

 OSTİM TEKNİK ÜNİVERSİTESİ A N K A R A	FACULTY OF ENGINEERING COURSE SYLLABUS FORM	Doküman Kodu	MF.FR.003
		Yayın Tarihi	06.09.2024
		Revizyon No	0
		Revizyon Tarihi	0
		Gizlilik Sınıfı	Hizmet içi

NE 207 -- Nanophysics					
Course Code	Course Name			Semester	
NE 207	Nanophysics			Fall ☒ Spring ☐ Summer ☐	
Hours				Credit	ECTS
Theory	Practice	Lab		3	5
3	0	0			

Course Details	
Department	Nanotechnology Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☒ Elective ☐
Course Objectives	• To introduce the fundamental physical principles governing matter at the nanoscale. • To explain quantum phenomena and size-dependent properties relevant to nanomaterials and nanostructures. • To provide a comprehensive understanding of the electronic, optical, mechanical, and thermal behaviors of nanoscale systems. • To explore experimental and theoretical techniques used to investigate nanoscale phenomena, including scanning probe microscopy, spectroscopy, and computational modeling. • To examine applications of nanophysics in areas such as nanotechnology, nanoelectronics, nanophotonics, and quantum devices. • To develop students' ability to analyze and solve problems related to nanoscale systems and processes. • To foster critical thinking and interdisciplinary approaches in understanding the challenges and opportunities in nanoscience and nanotechnology.

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Course Content	This course introduces the fundamental physical concepts governing phenomena at the nanoscale and provides an understanding of how nanoscale systems behave differently from their bulk counterparts. The course integrates theoretical foundations with experimental techniques, highlighting applications across multiple fields of nanotechnology. Course Topics: • Introduction to Nanophysics ○ Definition and importance of nanophysics ○ Size-dependent properties of matter ○ Applications and challenges in nanotechnology • Quantum Mechanics at the Nanoscale ○ Quantum confinement and discrete energy levels ○ Quantum tunneling and quantum dots ○ Wave-particle duality and uncertainty principle in nanosystems • Electronic Properties of Nanomaterials ○ Band structure in low-dimensional systems ○ Electron transport in nanostructures ○ Coulomb blockade and single-electron devices • Optical Properties of Nanostructures ○ Light-matter interactions at the nanoscale ○ Surface plasmon resonance ○ Nanophotonics and applications in sensing and imaging • Mechanical and Thermal Properties of Nanomaterials ○ Surface effects on mechanical strength ○ Elasticity, hardness, and deformation at the nanoscale ○ Heat transfer and thermal conductivity in nanosystems • Characterization Techniques ○ Scanning Probe Microscopy (AFM, STM) ○ Electron Microscopy (SEM, TEM) ○ Spectroscopic techniques (Raman, FTIR, UV-Vis) • Nanofabrication Methods ○ Top-down and bottom-up fabrication approaches ○ Lithography, self-assembly, and chemical synthesis ○ Nanopatterning and thin film deposition • Applications of Nanophysics ○ Nanoelectronics and quantum computing ○ Nanomedicine and drug delivery ○ Energy storage and nanomaterials for renewable energy ○ Surface engineering and nanocoatings • Ethics and Societal Impacts
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	○ Safety, environmental, and ethical considerations in nanotechnology ○ Societal benefits and risks ○ Regulation and standards in nanotechnology applications
Course Method/Techniques	Lecture ☒ Question & Answer ☒ Presentation ☒ Discussion ☐
Prerequisites/Corequisites	-
Work Placement(s)	-
Textbook/References/Materials	
Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, <i>Author:</i> Edward L. Wolf <i>Publisher:</i> Wiley-VCH, 3rd Edition, 2015. Handbook of Nanoscience, Engineering, and Technology, Edited By William A. Goddard III, Donald Brenner, Sergey Edward Lyshevski, Gerald J Iafrate, CRC Press, 2018. Journal of Nanoscience and Nanotechnology <i>Publisher:</i> American Scientific Publishers <i>A leading peer-reviewed journal publishing original research articles on nanoscience, nanotechnology, and nanophysics.</i>	

Course Category				
Mathematics and Basic Sciences	☒		Education	☐
Engineering	☒		Science	☒
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☐

Weekly Schedule		
No	Topics	Materials/Notes
1	Introduction to Nanophysics: Definition, Scope, and Importance	Lecture Notes
2	Quantum Mechanics Basics for Nanoscale Systems	Lecture Notes
3	Quantum Confinement, Quantum Dots, and Tunneling Effects	Lecture Notes
4	Electronic Properties of Nanomaterials and Low-Dimensional Systems	Lecture Notes
5	Optical Properties: Plasmonics, Photonic Nanostructures, Light-Matter Interaction	Lecture Notes
6	Mechanical and Thermal Properties of Nanomaterials	Lecture Notes
7	Characterization Techniques I: Scanning Probe Microscopy (AFM, STM)	Lecture Notes
8	Middterm Exam	

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9	Characterization Techniques II: Electron Microscopy (SEM, TEM) and Spectroscopy (Raman, UV-Vis, FTIR)	Lecture Notes
10	Nanofabrication Methods: Top-Down and Bottom-Up Approaches	Lecture Notes
11	Lithography Techniques, Self-Assembly, and Chemical Synthesis	Lecture Notes
12	Applications of Nanophysics: Electronics, Energy, Medicine, Materials Science	Lecture Notes
13	Emerging Technologies: Quantum Devices, Nanorobotics, Future Trends	Lecture Notes
14	Emerging Technologies: Quantum Devices, Nanorobotics, Future Trends	Lecture Notes
15	Ethical, Safety, and Societal Aspects of Nanotechnology	Lecture Notes
16	Final Exam	

Assessment Methods and Criteria		
In-term studies	Quantity	Percentage
Attendance	14	10
Lab		0
Practice		0
Fieldwork		0
Course-specific internship		0
Quiz/Studio/Criticize		0
Homework	1	5
Presentation / Seminar	1	5
Project		
Report		0
Seminar		0
Midterm Exam	1	30
Final Exam	1	50
Total		100%
Contribution of Midterm Studies to Success Grade		50
Contribution of End of Semester Studies to Success Grade		50
Total		100%

ECTS Allocated Based on Student Workload			
Activities	Quantity	Duration (Hrs)	Total Workload
Course Hours	14	3	52
Lab	0	0	0
Practice	0	0	0
Fieldwork			
Course-specific Work Placement			

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Out-of-class study time			
Quiz/Studio/Criticize			
Homework/Attendance	1	20	20
Presentation / Seminar	1	3	3
Project			
Report			
Midterm Exam and Preparation for Midterm	1	20	20
Final Exam and Preparation for Final Exam	1	30	30
Total Workload			125
Total Workload / 25			
ECTS Credit			5

Course Learning Outcomes	
No	Outcome
L1	Understand and explain the fundamental physical principles governing phenomena at the nanoscale, including quantum effects and size-dependent behaviors.
L2	Analyze the electronic, optical, mechanical, and thermal properties of nanoscale materials and structures.
L3	Apply appropriate experimental and theoretical methods for the characterization and analysis of nanomaterials.
L4	Evaluate and compare fabrication techniques used for producing nanoscale structures and devices.
L5	Develop problem-solving skills and interdisciplinary approaches for addressing challenges in nanoscience and its technological applications.

Contribution of Course Learning Outcomes to Program Competencies/Outcomes																														
Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant																														
	PO-1		PO-2		PO-3		PO-4		PO-5			PO-6			PO-7						PO-8		PO-9		PO-10			PO-11		Total
#	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	7.1	7.2	7.3	7.4	7.5	7.6	8.1	8.2	9.1	9.2	10.1	10.2	10.3	11.1	11.2	#
L1	X	X												X	X															-
L2		X	X				X							X	X															-
L3	X	X			X									X	X															-
L4	X	X												X	X															-
L5	X		X	X	X									X	X															-
L6	X			X	X		X							X	X															-
Total=																											-			

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- i. Matematik, fen bilimleri ve ilgili mühendislik disiplinine özgü konularda yeterli bilgi birikimi; bu alanlardaki kuramsal ve uygulamalı bilgileri, karmaşık mühendislik problemlerinin çözümünde kullanabilme becerisi.
- ii. Karmaşık mühendislik problemlerini tanımlama, formüle etme ve çözme becerisi; bu amaçla uygun analiz ve modelleme yöntemlerini seçme ve uygulama becerisi.
- iii. Karmaşık bir sistemi, süreci, cihazı veya ürünü gerçekçi kısıtlar ve koşullar altında, belirli gereksinimleri karşılayacak şekilde tasarlama becerisi; bu amaçla modern tasarım yöntemlerini uygulama becerisi.
- iv. Mühendislik uygulamalarında karşılaşılan karmaşık problemlerin analizi ve çözümü için gerekli olan modern teknik ve araçları seçme ve kullanma becerisi; bilişim teknolojilerini etkin bir şekilde kullanma becerisi.
- v. Karmaşık mühendislik problemlerinin veya disipline özgü araştırma konularının incelenmesi için deney tasarlama, deney yapma, veri toplama, sonuçları analiz etme ve yorumlama becerisi.
- vi. Disiplin içi ve çok disiplinli takımlarda etkin biçimde çalışabilme becerisi; bireysel çalışma becerisi.
- vii. Sözlü ve yazılı etkin iletişim kurma becerisi; en az bir yabancı dil bilgisi; etkin rapor yazma ve yazılı raporları anlama, tasarım ve üretim raporları hazırlayabilme, etkin sunum yapabilme, açık ve anlaşılır talimat verme ve alma becerisi.
- viii. Yaşam boyu öğrenmenin gerekliliği konusunda farkındalık; bilgiye erişebilme, bilim ve teknolojiye gelişmeleri izleme ve kendini sürekli yenileme becerisi.
- ix. Etik ilkelerine uygun davranma, mesleki ve etik sorumluluk ve mühendislik uygulamalarında kullanılan standartlar hakkında bilgi.
- x. Proje yönetimi, risk yönetimi ve değişiklik yönetimi gibi, iş hayatındaki uygulamalar hakkında bilgi girişimcilik, yenilikçilik hakkında farkındalık; sürdürülebilir kalkınma hakkında bilgi.
- xi. Mühendislik uygulamalarının evrensel ve toplumsal boyutlarda sağlık, çevre ve güvenlik üzerindeki etkileri ve çağın mühendislik alanına yansıyan sorunları hakkında bilgi; mühendislik çözümlerinin hukuksal sonuçları konusunda farkındalık.