KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

DEPARTMENT OF PHYSICS

INTRODUCTION TO SOLID STATE PHYSICS
PHYS 432 – TERM 222

INSTRUCTOR: **Dr. Khan Alam**

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COURSE OBJECTIVE:

- Teach all the basics of crystalline structure, Miller indices, crystal directions, form factor.
- Teach students how to apply the results of X-ray diffraction techniques to distinguish between basic structures, using selection rules.
- Enable students to master the basics of chemical bonding, mechanical, structural, electronic, and magnetic properties.

TOPICS COVERED:

Crystal structures; Crystal diffraction and reciprocal lattice; Crystal bonding; Lattice vibrations; Thermal properties of insulators, Free electron theory of metals; Band theory; Semiconductors; Ferromagnetism and Antiferromagnetism; Computer software for crystal structures, x-ray diffraction, and Miller indices

COURSE LEARNING OUTCOMES:

CLO1. Recognize the crystals, amorphous, and crystal structures.
CLO2. Recognize the fundamentals of x-ray diffraction.
CLO3. Recognize the lattice vibration, electrical, magnetic, acoustic and optical properties of solids.
CLO4. Apply classical theories of solids on selected applications.
CLO5. Apply quantum mechanical theories of solids on selected applications.
CLO6. Be an effective and self-learner

LEARNING RESOURCES:
TEXTBOOK:
Charles Kittle, "Introduction to Solid State Physics", 8th Ed. Wiley, 2005

ADDITIONAL REFERENCES:
1. M. Ali Omar, "Elementry Solid State Physics" 4th Ed. Addison-Wesly

2. N. W. Ashcroft and N. D. Mermin, "Solid State Physics" Thomson Learning Inc. 1976
3. M. A. Wahab, "Solid State Physics: Structure and Properties of Materials" Alpha Science Int'l Ltd., 2005

PRE-REQUISITE:
PHYS 310: Quantum Mechanics and Applications I

GRADING POLICY:

ASSESSMENT:

Homework		20%
Quizzes		10%
Midterm Exam	Chapters 1-5	30%
Final Exam	Comprehensive	40%

ATTENDANCE:
A DN grade will be reported for more than 9 unexcused absences.

HOMEWORK:
Homework will be assigned on important topics, and students are encouraged to solve all problems.

QUIZZES:
All Quizzes are important.
There will be no make up for the quizzes without an official excuse.

MAKE-UP EXAM:
Make-up exams will be given only for students who have officially documented excuse.

OFFICE HOURS:

Sunday   2:00 PM – 3:00 PM

Wednesday   10:00 AM – 11:00 AM & 1:00 PM – 2:00 PM

Thursday 2:00 PM – 3:00 PM

Week	Lect.	Date	Topics	Chapter
1	1	15 Jan	Lattices, basis, primitive cells, symmetry operation, two- and three-dimensional lattice types, crystallographic directions, Miller indices, densely packed structures, packing factor, simple crystal structures, polytypism	1
1	2	17		
1	3	19		
2	4	22		
2	5	24		
3	6	26	Bragg's law, reciprocal lattice, diffraction conditions, Brillouin zone, Fourier analysis of the basis, structure factor, atomic form factor	2
3	7	29		
3	8	31		
3	9	02 Feb		
4	10	05	Crystals of inert gases, Van der Waals-London interaction, ionic crystals, covalent crystals, metallic bond, hydrogen bond, atomic & ionic radii, analysis of elastic strains, elastic waves in cubic crystals	3
4	11	07		
4	12	09		
5	13	12		
5	14	14		
5	15	16		
6	16	19	Crystal vibrations: monatomic and diatomic basis, quantization of elastic waves, phonons momentum, inelastic scattering by phonons	4
6	17	21		
6		**23**	**Feb 23: Saudi Founding Day Holiday**	
7	18	26		
7	19	28		
8	20	02 Mar	Planck distribution, normal mode enumeration, Density of states in one and three dimensions, Debye model, general density of states, Einstein model of the density of states, anharmonic interactions, thermal conductivity, Normal and Umklapp processes.	5
8	21	05		
8	22	07		
8	23	09		
9	24	12		
9			**Mar 20 Midterm Exam**	
10	25	14	Quantum statistics, free electron gas in one and three dimensions, heat capacity of the free electron gas, electrical conductivity and Ohm's law, motion in a magnetic field, Hall effect, thermal conductivity of metals	6
10	26	16		
10	27	19		
10	28	21		
10	29	23		
11	30	26	Band theory, one dimensional potential well, Kronig-Penney model, wave equation of electron in a periodic potential, Solution of the central equation, Empty lattice approximation, Approximate solution near a zone boundary, number of orbitals in a band, Metals and insulators,	7
11	31	28		
11	32	30		
12	33	02 Apr		
12	34	04		
12	35	06		
13	36	09	Semiconductors – Overview (band gap, electrical conduction, holes), Effective mass, Intrinsic and extrinsic semiconductors,	8
13	37	11		
13	38	13		
			April 14 - 27 Eid Al-Fitr Holidays	
14	39	30	Charge carrier concentration, conductivity, Donor and acceptor states, Thermoelectric effects.	
14	40	02 May		
15	41	04	Ferromagnetic, Ferrimagnetic, and antiferromagnetic orders, Quantization of Spin Waves, Thermal Excitation of Magnons, Ferromagnetic Domains, Anisotropy Energy, Transition Region between Domains, Origin of Domains, Coercivity and Hysteresis	12
15	42	07		
15	43	09		
15	44	11		
	45	15	**Normal Thursday classes-Last day of classes**	
			Final Exam: TBA	