Politechnika Krakowska im. Tadeusza Kościuszki

Karta przedmiotu

obowiązuje studentów rozpoczynających studia w roku akademickim 2021/2022

Wydział Inżynierii Materiałowej i Fizyki

Kierunek studiów: Nanotechnologie i Nanomateriały — Profil: Praktyczny

Forma sudiów: stacjonarne — Kod kierunku: NtiNm

Stopień studiów: I

Specjalności: Inżynieria nanostruktur

1 Informacje o przedmiocie

Nazwa przedmiotu	Nanotechnologia w nauce i przemyśle
Nazwa przedmiotu w języku angielskim	Nanotechnology in science and industry
Kod przedmiotu	WIMiF NTINM pIS D6 21/22
Kategoria przedmiotu	Przedmioty specjalnościowe
Liczba punktów ECTS	3.00
Semestry	1

2 Rodzaj zajęć, liczba godzin w planie studiów

Semestr	Wykład	Ćwiczenia	Laboratorium	Laboratorium komputerowe	Seminarium	Projekt
1	20	10	0	0	0	15

3 Cele przedmiotu

Cel 1 To provide the basic knowledge in the rapidly developing field of nanotechnology, familiarize students with the history of nanoscience and nanotechnology, characteristic size and types of nanoobjects, architecture of nanostructures in one, two, and three dimension.

Cel 2 To describe top-down and bottom-up approaches for the synthesis of nanomaterials, physical and chemical

techniques for nanoparticle (metal, magnetic, semiconductor) preparation, self-assembling of various nanostructures, nanolithography techniques.

Cel 3 Familiarize students with tools and experimental techniques for studying of nanomaterials, electron and probe microscopy, spectroscopy.

Cel 4 To discuss optical, electronic and physicochemical properties of nanoparticles and nanostructures, numerical methods of calculations of physicochemical properties of nanomaterials, transport phenomena in 2D materials.

Cel 5 To discuss variety of practical applications of the nanomaterials in chemistry, biophysics, medicine, photonics, photovoltaics, etc. Social and ethical issues in nanotechnology.

4 Wymagania wstępne w zakresie wiedzy, umiejętności i innych kompetencji

1 Basic knowledge in physics, optics, electrical engineering, chemistry.

5 Efekty kształcenia

EK1 Wiedza Student has a knowledge about history of nanoscience and nanotechnology, aware of the basic concepts in the field of nanotechnology; student is able to explain the main characteristics of nanoobjects and nanostructures architecture.

EK2 Wiedza Student has a knowledge about top-down and bottom-up approaches for the synthesis of nanomaterials, physical and chemical techniques for nanoparticle preparation, self-assembling of nanoparticles, nanolithography techniques.

EK3 Wiedza Student has a knowledge about numerical calculations of the optical, electronic and physicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.

EK4 Umiejętności Student has ability to qualitatively analyze optical spectra of metal nanoparticles, calculate optical efficiency of metal nanoparticles and color characteristic of metal nanoparticles suspensions, perform numerical calculations of physicochemical properties of nanomaterials.

EK5 Wiedza Student has a knowledge about practical applications of nanomaterials based on their unique properties: sensors, biomarkers, drug delivery and cancer therapy, photovoltaics. Student has a knowledge about social and ethical issues in nanotechnology.

6 Treści programowe

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

Ćwiczenia		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
C1	Calculations related to the subject of the lectures.	10

Wykład		
Lp	Tematyka zajęć Opis szczegółowy bloków tematycznych	Liczba godzin
W1	History of nanoscience and nanotechnology. Characteristic size of nanoobjects. Surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles. Architecture of nanostructures in one, two, and three dimension, nanocomposites. Different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.	5
W2	Synthesis of nanomaterials techniques. Top-down and bottom-up approaches in nanomaterial fabrication. Physical and chemical techniques for nanoparticle (metal, magnetic, semiconductor) preparation: laser ablation, mechanical grinding, chemical synthesis. Fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.	3
W3	Tools for studying of nanomaterials: SEM, TEM, AFM, optical microscopy, spectroscopy.	2
W4	Optical and physicochemical properties of nanoparticles and nanostructures. Numerical methods of calculations of physicochemical properties of nanomaterials and nanostructures. Localized surface plasmon resonance in metal nanoparticles. Optical efficiency of metal NP, local field enhancement. Electronic properties and transport phenomena in 2D materials.	7
W5	Practical applications of nanomaterials based on their unique properties. Sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies. Social and ethical issues in nanotechnology.	3

7 Narzędzia dydaktyczne

N1 Wykłady

N2 Ćwiczenia projektowe

N3 Prezentacje multimedialne

N5 Konsultacje

N6 Praca w grupach

8 Obciążenie pracą studenta

Forma aktywności	Średnia liczba godzin na zrealizowanie aktywności
Godziny kontaktowe z nauczycielem akademickim, w tym:	
Godziny wynikające z planu studiów	45
Konsultacje przedmiotowe	15
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	10
Opracowanie wyników	5
Przygotowanie raportu, projektu, prezentacji, dyskusji	10
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 Kolokwium

F2 Projekt indywidualny

F3 Test

Ocena podsumowująca

P1 Średnia ważona ocen formujących

Warunki zaliczenia przedmiotu

W1 Projekt indywidualny

W2 Kolokwium

W3 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 nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.
Na ocenę 3.5	61%-70% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.
Na ocenę 4.0	71%-80% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.
Na ocenę 4.5	81%-90% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.
Na ocenę 5.0	91%-100% of knowledge about history of nanoscience and nanotechnology, characteristic size of nanoobjects, surface to volume ratio for nanoparticles, enhancement of the local field around nanoparticles, architecture of nanostructures in one, two, and three dimension, nanocomposites, different types of nanomaterials: metal nanoparticles, CNT, fullerenes, quantum dots, magnetic nanoparticles.
Efekt kształcenia 2	
Na ocenę 2.0	lack of knowledge of the subject.
Na ocenę 3.0	55%-60% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.
Na ocenę 3.5	61%-70% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.
Na ocenę 4.0	71%-80% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.

Na ocenę 4.5	81%-90% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.
Na ocenę 5.0	91%-100% of knowledge about synthesis of nanomaterials techniques, top-down and bottom-up approaches in nanomaterial fabrication, physical and chemical techniques for nanoparticle preparation, fabrication of nanoparticle arrays: self-assembling technique, electron beam lithography and soft nanolithography.
Efekt kształcenia 3	
Na ocenę 2.0	lack of knowledge of the subject.
Na ocenę 3.0	55%-60% of knowledge about numerical methods of calculations of the optical, electronic and phycicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.
Na ocenę 3.5	61%-70% of knowledge about numerical methods of calculations of the optical, electronic and phycicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.
Na ocenę 4.0	71%-80% of knowledge about numerical methods of calculations of the optical, electronic and phycicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.
Na ocenę 4.5	81%-90% of knowledge about numerical methods of calculations of the optical, electronic and phycicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.
Na ocenę 5.0	91%-100% of knowledge about numerical methods of calculations of the optical, electronic and phycicochemical properties of nanomaterials and nanostructures, transport phenomena in 2D materials.
Efekt kształcenia 4	
Na ocenę 2.0	lack of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.
Na ocenę 3.0	55%-60% of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.
Na ocenę 3.5	61%-70% of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.
Na ocenę 4.0	71%-80% of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.
Na ocenę 4.5	81%-90% of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.

Na ocenę 5.0	91%-100% of ability to analyze optical spectra of metal nanoparticles, calculate of physicochemical properties of nanoparticles and color characteristic of metal nanoparticles suspensions.
Efekt kształcenia 5	
Na ocenę 2.0	lack of knowledge of the subject.
Na ocenę 3.0	55%-60% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies and ethical issues in nanotechnology.
Na ocenę 3.5	61%-70% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies and ethical issues in nanotechnology.
Na ocenę 4.0	71%-80% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies and ethical issues in nanotechnology.
Na ocenę 4.5	81%-90% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies and ethical issues in nanotechnology.
Na ocenę 5.0	91%-100% of knowledge about practical applications of nanomaterials based on their unique properties; sensors, biomarkers, drug delivery, cancer therapy, photovoltaics, display technologies and ethical issues in nanotechnology.

10 Macierz realizacji przedmiotu

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK1	K1_W01 K1_W02 K1_W04 K1_W05 K1_W09 K1_U01 K1_U02 K1_U03 K1_U04 K1_U05 K1_U06 K1_K04	Cel 1	P1 C1 W1	N1 N2 N3 N5 N6	F1 F2 F3 P1

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK2	K1_W01 K1_W02 K1_W04 K1_W05 K1_W06 K1_W09 K1_W10 K1_W11 K1_U01 K1_U02 K1_U03 K1_U04 K1_U05 K1_U06 K1_U10 K1_K04	Cel 2	P1 C1 W2	N1 N2 N3 N5 N6	F1 F2 F3 P1
EK3	K1_W01 K1_W02 K1_W04 K1_W05 K1_W06 K1_W11 K1_U01 K1_U02 K1_U03 K1_U04 K1_U05 K1_U06 K1_U07 K1_U11 K1_U15 K1_K04	Cel 3	P1 C1 W3	N1 N2 N3 N5 N6	F1 F2 F3 P1

Efekt kształcenia	Odniesienie danego efektu do szczegółowych efektów zdefiniowanych dla programu	Cele przedmiotu	Treści programowe	Narzędzia dydaktyczne	Sposoby oceny
EK4	K1_W01 K1_W02 K1_W04 K1_W05 K1_W06 K1_U01 K1_U02 K1_U03 K1_U04 K1_U05 K1_U06 K1_U07 K1_U09 K1_U11 K1_K04	Cel 4	P1 C1 W4	N1 N2 N3 N5 N6	F1 F2 F3 P1
EK5	K1_W01 K1_W02 K1_W04 K1_W05 K1_W07 K1_U01 K1_U02 K1_U03 K1_U04 K1_U05 K1_U06 K1_U13 K1_K02 K1_K04	Cel 5	P1 C1 W5	N1 N2 N3 N5 N6	F1 F2 F3 P1

11 Wykaz literatury

Literatura podstawowa

[1] Guozhong Cao — *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, London, 2004, Imperial College Press

[2] Krzysztof Kurzydłowski, Małgorzata Lewandowska — *Nanomateriały inżynierskie: konstrukcyjne i funkcjonalne*, Warszawa, 2010, Wydawnictwo Naukowe PWN

[3] Edward L. Wolf — *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, , 2006, Wiley-VCH

Literatura uzupełniająca

[1] Earl Boysen, Nancy C. Muir, Desiree Dudley, Christine Peterson — *Nanotechnology For Dummies*, , 2011, Wiley Publishing, Inc.

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)

. . . . . .