Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2021/2022

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 21/22
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

Projekt		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin

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

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

7 Narzędzia dydaktyczne

N1 Lectures

N2 Computer calculations

N3 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	15
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	5
Opracowanie wyników	2
Przygotowanie raportu, projektu, prezentacji, dyskusji	5
Sumaryczna liczba godzin dla przedmiotu wynikająca z całego nakładu pracy studenta	**90**
Sumaryczna liczba punktów ECTS dla przedmiotu	3.00

9 Sposoby oceny

Ocena formująca

F1 Test

F2 Projekt indywidualny

Ocena podsumowująca

P1 Średnia ważona ocen formujących: Average weight of marks

Warunki zaliczenia przedmiotu

W1 Test

W3 Projekt indywidualny

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	K_W01b K_W03 K_W06 K_W10 K_U01b K_U02 K_U03b K_U04b K_U07b K_U08b K_U10b K_U16 b K_K04	Cel 1	K1 P1 W1	N1 N2 N3	F1 F2 P1
EK2	K_W01b K_W03 K_W06 K_W10 K_U01b K_U02 K_U03b K_U04b K_U07b K_U08b K_U10b K_K04	Cel 1	K1 P1 W1	N1 N2 N3	F1 F2 P1
EK3	K_W01b K_W03 K_W06 K_W10 K_U01b K_U02 K_U03b K_U04b K_U07b K_U08b K_U10b K_U16 b K_K04	Cel 2	K1 P1 W2	N1 N2 N3	F1 F2 P1
EK4	K_W01b K_W03 K_W06 K_W10 K_U01b K_U02 K_U03b K_U04b K_U07b K_U08b K_U10b K_U16 b K_K04	Cel 3	K1 P1 W3	N1 N2 N3	F1 F2 P1

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK5	K_W01b K_W03 K_W06 K_W10 K_U01b K_U02 K_U03b K_U04b K_U07b K_U08b K_U10b K_U16 b K_K04	Cel 5	K1 P1 W5	N1 N2 N3	F1 F2 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 Zoriana Danel (kontakt: zoriana.danel@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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