipation rate, turbulence intensity. Visualization of vortices formation Q-kriterion, vorticity, helicity. Temperature distribution and heat transfer coefficients. Simulations of flow inducted in mixing vessels, cyclone separators, tubular reactors, heat exchangers.	5

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P1	Numerical analysis of single phase flow in static mixer. Creation of model geometry and generation of numerical grid. Choice of liquid properties and start parameters. Selection of the proper solver and solution method. Monitoring of convergence. Presentation of results obtained for various velocities of flow at mixer inlet (velocity distribution, turbulent kinetic energy distribution, vortices formation). Comparison results with experimental data obtained from LDA measurements.	6
P2	Simulations of two phase flows (gas and dust) in a cyclone separator with different vortex finder in geometry. Preparation of geometry for several cyclone models. Definition of dust parameters density, size distribution. Choice of a proper model for turbulence modelling. Performance of calculation. Optimization of cyclone design. Analysis of flow patterns, pressure drops and dedusting efficiency depending on vortex finder length and diameter. Results comparison with measurements data carried out with thermoanemometer.	6
P3	Analysis of flow and heat transport in a pipe heat exchanger. Conducting of numerical simulations for various temperatures and capacities of feeding liquids in the mode of cocurrent and counter-current flow. In both cases analysis of temperature distribution along heat exchanger, calculation of heat exchange coefficients. Numerical investigations of pressure drop. Comparison of results with data obtained on the basis of experiments.	6

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P4	Analysis of flow and heat transport in the plate heat exchanger. Modification of heat exchanger design towards intensification of heat exchange process and minimization of pressure drop. Identification the zones with the most intensive heat exchange, analysis of velocity and pressure distributions in several, single sections of exchanger. On the basis of CFD simulations selection of optimal parameters of feeding liquids.	6
P5	Simulation of a vibromixer with perforated discs. Creation of vibromixer geometry for disk agitators with different degree of perforation. Using UDF function for definition up-and down moving disc. Choice of operating and numerical parameters and monitoring of calculations. Detailed analysis of flow in the vicinity of discs and inside of holes. Qualitative and quantitative analysis of flow velocity, pressure and turbulence intensity at the different levels in the vibromixer. Comparison of performance of vibromixer with solid and perforated disc. Choice on the basis of numerical simulations optimal design.	6

7 Narzędzia dydaktyczne

N1 Lectures

N2 Multimedia presentations

N3 Design exercises

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	4
Egzaminy i zaliczenia w sesji	2
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	30
Opracowanie wyników	30
Przygotowanie raportu, projektu, prezentacji, dyskusji	20
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**146**
Sumaryczna liczba punktów ECTS dla przedmiotu	7.00

9 Sposoby oceny

Ocena formująca

F1 Projekt indywidualny

Ocena podsumowująca

P1 Projekt

Kryteria oceny

Efekt kształcenia 1	
Na ocenę 3.0	Student is able to define the concept of fluid and basic concepts of fluid movement.
Efekt kształcenia 2	
Na ocenę 3.0	Knows and understands mathematical models of physical phenomena and a description of physical phenomena occurring in engineering problems
Efekt kształcenia 3	
Na ocenę 3.0	Is able to analyze the operation of a system or process and the possibility of its optimization, through the introduction of modern technical solutions
Efekt kształcenia 4	

Na ocenę 3.0	is able to use basic forms of communication in the field of mechanical engineering, including technical drawings with the use of CAD

10 Macierz realizacji przedmiotu

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK1		Cel 1 Cel 2	W1 W2 P1 P2	N1 N2 N3	F1 P1
EK2		Cel 1 Cel 2	W2 P2	N1 N2 N3	F1 P1
EK3		Cel 1 Cel 2	W3 W4 P3 P4	N1 N2 N3	F1 P1
EK4		Cel 1 Cel 2	W4 W5 P4 P5	N1 N2 N3	F1 P1

11 Wykaz literatury

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

dr inż. Ryszard, Krzysztof Wójtowicz (kontakt: ryszard.wojtowicz@pk.edu.pl)

Osoby prowadzące przedmiot

1 dr inż. Ryszard Wójtowicz (kontakt: rwojtowi@usk.pk.edu.pl)

2 prof. dr hab. inż. Piotr Duda (kontakt: pduda@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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