Politechnika Krakowska
im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2019/2020

Wydział Inżynierii Materiałowej i Fizyki

Kierunek studiów: Fizyka Techniczna w Języku Angielskim — Profil: Ogólnoakademicki

Forma sudiów: stacjonarne — Kod kierunku: FTja

Stopień studiów: II

Specjalności: Computer modelling (modelowanie komputerowe w języku angielskim)

1 Informacje o przedmiocie

Nazwa przedmiotu	Polymer physics
Nazwa przedmiotu w języku angielskim	Polymer physics
Kod przedmiotu	WIMiF FTJA oIIS F9 19/20
Kategoria przedmiotu	Przedmioty wybieralne
Liczba punktów ECTS	3.00
Semestry	1

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Ćwiczenia	Laboratorium	Laboratorium komputerowe	Seminarium	Projekt
1	30	0	0	15	0	15

3 Cele przedmiotu

Cel 1 Familiarize students with history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models

Cel 2 Familiarize students with the excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent

Cel 3 Familiarize students with elastic properties of polymer chains and deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls and with process of adsorption of polymers on surfaces and Flory theory of an adsorbed chain

Cel 4 Familiarize students with thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, analysis of phase diagrams of polymer solutions

Cel 5 Familiarize students with random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 The knowledge of mathematics, thermodynamics and statistical physics

5 Efekty kształcenia

EK1 Wiedza Student has a knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models

EK2 Umiejętności Student has ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains

EK3 Wiedza Student has a knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent

EK4 Umiejętności Student has ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries

EK5 Wiedza Student has a knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models

6 Treści programowe

Laboratorium komputerowe		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
K1	Calculations related to the subject of the lectures	15

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	Treści programowe 1: History of polymer science. Polymer microstructure and architecture. Fractal nature of polymer conformations. Different types of polymeric substances. Conformational statistics of flexible, semi-flexible and stiff polymers. Ideal chain models	6
W2	Treści programowe 2: Excluded volume effects and self-avoiding walks of real polymer chains. Flory theory of polymer chains in a good solvent. Flory theory of polymer chains in a poor solvent	5
W3	Treści programowe 3: Elastic properties of polymer chains and deformation of ideal and real polymer chains under tension. Compression of ideal and real polymer chains in cylindrical pore. Behavior of ideal and real polymer chains confined in a slit geometry of two parallel walls. Investigation of adsorption process of polymers on surfaces. Flory theory of an adsorbed chain	6
W4	Treści programowe 4: Thermodynamics of binary mixtures. Flory-Huggins theory of binary mixtures. Equilibrium and lokal stability. Thermodynamics of dilute, semi-dilute and concentrated polymer solutions. Analysis of phase diagrams of polymer solutions	6
W5	Treści programowe 5: Random branching and gelation. Thermodynamics of rubbers. Unentangled and entangled rubber elasticity. Unentangled and entangled polymer dynamics. Rouse and Zimm models	7

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
P1	Projects connected with the subject of the lectures	15

7 Narzędzia dydaktyczne

N1 Narzędzie 1: Lectures

N2 Narzędzie 2: Computer calculations

N3 Narzędzie 3: Realization of the project

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	30
Egzaminy i zaliczenia w sesji	10
Godziny bez udziału nauczyciela akademickiego wynikające z nakładu pracy studenta, w tym:	
Przygotowanie się do zajęć, w tym studiowanie zalecanej literatury	15
Opracowanie wyników	15
Przygotowanie raportu, projektu, prezentacji, dyskusji	15
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**145**
Sumaryczna liczba punktów ECTS dla przedmiotu	3.00

9 Sposoby oceny

Ocena formująca

F1 Ocena 1:Test

F2 Ocena 2: Test

F3 Ocena 3: Project

Ocena podsumowująca

P1 Średnia ważona ocen formujących: Average weight of marks

Warunki zaliczenia przedmiotu

W1 Test

W2 Test

W3 Project

Ocena aktywności bez udziału nauczyciela

B1 Test

Kryteria oceny

Efekt kształcenia 1	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% of knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models
Na ocenę 3.5	61%-70% of knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models
Na ocenę 4.0	71%-80% of knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models
Na ocenę 4.5	81%-90% of knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models
Na ocenę 5.0	91%-100% of knowledge about history of polymer science, polymer microstructure and architecture, fractal nature of polymer conformations, different types of polymeric substances, conformational statistics of flexible, semi-flexible and stiff polymers and different ideal chain models
Efekt kształcenia 2	
Na ocenę 2.0	lack of ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains
Na ocenę 3.0	55%-60% ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains
Na ocenę 3.5	61%-70% ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains
Na ocenę 4.0	71%-80% ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains
Na ocenę 4.5	81%-90% ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains

Na ocenę 5.0	91%-100% ability to perform the calculations of the mean-square end-to-end distance and the mean square radius of gyration for flexible, semi-flexible and stiff ideal polymer chains
Efekt kształcenia 3	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent
Na ocenę 3.5	61%-70% knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent
Na ocenę 4.0	71%-80% knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent
Na ocenę 4.5	81%-90% knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent
Na ocenę 5.0	91%-100% knowledge about excluded volume effect and self-avoiding walk of real polymer chains and Flory theory of polymer chains in a good solvent and in a poor solvent
Efekt kształcenia 4	
Na ocenę 2.0	lack of ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries
Na ocenę 3.0	55%-60% ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries
Na ocenę 3.5	61%-70% ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries
Na ocenę 4.0	71%-80% ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries

Na ocenę 4.5	81%-90% ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries
Na ocenę 5.0	91%-100% ability to perform the calculations of elastic properties of polymer chains and investigate the deformation of ideal and real polymer chains under tension or compression in cylindrical pore and in a slit geometry of two parallel walls, investigate the process of polymer adsorption on surfaces and dynamics of polymer chains in confined geometries
Efekt kształcenia 5	
Na ocenę 2.0	lack of knowledge of the subject
Na ocenę 3.0	55%-60% knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models
Na ocenę 3.5	61%-70% knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models
Na ocenę 4.0	71%-80% knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models
Na ocenę 4.5	81%-90% knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models
Na ocenę 5.0	91%-100% knowledge about the thermodynamics of binary mixtures, Flory-Huggins theory of binary mixtures, equilibrium and local stability, thermodynamics of dilute, semi-dilute and concentrated polymer solutions, about analysis of phase diagrams of polymer solutions, random branching and gelation, thermodynamics of rubbers, unentangled and entangled rubber elasticity, unentangled and entangled polymer dynamics, Rouse and Zimm models

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	W1	N1	F1 P1
EK2		Cel 1	K1 W1	N1 N2	F1 P1
EK3		Cel 2	W2	N1 N2	F1 P1
EK4		Cel 3 Cel 5	K1 W3 W5 P1	N1 N2 N3	F2 P1
EK5		Cel 4 Cel 5	W4 W5 P1	N1 N3	F2 F3 P1

11 Wykaz literatury

Literatura podstawowa

[1] **M. Rubinstein, R.H. Colby** — *Polymer Physics*, New York, 2003, Oxford University Press

Literatura uzupełniająca

[1] **P.-G. de Gennes** — *Scaling Concepts in Polymer Physics*, Itaca and London, 1979, Cornell University Press

Literatura dodatkowa

[1] **H. Galiny** — *Fizyka materiałów polimerowych: Makrocząsteczki i ich układy*, Warszawa, 2008, Wydawnictwo Naukowo-Techniczne

12 Informacje o nauczycielach akademickich

Osoba odpowiedzialna za kartę

dr hab. prof.PK. Zoryana Usatenko (kontakt: `zusatenko@pk.edu.pl`)

Osoby prowadzące przedmiot

1 dr hab. Prof. PK Zoryana Usatenko (kontakt: `zusatenko@pk.edu.pl`)

13 Zatwierdzenie karty przedmiotu do realizacji

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

Przyjmuję do realizacji (data i podpisy osób prowadzących przedmiot)

. . . .