Işık University
Faculty of Arts and Sciences
Department of Physics

PHYS 454 - Solid State Physics

COURSE SYLLABUS

Course Name	Code	Semester	Theory (hour/week)	Application (hour/week)	Laboratory (hour/week)	Local Credits	ECTS
Solid State Physics	PHYS 454	Spring	**3**	0	**0**	**3**	5

Prerequisities	PHYS 333, PHYS 344

Course Language	English
Course Type	Elective
Course Level	First Cycle
Course Coordinator	-
Course Lecturer(s)	-
Course Assistants	-
Course Objectives	This is a one semester introductory course on the physics of solid state. The topics which are covered include crystal structures, lattice vibrations, electron states, energy bands, semiconductors, metals, optical and magnetic properties of solids. By the end of the course, students should • describe the structure of solid materials. • demonstrate a knowledge of the thermal and electronics properties of solid materials. • recognize the distinction between metals, insulators, and semiconductors. • develop a conceptual understanding of the magnetic properties of materials.
Course Learning Outcomes	On successful completion of this course students will be able to 1. identify the lattice and crystal structures in one, two and three dimensions. 2. interpret the phonon dispersion curves of monatomic and diatomic chains. 3. demonstrate a knowledge of how the presence of the periodic crystal potential changes the band structure of electrons in solids. 4. describe the electrons' and phonons'contributions to electrical and thermal properties of solids. 5. compare free electron and nearly free electron theories in terms of their strengths and weaknesses. 6. develop an understanding of the basic properties of semiconductors. 7. discuss the basic magnetic properties of solids.
Course Content	Crystal diffraction; crystal binding; phonons and lattice vibrations; thermal, acoustic and optical properties; free electron model; quantum theory of solids, energy bands, tight binding approximation; semiconductors; diamagnetism and paramagnetism; ferromagnetism and anti-ferromagnetism.

WEEKLY SUBJECTS AND RELATED PREPARATION STUDIES

Week	Subject
1	Crystal structure, unit cell, lattice symmetries, index system for crystal directions and planes, simple crystal structures
2	Wave diffraction, Bragg law, reciprocal lattice, diffraction conditions, Ewald construction, Brilloin zones, diffraction amplitude
3	Crystal binding: Van der Waals, ionic, covalent, metallic, and hydrogen bonds
4	Lattice vibrations: oscillations in monatomic and diatomic lattices in one-dimension, phonons
5	Lattice vibrations: oscillations in monatomic and diatomic lattices in one-dimension, phonons
6	Thermal properties of solids: phonon contribution to heat capacity, density of states (Deby and Einstein models)
7	Thermal properties of solids: thermal expansion, thermal conductivity of phonons, Umklapp process
8	Review
9	Electronic properties of solids: free electron model, energy levels and density of states, electronic contribution to heat capacity
10	Electronic properties of solids: electrical conductivity and ohms law, motion in a magnetic field, Hall effect, thermal conductivity of metals
11	Energy bands: nearly free electron model, Bloch theorem, energy bands, metals and insulators
12	Fermi Surfaces and metals: Tight binding approximation
13	Semiconductors: band structure, valance and conduction bands, donor and acceptor impurity states, electrical conductivity (mobility), excitons
14	Magnetic properties of materials: diamagnetism, paramagnetism
15	Magnetic properties of materials: ferromagnetism, antiferromagnetism and ferrimagnetism

TEXTBOOKS

Required Textbook(s)	Charles Kittel, *Introduction to Solid State Physics*, 8^{th} *Edition*, John Wiley & Sons, 2005.
Recommended Readings	Neil W. Ashcroft and N. David. Mermin, *Solid State Physics,* Saunders College Publishing, 1976.

EVALUATION SYSTEM

Semester Requirements	**Number**	**Percentage of Grade**
Attendance/Participation	-	-
Laboratory	-	-
Application	-	-
Field Work	-	-
Special Course Internship (Work Placement)	-	-
Quizzes/Studio Critics	3	8
Homework Assignments	10	14
Presentation/Jury	-	-
Project	-	-
Seminar/Workshop	-	-
Midterms/Oral Exams	2	52
Final/Oral Exam	1	26
Total	16	100

Percentage of Semester Work	15	74
Percentage of Final Work	1	26
Total	16	100

COURSE CATEGORY

ISCED GENERAL FIELD CODE	GENERAL FIELDS	ISCED MAIN AREA CODE	MAIN EDUCATIONAL AREAS	%
1	Eğitim	14	Öğretmen Yetiştirme ve Eğitim Bilimleri	0
2	Beşeri Bilimler ve Sanat	21	Sanat	0
2	Beşeri Bilimler ve Sanat	22	Beşeri Bilimler	0
3	Sosyal Bilimler, İşletme ve Hukuk	31	Sosyal ve Davranış Bilimleri	0
3	Sosyal Bilimler, İşletme ve Hukuk	32	Gazetecilik ve Enformasyon	0
3	Sosyal Bilimler, İşletme ve Hukuk	38	Hukuk	0
4	Bilim	42	Yaşam Bilimleri	0
4	**Bilim**	**44**	**Doğa Bilimleri**	**80**
4	**Bilim**	**46**	**Matematik ve İstatistik**	**15**
4	Bilim	48	Bilgisayar	0
5	**Mühendislik, Üretim ve İnşaat**	**52**	**Mühendislik**	**5**
5	Mühendislik, Üretim ve İnşaat	54	Üretim ve İşleme	0
5	Mühendislik, Üretim ve İnşaat	58	Mimarlık ve Yapı	0
6	Tarım	62	Tarım, Ormancılık, Hayvancılık ve Su Ürünleri	0
6	Tarım	64	Veterinerlik	0
7	Sağlık ve Refah	72	Sağlık	0
7	Sağlık ve Refah	76	Sosyal Hizmetler	0
8	Hizmet	81	Kişisel Hizmetler	0
8	Hizmet	84	Ulaştırma Hizmetleri	0
8	Hizmet	85	Çevre Koruma	0
8	Hizmet	86	Güvenlik Hizmetleri	0

THE RELATIONSHIP BETWEEN COURSE LEARNING OUTCOMES AND PROGRAM OUTCOMES

Number	Program Outcomes	Level of Contribution*				
		1	2	3	4	5
1	To have a comprehension of the core areas of physics, including classical and quantum mechanics, electromagnetism, statistical and thermal physics.					X
2	To have a comprehension of basic mathematics, including differential and integral calculus, linear algebra, differential equations and complex analysis.					X
3	To have a comprehension of computer programming and chemistry.					
4	To have a comprehension of the importance and practice of good ethical standards.					
5	To have a recognition of contemporary issues in science and its applications.					X
6	To have an ability to construct theoretical models, solve problems, design and conduct experiments, as well as to analyze and interpret data.					X
7	To have an ability to demonstrate their understanding of at least one advanced topic in theoretical or experimental physics.					X
8	To have an ability to function on multi-disciplinary teams					
9	To have an ability to effectively communicate information in both written and verbal form		X			
10	To have a recognition of the need for and an ability to engage in life-long learning.				X	
11	To have an ability to use modern physics techniques, skills, and computing tools necessary for physics practice (use laboratory and workshop equipment to generate data, prepare technical drawings, prepare technical reports, give technical presentations, take notes effectively, write computer programs, use mathematics and/or computational tools and packages to make models) .					X

*1 Lowest, 2 Low, 3 Average, 4 High, 5 Highest

Contribution of Course Learning Outcomes to Program Outcomes	The class contributes to the student development in terms of developing methods to comprehend crystal structures, electrical and thermal properties, band structure, optical and magnetic properties of solids. Students should develop problem solving abilities and enhance critical thinking and improve their written communication skills.

ECTS / WORKLOAD TABLE

Activities	**Number**	**Duration (Hour)**	**Workload (Hour)**
Course Hours (Including Exam Week: 16 x Total Hours)	15	3	45
Laboratory	-	-	-
Application	-	-	-
Special Course Internship (Work Placement)	-	-	-
Field Work	-	-	-
Study Hours Out of Class	15	2	30
Presentations / Seminar	-	-	-
Project	-	-	-
Homework Assignments	10	2	20
Quizzes	3	1	3
Midterms / Oral Exams	2	9	18
Final / Oral Exam	1	9	9
		Total Workload	**125**
		Total Workload/25	**5**